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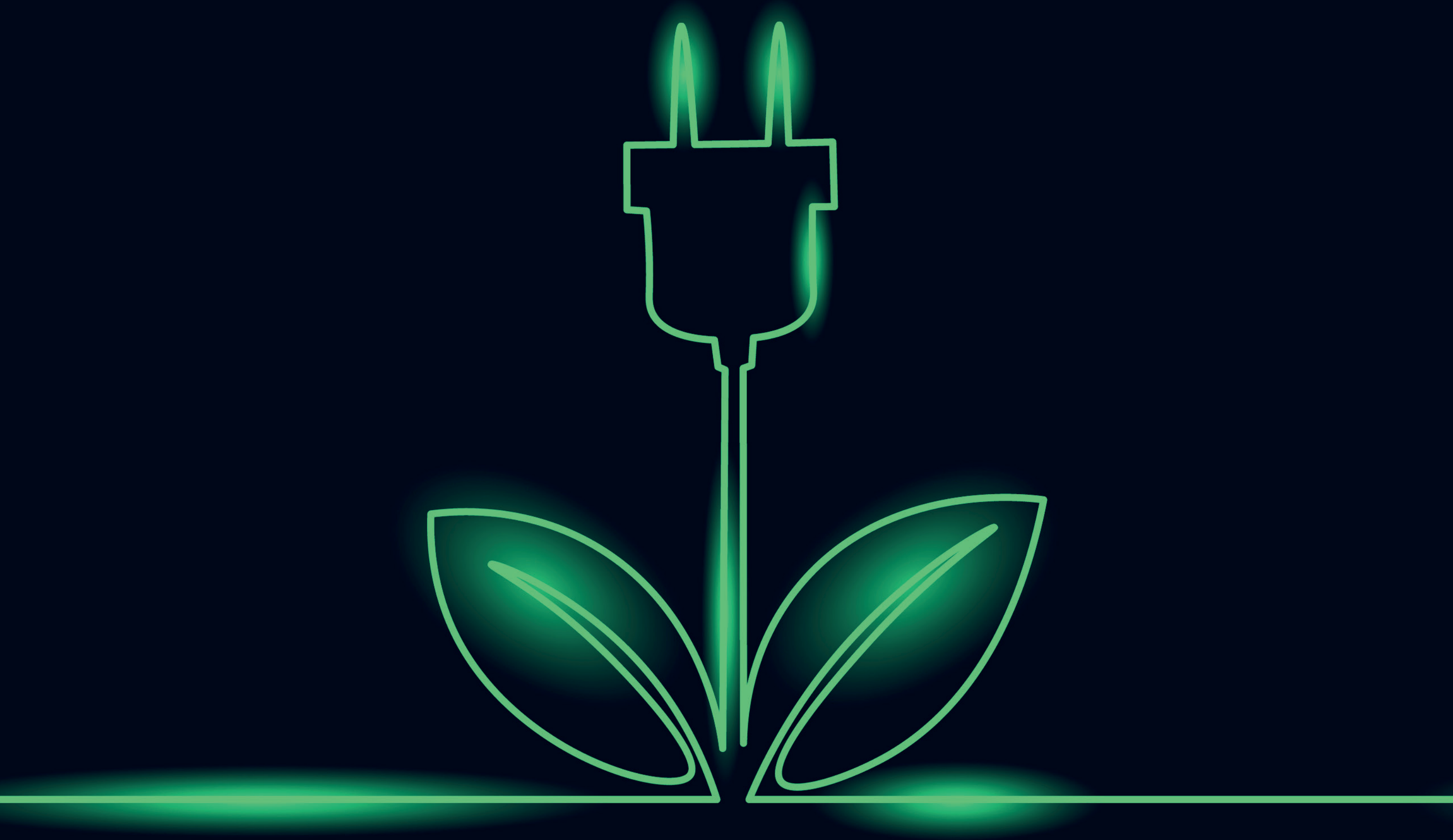

ENERGY STORAGE

SAIEE THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS | JANUARY 2022

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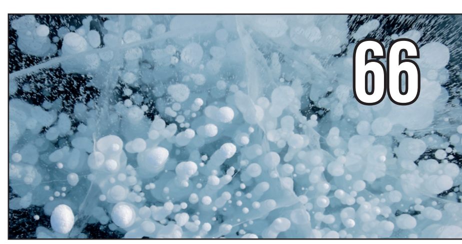

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SAIEE

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Dear Valued **watt**now Reader

I trust all my readers enjoyed a fabulous and restful festive season. The SAIEE Head Office is open for business, and we are all bright-eyed and bushy-tailed - ready to start this year with a bang!

This first issue for 2022 of **watt**now features Energy Storage. Energy storage is the capture of energy produced at one time for use later to reduce imbalances between energy demand and energy production. A device that stores energy is generally called an accumulator or battery.

After my research in bringing you up-to-date feature articles, I have concluded that Battery Energy Storage (BES) is the new buzzword. In our first feature article, on page 24, "Energy Transition - a new path to power in Africa", we take a look at how traditional companies with hybrid business models can make the best of both traditional utilities and renewable energy.

The growth of energy storage shows no sign of abating—quite the opposite. In November 2017, Bloomberg New Energy Finance predicted the global energy storage market would double no fewer than six times between 2016 and 2030, rising to a total of 125 GW and 305 GWh of installed capacity. Read this article on page 40.

And of course, as per my annual futuristic lookout, what will this issue be without looking at the Global Energy trends for 2022. Find it on page 48.

The February 2022 issue features Mining, and the deadline for article submission is 17 January 2022. Please email your articles/ white papers to minx@saiee.org.za.

Herewith your January issue, enjoy the read!

Minx

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INDUSTRY AFFAIRS

Sungrow supplying 430MWh BESS to Israel solar-plus-storage developer Enlight

Sungrow battery storage at a solar PV plant in northern Japan

The energy storage division of solar PV inverter manufacturer Sungrow has signed a 430MWh battery energy storage system (BESS) contract with Israel's Enlight Renewable Energy.

China-headquartered Sungrow said on Sunday (2 January) that it will supply four-hour duration liquid-cooled BESS for the developer and independent power producer (IPP) Enlight's solar energy project at an undisclosed location in Israel.

Claimed by the pair to be the country's largest energy storage system (ESS) agreement so far, the equipment will be installed in two phases: the first of 230MWh, which is already contracted for, and the second 200MWh is "locked".

Enlight Renewable Energy CEO Gilad Yavetz noted that the BESS will utilise Chinese manufacturer CATL's lithium iron phosphate (LFP) battery cells integrated into Sungrow's newest ESS solution technology.

In November 2020, it was reported that Israel's national Electricity Authority, PUA, had modelled that the country expected to require around 2GW / 8GWh of energy storage by 2030 to accommodate a targeted 30% share of renewable energy in its electricity mix — equating to about 12GW of solar PV.

PUA held a tender for solar-plus-storage projects, which closed in late December.

The auction was the second of its kind in Israel and led to the award of 609MW of solar PV alongside 2.4GWh of energy storage, while in the previous round, PUA had awarded 168MW of solar and 672MWh of storage.

Clean Horizon CEO Michael Salomon said that the two auctions had put Israel firmly onto the global energy storage map. The country could reach 8GWh of cumulative capacity well before the end of the decade.

Enlight was among the companies to win in the PUA tender process. Sungrow said it will supply the developer and IPP with pre-assembled BESS equipment which can be easily installed and includes features that slow the process of capacity loss through cell degradation. The company said it will include DC-to-DC conversion systems and come with up-to-date safety features.

Sungrow Israel country manager Tzvi Ben David said customer Enlight carried out a "stringent selection process," including visits to Sungrow ESS sites and its manufacturing facility. At the same time, the equipment supplier was able to meet Enlight's "strict technical specifications".

In July, US BESS manufacturer Powin Energy announced the completed installation of a 1MW / 3.2MWh BESS at Israel's first utility-scale microgrid project. Meanwhile, last month Israeli developer Nofar Energy formed a joint venture (JV) with investment group Interland to pursue BESS opportunities in the UK, starting with a potential 700MWh project which would cost about US$280 million and earn estimated annual revenues of more than US$56 million. wn

Peak Wind acquires stake in energy storage player

Lars Nagstrup Conradsen - co-founder of Peak Wind

Renewables asset manager Peak Wind has acquired a minority stake in energy storage start-up Hybrid Greentech.

Peak Wind has made a strategic equity investment in the battery start-up, following a partnership formed in 2021.

Peak Wind also has the option to increase its stake to 27.5%, subject to the fulfilment of particular objectives. "With this investment, we will be able to provide energy management services and solutions. The entire power system needs to cater for more renewable electricity and consequently more intermittency," said Lars Nagstrup Conradsen (pictured), co-founder of Peak Wind.

Hybrid Greentech was founded in 2018 by Rasmus Rode Mosbaek, who has assembled a group of researchers from DTU specialising in energy storage management and virtual power plant technology.

Since its inception, Hybrid Greentech has developed a proprietary software system, HERA, which enables the company to intelligently size and manage battery solutions to leverage the full revenue potential and optimise the lifetime cost of energy storage.

Hybrid Greentech offers advisory services and technical evaluation of solutions for battery energy storage, including degradation analysis for sizing of battery energy storage solutions.

It also provides virtual power plant software for aggregating energy storage and power-to-x systems.

Customer segments include shipping, aviation, large scale charge point infrastructure, large energy users and generators. wn

Fluke's Simplified Safety Compliance Testing

The Fluke® PRV240 Proving Unit provides a safe and convenient method for "test before touch" TBT verification of electrical test tools without placing the electrician or technician in potentially hazardous electrical environments, which would generally involve using known live voltage sources.

In contrast to using a known live source, using the PRV240 does not require personal protective equipment (PPE) for tester verification. Use of the PRV240 reduces the risk of shock and arc flash compared to verification of test instruments on high-energy sources in potentially hazardous electrical environments because the PRV240 provides a known voltage in a controlled, low-current state in accordance with safe work practices.

The pocket-sized PRV240 sources 240 V of both ac and dc steady-state voltage for testing of both high- and low-impedance multimeters, clamp meters, and two-pole testers, eliminating both the need for multiple verification tools and the use of a known high-energy voltage source for test instrument verification. For more info, contact [COMTEST](). wn

INDUSTRY AFFAIRS

Tech company receives internationally accredited certification

The Vox team proudly accepts the BSI stamp of approval for high-quality products and services as well as information security with its ISO 9001 and ISO/ISE 27001 certifications.

End-to-end integrated ICT infrastructure and telecommunications company Vox has recently implemented and received ISO 9001 certification as a way of improving its internal management systems to be more profitable, efficient and productive.

As a result of the implementation and certification to ISO 9001, Vox significantly improved its internal management systems. Profitability, efficiency and productivity all improved as a result of certification. They have increased client satisfaction with exceptional response, which has caused a reduction in client churn and an increase in the client acquisitions rate.

Vox provides a wide range of products including data and voice, as well as cloud, business collaboration and conferencing tools that promote intelligent solutions that connect South Africans to the world. The company supports entrepreneurs, customers and commerce, whilst practicing values of integrity, choice and service excellence in all of its dealings. wn

Differential Transmitter Performs under Pressure

INSTROTECH offers Kobold differential pressure transmitter models PAD & PAS. These microprocessor-based, high-performance transmitters have flexible pressure calibration and output, with automatic compensation of ambient temperature and process variable configurations of multiple parameters and HART® protocol communication. Applications are varied and include media like steam, gases, liquids and other critical media. Pressure, flow and level measurement are done by the application. The input of all data for sensors is added, modified and stored in EEPROM.

As an option, the Kobold PAD-F is also available as a flow meter with a totalizing function in the PAD transmitter, and so it can check the flow rate and totalizing flow. Flow rate is measured by using differential pressure without compensation of temperature and static pressure. The body of PAD-F is the same as the standard device, except for the terminal block which has two more pulse out-put terminals. wn

For more info, contact INSTROTECH.

KOBOLD PAD & PAS differential pressure transmitters

Hitachi Energy partners with National Grid on world's first replacement of SF6 in existing high-voltage equipment

The innovation called EconiQ™ retrofill uses an eco-efficient gas mixture to support National Grid in achieving its sustainability targets.

Hitachi Energy and National Grid have successfully energised a pilot project replacing SF6 in installed high-voltage gas-insulated lines with an eco-efficient fluoronitrile based gas mixture. This retrofill solution in Richborough, UK, is part of Hitachi Energy's EconiQTM portfolio designed to deliver superior environmental performance than conventional solutions.

As one of the world's most significant investor-owned transmission and distribution utilities, National Grid aims to remove all SF6 from its fleet by 2050. In this pioneering project, National Grid has replaced SF6 from 420-kilovolt (kV) gas-insulated lines installed in 2016, eliminating 755 kilograms of SF6. This is equivalent to taking approximately 100 passenger cars1 off the road.

For decades, SF6 has been used in the electrical industry due to its excellent insulation and current interruption properties. However, it has a high Global Warming Potential (GWP) and requires careful handling. Hitachi Energy is continuously reducing the use of SF6, improving its lifecycle management, and accelerating the development of eco-efficient products.

"We have a responsibility to help our customers like National Grid accelerate the energy transition," said Markus Heimbach, Managing Director of High Voltage Products business in Hitachi Energy.

"Innovative EconiQ retrofill technology for installed gas-insulated lines along with the new EconiQ switchgear and breakers portfolio will enable our customers and the industry as a whole to reduce carbon footprint and rapidly transition to eco-efficient solutions."

"Climate change is the greatest challenge of our time, and this new transformational green technology will help achieve wide-scale decarbonisation on our electricity transmission network. The retrofill solution replaces SF6, cutting emissions and network outages at the same time as saving costs by avoiding the need to spend on costly replacement equipment", said Chris Bennett, Acting President of National Grid.

"We are proud to be working with Hitachi Energy and to demonstrate a practical solution to a significant issue in the energy industry's transition to net zero."

Hitachi Energy has placed sustainability at the heart of its purpose and is advancing a sustainable energy future for all. EconiQ is Hitachi Energy's eco-efficient portfolio for sustainability, where products, services and solutions are proven to deliver exceptional environmental performance. Recently, the company announced the acceleration of its development of eco-efficient solutions, outlining its extensive EconiQ roadmap of switchgear and breakers in various voltage levels. wn

Johnson Controls is proud to announce the Graduation Class and Second Intake of Learners for its nationwide HVAC learnership initiative

JC Graduation Class and Second Intake of Learners.

Johnson Controls International (JCI), a Multinational Building Technology company that designs, manufactures, and installs heating, ventilation, and air conditioning (HVAC) systems, including Smart Building technology, has announced the Graduation Class of 2021. This successful milestone is followed by the start of its second annual local Learnership initiative, designed to address the shortage of skills in the local HVAC market.

The programme was launched last year to develop human capacity and empowerment through the development of technical skills in South Africa. Last year, Johnson Controls successfully enrolled a total of 25 learners in the inaugural programme and had hailed the initiative as a resounding success.

The Learnership provides young people from underprivileged communities from all walks of life an opportunity to gain HVAC skills, increasing the skills pool and promoting diversity within the industry. The program focuses on skills development that enables learners to build a foundation to pursue careers in the HVAC industry. The initiative is driven by Mr Archie Makatini (Regional General Manager) for the Sub-Saharan Africa region, in partnership with Mrs Lynn Millin (his HR partner).

Mr Makatini & Mrs Millin both proudly noted that last year's learnership yielded a 100% pass rate, with four candidates being subsequently placed in permanent positions at Johnson Controls throughout the country. The remainder is receiving additional training as part of a robust job rotation scheme.

Mrs Lynn Millin notably asserts that this year the JCI is onboarding a further 23 skilled learners from previously disadvantaged and diverse backgrounds who have had no previous work experience or opportunities for advanced studies. Some of them are technical college graduates, while managers within the Johnson Controls group have referred to some. The majority of these learners will complete apprenticeships with the Air Conditioning and Refrigeration Academy (ACRA), in Kempton Park, as part of the curriculum.

JCI is at the forefront and strongly believes in effective mentorship programs that foster connecting people, increase knowledge and build skills for future personal goals and milestones. It comprises a theoretical and practical component where each learner is assigned a coach and mentor for the duration of the training. In the last month of the learnership programme, the learners receive certification. "Additionally, the learnership has been redesigned this year to include a wider spectrum of skills, with a greater focus on Technical Sales. This is not only in line with supporting the business and its needs, but it's instrumental as well in providing Sales Acumen growth opportunities for the learners," says Mr Makatini. "We wanted to align the curriculum with skills requirements of the company, as the learners will be brought into the business to ensure that we have an adequate talent pool to draw from. Essentially, it's a win-win situation," he concluded. wn

Devan Pillay is Schneider Electric's new Cluster President for Anglophone Africa

Devan Pillay has been appointed Cluster President, Anglophone Africa for Schneider Electric, taking over from Albert Fuchet, after rejoining the company last year as Vice President for Buildings.

Formerly the president of Signify Africa, Pillay comes with a wealth of experience, including senior positions at Eskom, GE (General Electric), 3M and Schneider Electric from 1998 to 2003.

"Under the leadership of Pillay, Schneider Electric's Anglophone Africa business will undoubtedly continue to flourish, building on the firm foundation set by Fuchet, which has led the company to profitable and sustainable growth during his successful tenure", comments Caspar Hertzberg. President, Middle East and Africa at Schneider Electric.

"On behalf of Schneider Electric, I would like to extend my sincere and deep gratitude to Albert for his transformational and firm leadership. Devan is a strong business leader that is no stranger to Schneider Electric and will build on the positive impact that Albert has had on the company,"

"I look forward to the exciting challenges my new role as Cluster President will bring. Anglophone Africa offers many opportunities, and the region's business is firm footing. We have solidified our segment approach to South Africa and strengthened our business in East and West Africa," adds Pillay.

"I feel fortunate to continue this next chapter in my career at Schneider Electric which is now the market leader in many of the region's segments," he concludes. wn

Cummins offers a range of solutions for load shedding and backup power

Cummins' technology is particularly suited for load shedding due to features such as total load acceptance for critical equipment. A full range of alternative power solutions is available from mines to factories and even the small business and residential sector. "Our key differentiator is that we can supply a small 17 kVA genset for residential or commercial use, all the way to a 3 750 kVA unit for mining, data centre and hospital applications, for example," comments Warrick Gibbens, Power Generation Leader, Cummins Southern Africa.

Cummins' energy-efficient engines comply with international emission standards and have a high fuel tolerance level, making them ideal for arduous African operating conditions. In terms of automatic start-up, Cummins gensets have one of the best response times on the market.

In addition, Cummins can also supply one-stop solutions for multiple backup power requirements for largescale clients such as mining operations or factories. It not only provides the gensets themselves but for all ancillary components, from air and oil filters and even coolant.

"Our value proposition is to offer the highest quality products and also ensure that they are serviced and maintained properly," says Gibbens.

Cummins has a fully-fledged training facility where its technicians and clients can receive customised training on any engine platform. This training is fully accredited, with certificates presented to all successful candidates. wn

The Gentleman Engineer

- you have left a void...

Max Percival Preston Clarke was born on 15 February 1926 in Butterworth, in Transkei, where he spent his formative and schooling years. He proceeded to study Electrical Engineering at the University of the Witwatersrand. He graduated in 1947 with a BSc (Electrical Engineering) degree.

By | Jane Buisson-Street & Paul van Niekerk

In September 1946, Max joined the South African Institute of Electrical Engineers (SAIEE) as a Student Member. After his graduation, Max completed his pupillage with ESC in the East London area and then took up the position of Junior Engineering Assistant in King William's Town. In January 1951, Max was appointed as a Graduate Apprentice with British Thomson-Houston, Rugby, UK.

While in the UK (1951 to 1953), he not only succeeded in acquiring the required experience to register as a Professional Engineer, he also met a young Australian nurse, Eileen, who soon became his wife.

Max was later appointed as the Town Electrical Engineer in Somerset East, Eastern Cape, in 1954, where he ran the electricity department, which included a coal-fired power station for sixteen years. During this time, he obtained a government Certificate of Competency required for being in charge of machinery. Their three beautiful daughters were born there.

They lived in Somerset East until 1970, whereafter they moved to Newcastle in Natal in 1970, where Max took on the challenge of reconstructing the electrical infrastructure of the little town that was to become a boomtown due to the giant steelworks, Iscor, opening a second plant there. Newcastle, a sleepy village with a maximum demand of 4 MW with about 500 domestic consumers, was to suddenly expand to accommodate thousands of workers, management staff and, of course, the related supply industries multiplied as well. As always, Max

MAX CLARKE
1926 - 2021

was up for the challenge, and no engineering problem was ever too big for him. He rose to the occasion by designing a 132kV power system supplied from the 400kV Eskom supply and designing and overseeing the building of the Electricity Department's building, which was kitted out with state-of-the-art laboratories and control room and appointed staff accordingly.

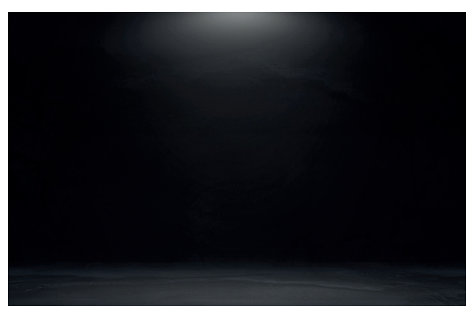
Max had an extensive skill set and was passionate and highly knowledgeable about all things to do with Electrical Engineering, particularly Municipal Electrical Engineering, and ran very successful projects. Ultimately he left Newcastle and moved on to yet another rapidly growing town.

On the outskirts of Johannesburg, Randburg Municipality was predominantly a rural town with agricultural smallholdings and electrical distribution by Eskom. There were plans to establish Randburg as another economic hub along with upmarket modern housing and large commercial undertakings. Max, as always, was up for the challenge. Once again, with his boundless and irrepressible energy, he proceeded to build an Electricity Department from the ground up, both literally and figuratively, managing the design and construction of buildings and infrastructure and appointing staff. Max eventually retired from Randburg Municipality in 1990.

This did not stop Max; he continued to work for the AMEU, editing and producing their newsletter; his last issue will be published in January 2022. Max was also an extremely active SAIEE member who was instrumental in motivating for the conversion of SAIEE House, the renovation of Innes House for establishing the SAIEE museum.

Max was the Chairman of SAIEE's Historic interest group; he led by example with knowledge, passion, energy and knowledge. In 2013, he was awarded the Engineer of the Year in recognition of his contribution to establishing SAIEE's museum and library.

Max, you have done your duty; may you and Eileen rest in peace. wn



Why ERP is the sector-specific boost to the economy

An enterprise resource planning (ERP) system is rarely the first thing that springs to mind when considering boosting sector growth and the economy. Yet, that's precisely what the right ERP system can do. Over the past few years, ERP platforms have evolved to become increasingly customisable and relevant to specific sectors – providing the tools and strategic capabilities that niche organisations and industries need to function effectively.

In the consumer packaged goods industry (CPG), McKinsey believes that while ERP systems remain the organisation's backbone, the sector will see the actual value by leveraging the exemplary architecture and customised processes. The company also believes that ERP is fundamental in transforming general and administrative structures within smaller organisations, being a key to unlocking the treasure chests of bottom-line savings and long-term efficiency. It's also a powerful tool that can be combined with other architectures and solutions to transform competencies within eCommerce.

"The business should always see ERP as a foundational system, one that sits at the core of the organisation," says Stephen Howe, co-founder and director at Times 3 Technologies, a local IT company that helps people and businesses using intuitive cloud software through Sage. "With a stable and agile core, companies can deftly manage financial, distribution and manufacturing requirements, and gain the added benefits of visibility and insights that can be used to improve decision making."

Many companies face the challenge that their unique vertical has unique complexities that are rarely addressed in a standard ERP platform. They have cobble architecture until it almost delivers what they need. This has been a common problem that has negatively impacted companies within specialised sectors, changing the dynamic of the ERP conversation from one about technology to one about business functionality.

"ERP systems need to fit the enterprise properly, as that's the only way the business can benefit from the insights and value from their ERP investment," says Howe. "This will then allow for the enterprise to leverage this investment to achieve measurable results and drive innovation and growth."

ERP can be used to standardise processes across all companies and operations, putting all information within one centralised database and providing access to this information from a central dataset. This allows the business to accurately measure their key performance indicators (KPIs) against strategy and use them to inform decision making. The right ERP system can also improve process efficiency and increase productivity as it's been customised to fit the business.

"An ERP solution with inbuilt business intelligence capabilities provides decision-makers with data that can be sliced and diced to deliver insights throughout the business," says Howe. "It should also be flexible enough to address specific areas of the business that may not be part of the standard functionality. Again, a customisable solution allows for the business to continually evolve and optimise, so that process efficiency and productivity are always on the increase."

As IDC points out, the right ERP system is proven to enhance business value. It's a digital foundation that needs to evolve and adapt to changing markets and unique business requirements. It creates a digital core that's invaluable in this information age where digital strategy defines enterprise success.

The future is proven to belong to those companies that centre digital in their conversations, strategies and planning. This planning needs to ensure that investment is into the right technologies, those that can be customised to suit specialised business requirements to cement success into the organisation's very fabric.

Times 3 Technologies, a Sage Platinum Partner, would agree to be the market leader in providing companies with one of the most robust performing, fully cloud-connected solutions on the market. wn

Trends to watch in energy storage in 2022

There's much to celebrate in energy storage as we ring in the New Year, and we're pleased to see that 2022 is expected to bring continued growth at an even faster pace. According to BloombergNEF reporting released in November 2021, by the end of 2030, the energy storage industry will have installed a total of 358 gigawatts (GW) /1,028 gigawatt-hours (GWh), breaking the one terawatt (TW) threshold. According to experts, this boom will attract more than $262 billion to the market. I have a few thoughts on the trends we'll see unfold as a result.

By | Andrew Tang, Vice President ES & O

All data suggest that continued advancements in materials and manufacturing are driving battery storage costs down for the next several years, making it increasingly cost-competitive with incumbent storage technologies. That will especially be the case in the US with the approval of vital federal funds for national energy infrastructure from President Biden's Infrastructure Investment and Jobs Act. We're particularly encouraged to see investments into transmission infrastructure prioritised, which will provide much-needed capacity on the grid for more renewable generation, necessitating additional energy storage capacity.

That said, there's plenty of room for regulatory improvements. Market growth will look especially promising in 2022 in the US if Congress passes the Build Back Better Framework, which includes an investment tax credit for standalone energy storage. At the state level, we expect to see more storage systems required for frequency regulation as more renewables are deployed, and we hope to see changes to the regulatory framework that reflects the duration limitation in the context of a portfolio so that asset owners can earn capacity credits or resource adequacy payments for grid services.

As demand for renewables continues, we'll also see long-duration storage become more critical. We're preparing for the average duration of systems to increase over 2 hours this year on the backs of these 4-hour systems. This advancement is already taking place in American markets, and we expect to see global markets match this trend in 2022. Over the last year, we've deployed more than 16 projects using multi-hour systems in Australia, the Philippines, Taiwan, the US and the UK. We will increasingly see 4-hour systems paired with renewables in the US, and we're planning to develop multiple 2-hour systems in Australia. In the meantime, we're seeing that gas plants remain the best solution for on-demand backup and peaking power for longer durations. We're working hard to make gas plants more sustainable by incorporating green hydrogen and "future fuels" instead of natural gas while long-duration battery storage technologies catch up.

Alongside explosive growth, we expect to see some growing pains. Across the

globe and industries, labour shortages threaten continued growth. This is especially true in the energy storage industry, where the skillset is in short supply and often requires advanced technical training. Some are providing training and workforce development programs to fossil fuel-based energy industry workers. Still, in general, the industry is facing challenges in changing mindsets, hiring, training, and retaining new talent.

Battery and lithium bottlenecks and supply imbalance will remain a challenge for the near term. There's no easy fix here, and there's always the potential for shocks to lithium-ion markets due to the sheer scale of demand. The demand for low-cost lithium-ion is already a record high, significantly as demand for electric vehicles (EVs) increases. Recent reporting indicates that the global lithium-ion battery market will grow from $41.1 billion in 2021 to $116.6 billion by 2030.

Research indicates that in 2050 EVs could contribute to a 33% increase in energy use during peak electrical demand. The continued adoption of EVs will also intensify pressure on energy providers next year, creating challenges for utilities and opportunities for storage. In preparation, we're seeing EV charging co-optimised with ample onsite energy storage used to alleviate strain on the grid and provide essential capacity for rapid EV charging.

Ultimately, I'm eager to move this industry forward because scaling energy storage is critical for accelerating the transition to decarbonised energy infrastructure. Last month, we released a report modelling pathways to a 100% renewable grid that found "front-loading" the deployment of renewables can slash global energy costs. We're working with industry leaders who are eager to support the transition strategically by deploying technologies needed to balance renewable intermittency, such as energy storage. Energy storage is key to preparing for and capturing more value from the increasing penetration of intermittent resources while efficiently supporting system reliability. Let's usher in the new year, ready to collaborate across sectors to accelerate our transition to a clean energy future. wn

The Latest Energy Storage Gizmo is an "Ocean Battery" with a Bladder

The Intertubes are absolutely on fire with news about a new "ocean battery" energy storage invention that uses gigantic undersea bladders to soak up excess energy from offshore wind turbines. The idea is not as crazy as it sounds — at least the judges at the 2022 Consumer Electronics Show in Las Vegas don't think so.

BY | Tina Casey

THE SEAWATER VERSION OF COMPRESSED AIR ENERGY STORAGE

If you think this is bladder idea is similar to compressed air storage, well, kind of. The foundational element is that wind energy runs on its own timetable, and its schedule is often out of sync with the electricity demand.

Energy storage systems enable wind turbines to keep working even when demand is low.

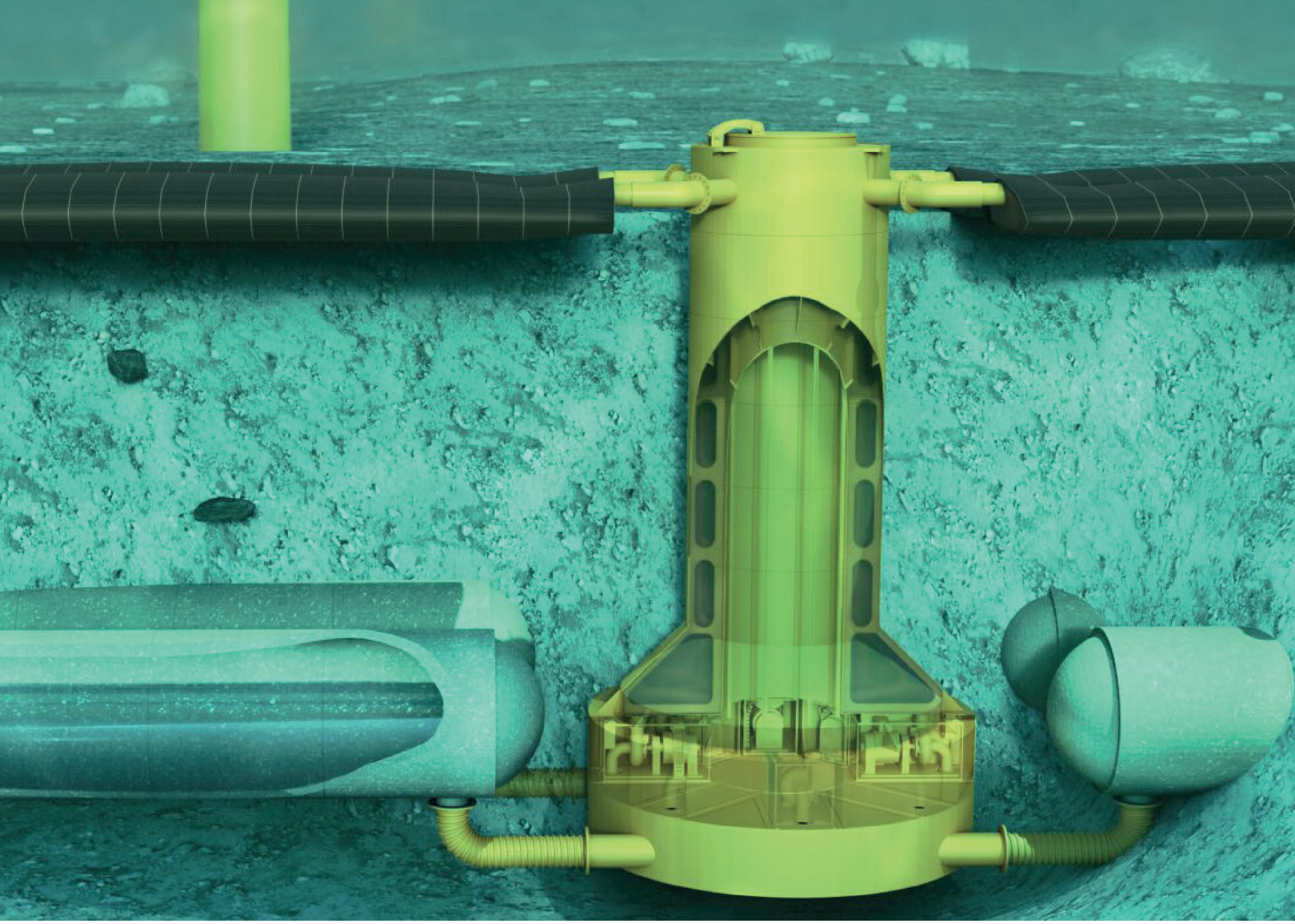
The formula is pretty straightforward in compressed air storage: use excess electricity to run air compression systems when demand is low, then release the air to run turbines that generate electricity when demand is high.

The "ocean battery" undersea energy storage concept is more similar to pumped hydro storage, in which renewable energy is used to pump water uphill to a reservoir. When extra electricity is needed, gravity is deployed to release the water downhill to hydropower generators.

A BETTER BATTERY FOR OFFSHORE WIND FARMS

The Dutch startup Ocean Grazer wowed the judges at CES 2022 with its contribution to the undersea storage field, garnering a CES 2022 "Best of Innovation" award for its Ocean Battery technology.

Relatively speaking, it's been a short road trip from lab to market for the company. Ocean Grazer spun off from the University of Groningen in 2014 as a study project, then made a quick



pivot into commercial development in 2019.

Ocean Grazer won its "Best of" title not only on account of the technology itself but on its potential for application at offshore wind farms.

"The Ocean Battery is a Breakthrough solution based on our proprietary Key Enabling Technology to solve the huge Challenge of Balancing Supply & Demand for the Global offshore e-Power industry due to Intermittent Production of Wind Power," Ocean Grazer explains.
"Our Patented and Sustainably produced Ocean Battery system substantially Lowers the CapEx for the massively expensive Offshore Power Grid, generating a very high ROI for the unique Ocean Battery."

Ocean Grazer notes that the rush to develop offshore wind farms will result in wild fluctuations in supply and demand unless energy storage scales up. Energy storage will help avoid — if not eliminate — brownouts and blackouts when the wind dies down.

It will also enable producers to reserve excess kilowatts during periods of oversupply, avoiding the impact of low or even negative pricing on their bottom lines.

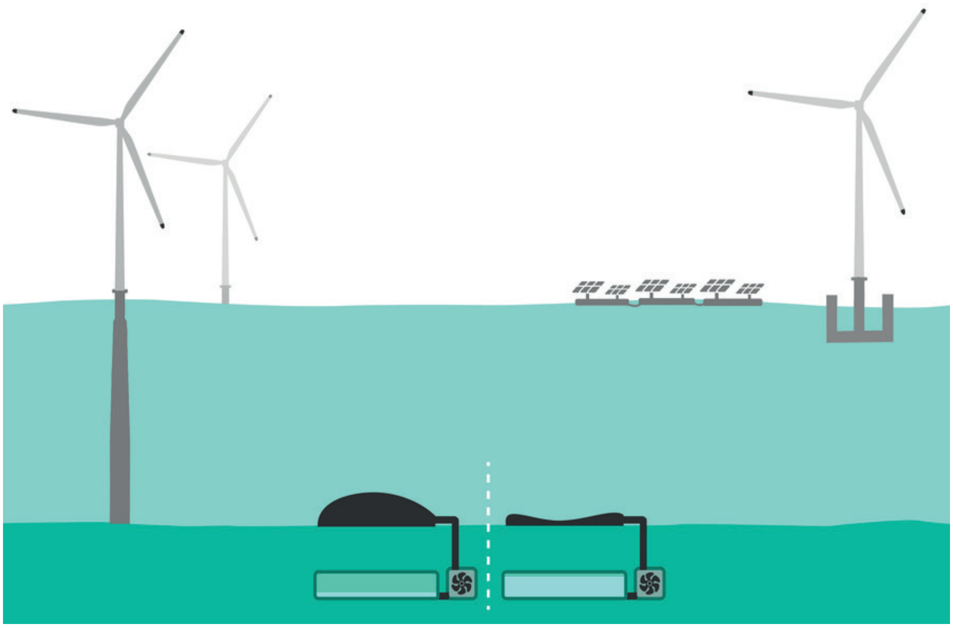
UNDERSEA ENERGY STORAGE VS. PUMPED HYDRO: COMPARE AND CONTRAST

Several firms have been tackling the challenge of undersea energy storage, and the challenges are many. In addition to difficulties in deploying, maintaining and repairing undersea systems, saltwater corrosion is an issue.

Despite the challenges, Ocean Grazer points out that its system has a crucial advantage over-pumped hydro storage: with its "in-a-box" undersea system, you don't have to find a spot to build a new pumped hydro reservoir on land.

That's a significant advantage. In the US, pumped hydro has been the number one bulk, long-duration storage technology for many years, and it will probably continue to maintain that status. However, it will be difficult, if not impossible, to build any significant number of new pumped hydro reservoirs.

Of course, you can't just plop down massive undersea structures just



New energy storage for offshore wind farms: gigantic undersea bladders (image courtesy of Ocean Grazer).

anywhere without running into environmental impacts and competing for commercial uses. Nevertheless, Ocean Grazer has come up with a formula that could work by linking its system with approved wind farms that have already undergone extensive review.

"Our solution is embedded into the seabed and can be installed in between or next to existing and new wind farms to enhance the stability, reliability, and profitability of your project," Ocean Grazer explains, further noting that floating solar and tidal power systems are also candidates for development.

HOW DOES IT WORK?

The meat of the system is a high pressure, flexible bladder contained within a concrete reservoir buried under the seabed. You pump seawater from the rigid reservoir into the bladder to charge the battery.

Pressure within the bladder does the rest. When extra kilowatts are needed, water is released to run turbines for generating electricity.

The pumps and turbines are based on existing technology and are housed in an accessible machine room.

Speaking of comparisons with pumped hydro storage on land, the US Department of Energy has been trying to get the pumped hydro industry to bring down costs by standardizing and modularizing their technology. Ocean Grazer has a jump on that angle:

"The Ocean Battery is constructed based on standardized building blocks and makes it possible to mix and merge storage volume and capacity.

The storage volume can be sized by connecting the exact amount of rigid reservoir elements, each with a storage volume of 10 MWh, to create the desired storage volume," they explain.

UNDERSEA ENERGY STORAGE VS. BATTERY ENERGY STORAGE

Zooming out to the big picture, nothing will stop the lithium-ion battery juggernaut any time soon. However, the Li-ion field abounds with environmental pitfalls, especially concerning the use of critical metals. These issues are being facilitated through recycling, sustainable sourcing and other efficiencies, but the global electrification movement could overwhelm this progress unless alternative energy storage technologies are available.

In that regard, Ocean Grazer points out that its system kills two sustainability birds with one stone. One involves the use of critical materials, of which there are none. The other involves the restorative potential of Ocean Grazer's system:

"The construction of Ocean Battery systems in wind farms provides a perfect opportunity to create artificial safe havens for marine life to rebuild their ecosystems.

Fishery and shipping, and other activities by mankind in coastal areas, especially bottom trawl netting, have destroyed marine communities at the seabed. In many coastal areas around the globe, people are building artificial reefs, flexible geotextile structures etc., to achieve this. With the installation of the Ocean Battery at the seabed, these structures come for free and allow marine life to recover and flourish."

They might just be on to something. A few years ago, New York City famously repurposed many toilets to serve as oyster restoration beds among its local waterways. Now the idea is gaining new legs as a flood control strategy, so stay tuned for more on that. wn

Yorkshire site secured for new battery storage facility

Plans to invest up to £300m in new battery storage sites take a significant step forward with acquiring the former power station site.

By | James Murray

Catalyst Capital has announced the acquisition of a former power station site next to the M1 motorway in Yorkshire, where it plans to develop a new 100MW battery storage facility.

The asset investment firm's Catalyst Energy Storage Platform (CESP) confirmed late last week that it had acquired the leasehold interest in a brownfield site at the former Skelton Grange power station, south-east of Leeds, from Referent, a renewable energy developer.

The site is part of a regional hub for renewable energy and is adjacent to a 19.5-acre waste-to-energy facility, which is currently under construction.

Last year, planning permission was granted for a 100MW battery storage facility, with the construction tendering process now being managed by CESP's engineering adviser, Fitchner.

The company said it was planning to be operational in the fourth quarter of 2022, delivering a significant step forward for Catalyst's plans to invest £300m in UK battery storage facilities.

The Skelton project follows a joint venture acquisition last year with Dowling LLP in Nursling, Southampton, to see a new 50MW battery facility come online next month.

Catalyst said it is now in talks with other investors to fund the battery storage platform's expansion jointly.

"We believe there is a compelling opportunity to deliver a portfolio of UK battery storage facilities," said Kean Hird, partner of Catalyst Capital. "This portfolio will allow our investors to invest in a scalable market with high ESG credentials in the renewables sector. Although the sector is still in evolution, it is quickly gaining institutional status while delivering very healthy cash-on-cash returns in the interim."

The UK's energy storage market is expected to expand rapidly in the coming years, as renewables developers and grid operators look to balance supply and demand as they integrate growing levels of renewables capacity onto the grid. wn

SA's Green Energy Outlook For 2022

With a background in electrical engineering, a knack for business, and a passion for sustainability, Jan Fourie has specialised in renewable energy projects for over a decade.

Currently serving as Southern Africa General Manager for Norwegian global renewables giants, Scatec, Fourie's career began as a consultant for Koeberg, SA's flagship nuclear power station, an experience which sparked his attraction for large-scale power generation and infrastructure projects.

Fourie's natural flair and passion for business became apparent while working in this space, and he augmented his technical qualification in electrical engineering with solid business credentials in the form of an MBA from the Graduate School of Business at UCT.

Fourie's love for South Africa and the natural environment, the landscapes and the flora and fauna, is core to his passion for sustainability and his current role at Scatec perfectly encapsulates his three-pronged passions for sustainability, business, and the technical side of large-scale power generation.

"Being part of an industry that accomplishes power generation, decarbonization, and job creation is a very fulfilling pursuit. We give power to the people on many levels. I get up excited for work, and I'm proud to tell my children about what we do at Scatec," he says.

Noting the devastation in the nation's coal belt, Emalahleni (formerly Witbank) and surrounds, where 5000 people perish every year due to lung diseases, and where childhood asthma is rife, Fourie says that, "the need for cleaner energy in SA is urgent".

"Nevertheless, the mines and coal-fired power stations are the lifeblood of many communities, and to abandon them would result in a landscape of ghost towns, and a human tragedy of mass unemployment. I therefore fully support the DMREs' plan to repurpose these areas, preferably by retro-fitting existing coal-fired plants with renewable energy plants and/or battery storage solutions, and training people in new skills to ensure that jobs can be transferred", says Fourie.

He says that the COP26 conference, which took place in Glasgow in November 2021, could herald solutions to some of Eskom's woes. "The Paris Climate Agreement of 2016 acknowledges the duty of developed nations, who are responsible for the bulk of greenhouse gasses emitted thus far, to assist developing nations in their efforts to decarbonise, and mitigate risks associated with climate-change", says Fourie.

"In what President Ramaphosa has called a 'watershed moment', at COP26 a coalition of developed nations (the EU, France, Germany, the UK and the USA), committed ZAR 131 billion to help SA - currently the continent's biggest polluter, and 12th biggest globallyi - to affect a just, inclusive energy transition".

Faced with international pressure to decarbonise, and the local economic imperative to liberalise and allow competition-driven efficiency, SA's state power utility initiated their unbundling process from a vulnerable position.

Saddled with ZAR 400 billion in debtii, and an ageing coal fleet that is increasingly unable to meet national grid demands, the embattled utility plans to separate into three divisions for its three primary functions: generation, transmission, and distribution, with each entity expected to be allocated a portion of the debt. There are legitimate concerns around how these entities will raise capital and stay afloat while shouldering such great arrears.

"Our task now is to bridge the gap between a beleaguered parastatal and their progressive vision to achieve carbon-neutrality by 2050.

The IRP 2019 outlines SA's stepping stones to reduce coal's contribution to the energy mix to below 60%, in favour of renewables like wind, and PV technologies, which would account for 25% of our energy mix by 2030", Fourie notes.

Fourie speculates that Municipal Energy Resilience (MER) funds, currently seeing success in the Western Cape, could be rolled out to facilitate municipal generation in other provinces. "Although it's a relatively small fund, only for preparatory work, by focusing on getting IPPs up-and-running, MER is giving the Western Cape energy sector a notable boost, bolstering domestic and industrial energy security, and bringing them into better alignment with the DMRE's progressive decarbonisation and circular economy goals".

The DMER's REIPPPP program also heralds strong prospects for the renewable energy industry, and job creation in 2022. "REIPPPP projects have already created some 40 000 jobs in SAiv, spread over some 100 sites procured by the IPP office during the first 5 rounds of IPP bidding.

In accordance with its vision for a just, inclusive transition, REIPPPP project applications must include 20-year commitment plans, detailing the project's projected socio-economic impact, and potential contributions to just employment and economic transformation", Fourie explains.

He adds that, with Round 6 planned for 2022, and Round 7 to follow in late 2022 or early 2023, many new jobs look set to be created at solar and wind plants, especially in the nation's three Cape provinces where the bulk of SA's renewable energy is produced.

Fourie is one of the executives at the helm of Scatec's ambitious new RMIPPP-endorsed 150MW flagship twin hybrid PV-and-storage site in the Northern Cape. Sporting 2 million individual solar panels, and an initial Capex of around 1 billion USD, the plant will be one of the biggest hybrid plants of its kind in the world. "Earlier this year, new policy amendments were announced that exempt IPPs with up to 100MW output capacity from previously onerous NERSA licencing. This relaxing of red-tape, in conjunction with REIPPPP bidding coming up again soon, and the fact that renewables are now the most competitive generation source, present an exciting landscape for renewables in 2022 and beyond", he says.

"Entire markets may start to open up for embedded generation, energy wheeling and power brokerage, with new legislation allowing complex energy mixes and innovative financing models.

"Renewables present significant opportunities for investors who are eager for their 'place in the sun'", says Fourie.

"Government collaboration with the private sector and international stakeholders, who possess the capital and expertise to unlock the rich potential offered by renewables in SA is imperative. This will further create an attractive investment environment, in which long-term Power Purchasing Agreements (PPAs) between IPPs and state utilities provide predictable cash flows and yield regular dividend pay-outs for investors", he adds.

"Industry players are cautiously optimistic that next year could herald an accelerated drive towards the just, inclusive energy transition enshrined in our IRP, in which all South Africans will be the beneficiaries of a cleaner, brighter future", concludes Fourie.

At the dawn of a new age for power, companies with hybrid business models can make the best of both traditional utilities and renewable energy.

By | Igor Hulak

Thanks to a larger GDP fueled by population growth and primary resource-based economic advancement, Africa's hunger for power has intensified. But for the power supply to keep up with demand, Africa will need to invest more than $43 billion in the power sector every year from now until 2040.

In our paper A private path to power in Africa, we discussed how the private sector could contribute to this significant investment.

The sector's participation is a complete recipe—a solution to a traditional problem that mature markets have already successfully applied. African countries can learn from this precedent.

But at the same time, we live in an energy transition: a period of unprecedented change in the global energy sector in both mature and emerging markets.

The essential question looks beyond the scope of traditional solutions to discover what the new age of energy can bring to chart a sustainable path for Africa's utilities, its economies, and ultimately its citizens.

Energy transition
- a new path to power in Africa

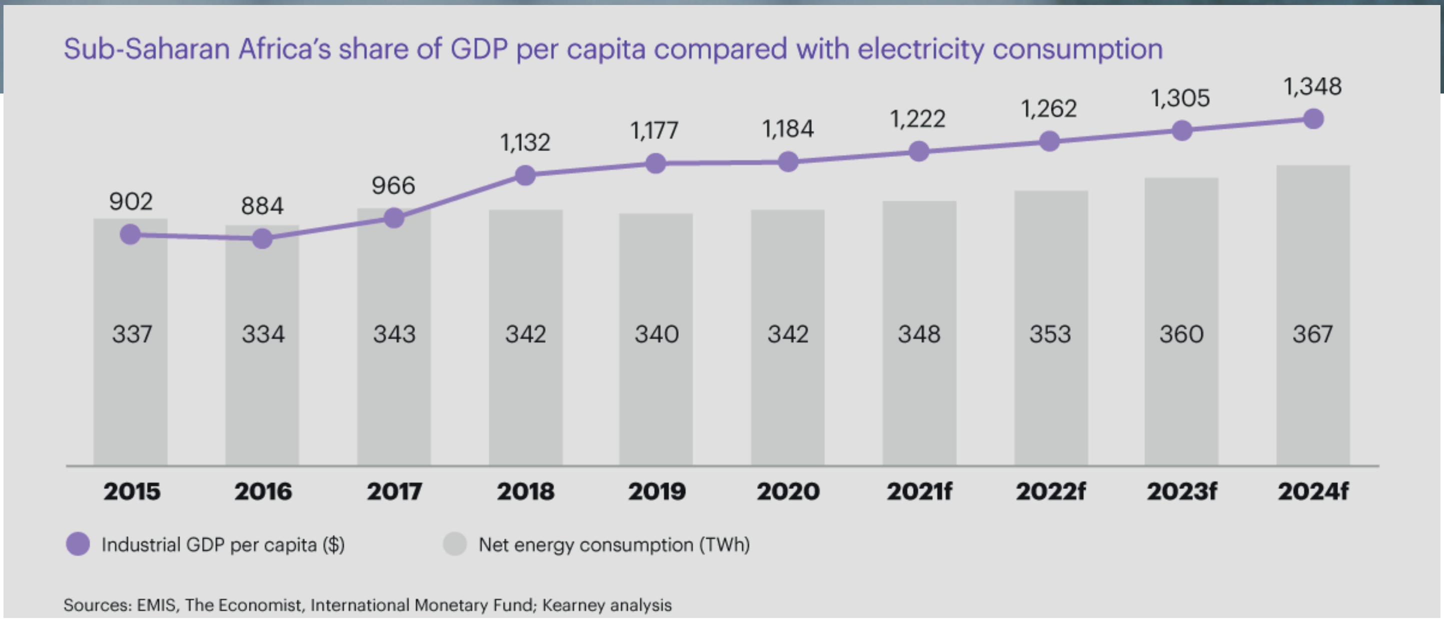


Figure 1: Sub-Sahara Africa's share of GDP per capita compared with electricity consumption.

THE DUAL MANDATE OF POWER: AVAILABLE FOR ECONOMIC GROWTH AND AFFORDABLE FOR SOCIAL DEVELOPMENT

Power is essential for economic growth. Since 2009, sub-Saharan Africa's 4.1 per cent average annual GDP growth has largely been fueled by natural resources. The uncertainty is whether such economic growth is sustainable and will lead to GDP per capita similar to the levels in mature markets or whether it will taper off and require a step-change in the form of increased industrialisation for the region to continue its growth story.

There is a strong correlation between the industry share of GDP and electricity consumption per capita, although not indicative of the direction of causality between them (see figure 1). Therefore, Africa's path to sustainable growth and economic development will involve readily available power. And this presents a real challenge since lack of power is a significant obstacle for African businesses.

In other continents, access to power is usually the second or third most significant challenge, but for sub-Saharan Africa, it ranks first (see figure 2). The path to sustaining the industrialisation growth curve rests on widening power availability and more reliable.

However, industrial development fueling GDP growth is only half the story. Countries need power not only for economic development but also for social development. A variety of statistics can prove this correlation.

Still, it is so profound that it can but vividly be illustrated by comparing nighttime lights in Africa with other world regions (see figure 3). Just as industrial development and power availability move parallel, so do social development and power availability.

The parallel between the United Nations Human Development Index and electricity consumption demonstrates this relationship from a quantitative perspective. Electricity usage directly impacts the Index, and access to electricity is inextricably linked to improved welfare and human development (see figure 4).

Power availability is essential for economic growth and social development. Research studies agree that two factors influence household electricity consumption the most: price and economic growth. Long-term income elasticity is typically evaluated at close to unitary, whereas long-term price elasticity tends to be around half of that and negative by nature.

Therefore, affordable electricity is a significant factor in domestic electricity consumption and social development. At the same time, major cost components of the electricity supply build-up are not country-specific, including fuel (if it is imported) and power generation technology.

Hence, in countries with a lower GDP per capita, there is a gap between the market economics of electricity supply and its affordability within the country's level of economic development.

For example, there is a wide gap between power affordability and cost in sub-Saharan Africa: the cost of power is on par or higher than in mature markets, but GDP per capita is only a fraction of more mature markets' GDP. For example, in the second half of 2019, the average price of electricity for non-household customers in EU 27 was $0.13, and only four countries in sub-Saharan Africa had lower prices.

Africa's governments and utilities are facing a strategic dilemma: either provide rapid access to energy

	Sub-Saharan Africa	East Asia and Pacific	Europe and Central Asia	Latin and Central America	South Asia	Middle East and North Africa
1	Power	Corruption	Tax rate	Corruption	Political instability	Corruption
2	Finance	Power	Political instability	Skills	Power	Political instability
3	Informality	Skills	Power	Power	Corruption	Land
4	Corruption	Political instability	Corruption	Tax rate	Finance	Power
5	Tax rate	Tax rate	Skills	Political instability	Land	Informality

Figure 2: Top five major or severe constraints that businesses face.

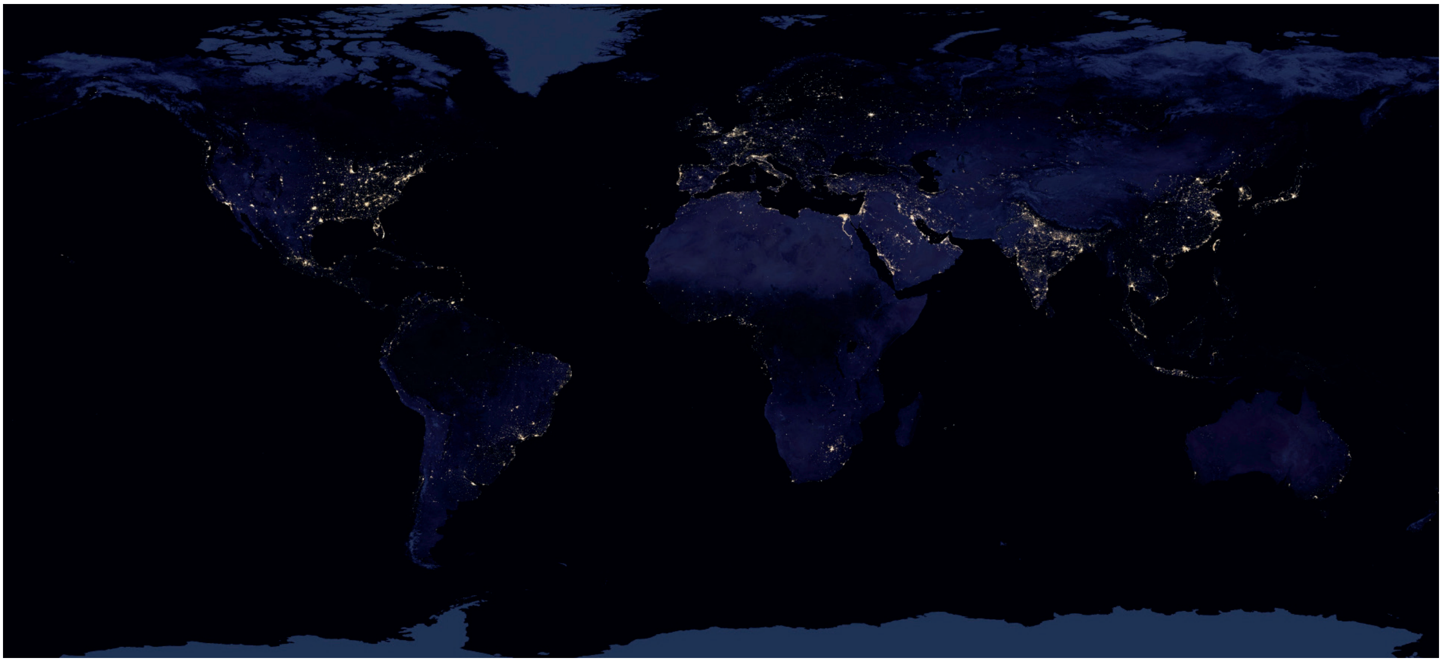


Figure 3: Africa has much fewer nighttime lights thasn other regions of the world.

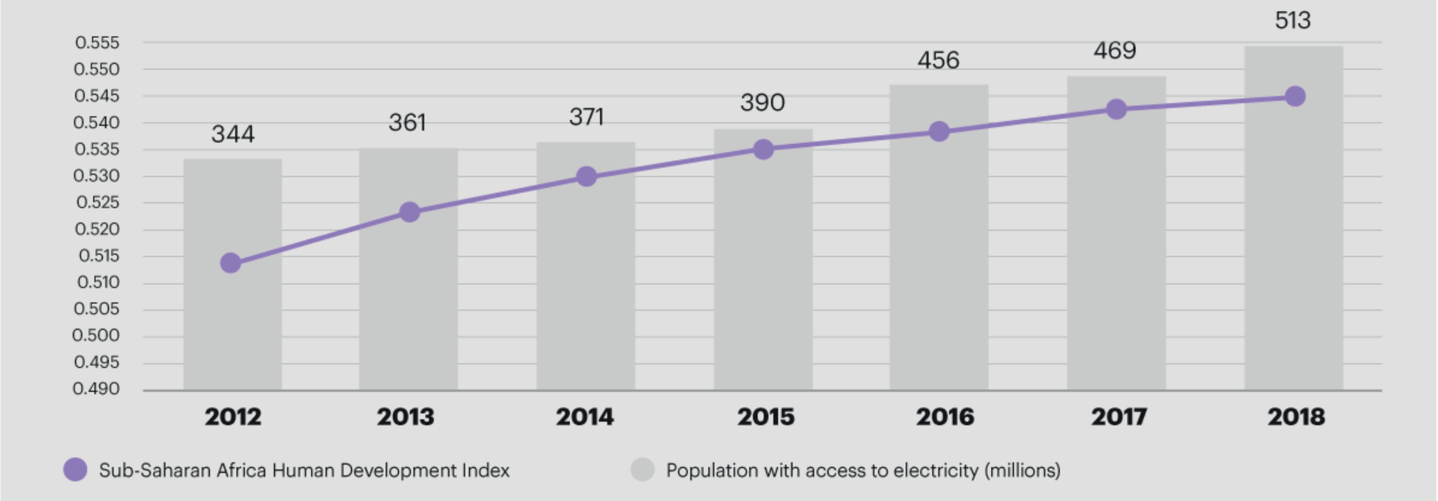


Figure 4: Sub-Saharan Africa's electricity access and Human Development Index growth.

with decentralised solutions, which come at a higher cost with imported technologies, or develop integrated networks, which require more investments and time but at a lower cost with the added opportunity of developing local economies.

The question is how to bridge this gap in a sustainable way that can accelerate electrification to a level of GDP per capita that eliminates the cost–affordability gap. Utilities have traditionally been the focal point where the disparity between the cost of electricity and the revenue from demand has materialised. As a result, household electricity tariffs (if they even exist) have been artificially low. Governments have subsidised utilities with funds from other economic sectors, such as exploiting natural resources, to bridge the affordability gap to the actual cost of electricity supply. However, these subsidies are not the only priority for government budgets. Depending on the economic and political situation, the priorities change—and so does the availability of funds for subsidising utilities, ultimately resulting in low profitability and high indebtedness.

As we advance, this equation will have to be moderated so that utilities can gradually become self-sustainable operations solely based on cost-reflective tariffs without any government subsidies.

COMMERCIALISE OPERATIONS AND UNBUNDLE THE VALUE CHAIN TO BOOST COMPETITION AND CREATE TRANSPARENCY

The dual mandate of African utilities is embedded in this model. Traditional utilities emerged as vertically integrated state-owned energy companies spanning the whole value chain from mining and extraction through generation, transmission, and distribution to the supply to the final customer. However, equally inherent is that utilities operate almost as government bodies rather than for-profit self-sustainable economic agents. The result: low efficiency because of a lack of competitive market forces that would otherwise drive inefficient companies out of business in unregulated markets and the need for government subsidies to bridge the gap between the affordability of tariffs and the cost of the power supply.

Two factors can help utilities transition to self-sustainability. First, fully commercialise operations to establish the legal, regulatory, and operational basis to charge for services, collect payments from customers, and discontinue service when customers do not honour their obligations. Second, unbundle the value chain with legal and functional separation of generation, transmission, distribution, and retail to shed light on the individual balance sheets and income statements of the components of electricity supply to open up the components that are not natural monopolies for competition and thus for market-driven efficiency.

Utilities have emerged as state-owned vertically integrated undertakings to minimise the complexity of their management and encourage internal cross-subsidies across the value chain. Africa's utilities are no exception. They rely on it because of the relative importance of development financing for African economies, channelled through governments—hence the need for close relations between utilities and government bodies. The first step to establish a commercial basis for self-sustainable utilities is to create a legislative right for them to charge for their services along with regulatory rules for measuring and pricing those services.

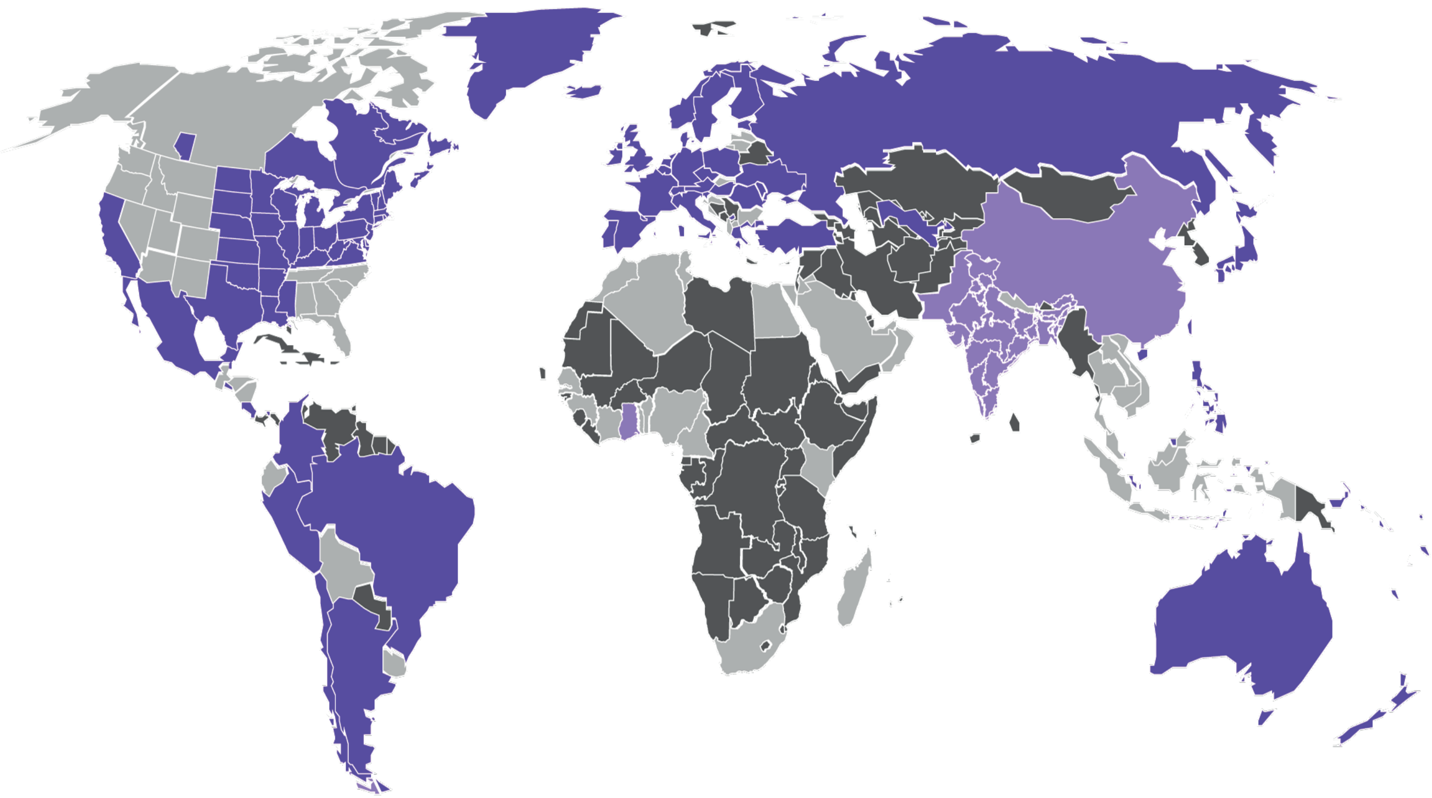
This is a move away from funding utilities' operations via government budget allocations, including infrastructure industries such as roads, and toward funding the operations from generated revenues—a fundamental utility transformation from government-like structures to commercial enterprises. Initially, the tariffs that utilities charge might not be cost-reflective, so they might still have to rely on partial government funding. It is also foreseeable that the commercialisation of operations will be a process rather than a one-off solution. This process will start with transparency about the funding sources and relative shares to fund the universal service utilities provide to customers, including revenue from customers, government budgets, and development financing.

Unbundling, however, is not without its challenges. The complexity of managing an unbundled power network will make it challenging to capture the value of some operational improvement levers, such as technology and smart grids. Additionally, a more complex system will leave room for corruption if not carefully managed. These challenges are highlighted in the unbundling of Europe's utilities. However, the opportunity for new competition will pressure Africa's already-high electricity prices because of the lack of competitive tariffs. Unbundling will also provide relief, capital, and an opportunity to restructure Africa's embattled vertically integrated utilities, which face a much different reality than what was happening when Europe unbundled its energy sector (see figure 5).

Such transparency will be a crucial ingredient in direction setting: establishing a horizon and measures to reach cost-reflective tariffs—tariffs that will enable the universal service to be funded solely from customer revenues. This will also allow for the structural focusing of the various funding sources. The priority should be for tariffs to cover direct operational costs. Government budget-funding and development funding should be directed toward capital expenditures, which will expand electrification, thereby increasing revenues, improving efficiency, and reducing costs.

Commercialising operations is only the first step on the path to sustainability. It will also create transparency and the right motivation for utilities to optimise their use of funds and send the right signals to customers and the government. Utilities in Africa are at various stages of development, with most of them operating as vertically integrated state-owned enterprises that have partially commercialised operations.

They have managed to achieve specific electrification rates, typically around the critical industrial sites and major towns. However, rural electrification is posing challenges—not only in terms of funding, which governments tend to provide partially but also in managing the complexity of a growing utility that spans a significant portion of the country. Initial electrification power would typically be provided to industries and limited residential areas with high consumption density, such as



Integrated monopoly. The electricity sector is organized as a vertically integrated utility (VIU), which is responsible for all functions: generation, transmission, and distribution and sales.

Independent power producers. VIU continues to account for most of the electricity-sector activities, but part of generation is financed, constructed, and operated by independent power producers (IPPs) and the energy and capacity purchased by the VIU under long-term power purchase agreements.

Market opening. The VIU is unbundled into separate entities for generation, transmission, and distribution and sales. Very large customers are allowed to choose their suppliers and enter bilateral contracts directly with IPPs and/or traders, while other customers continue to be supplied by the distribution and sales entity.

Competitive market. A distribution and sales entity is unbundled into separate entities for distribution and sales, which is also typically complemented with increased private-sector participation in both distribution and sales. Most or all customers are allowed to choose their suppliers, which is typically coupled with last-resort supplier and universal service obligation to ensure safety nets, especially for small commercial and residential customers. Wholesale market advances into a combination of bilateral contracts and organized markets (pools or power exchanges).

Figure 5: Countries have taken different approaches to open the energy market to free competition

the country's capital. However, further electrification yields inherently worse economics because consumption density—and affordability—become lower, which coupled with the greater complexity of operations and associated costs makes the viability of utilities even more difficult.

So what is the solution to this problem? As with the commercialisation of operations, a first step is to create transparency and motivation to become more efficient. The mechanism that mature markets have used and fit for this purpose is unbundling: legally and functionally separating generation from transmission, distribution, and even retail.

Energy delivery from generation through wholesale to retail is functionally and commercially independent from the natural monopolistic vehicle, namely the transmission and distribution grids. Unbundling creates three significant benefits: transparency, competition, and potential for private-sector participation. Transparency is created in the sense that cross-subsidies between generation and grids are no longer possible—or at least they are much more complex, which helps focus the effort on the most significant shortfalls without artificially masking them.

Competition is enabled in generation, wholesale, and potentially retail by opening those value chain segments to free entry on the back of non-discriminated access to the transmission and distribution grids. In practical terms, this means the grids will no longer be locked up for the in-house generation capacity of the previously vertically integrated monopoly even if those would have worse economic parameters but would be advantageous to the vertically integrated monopoly because of take-or-pay arrangements or other stranded costs. Last but not least, there is more potential for private-sector participation by improving the bankability of such investments because the associated risk can be limited to the particular segment of the value chain where the investment is directed rather than the all-or-nothing approach that the vertically integrated monopoly would only allow.

Private-sector participation is not a universal cure for all of the power sector's ailments; some can only be cured with government intervention and regulation. Hence, packing the power-sector value chain in a manner that also matches the risks and inefficiencies to be addressed with the private sector's capabilities can facilitate the entry—and the ultimate success— of private-sector participation.

Unbundling can create structural improvements - transparency and competition - and capitalisation improvements - increased efficiency and more significant potential for private-sector participation. Moreover, the sector's resulting footprint and mechanics bring one extra benefit: they set up the foundation for introducing solutions from the history of the traditional utility in mature markets and the future of a new energy world.

MAKING A QUANTUM LEAP TO THE NEW ENERGY WORLD

With the advent of decarbonisation, decentralisation, and digitalisation, utilities need to adjust their approach to respond to a new energy market. Traditional utilities have developed in an investment-heavy manner by building centralised fossil-fuel generation and unidirectional networks from the mega power plants to individual homes.

Decarbonisation is being driven globally by aggressive growth in the generation capacity of renewables (see figure 6). The 17.2 per cent per year growth since 2010 is primarily the result of two factors:

- Government enablement through renewables expansion targets as well as financial incentives for decarbonisation through subsidies, such as feed-in tariffs and investment rebates
- The cost competitiveness of renewable solutions, which has seen significant gains thanks to technology breakthroughs, leading to lower equipment costs and economies of scale because of the volume of projects

Furthermore, energy storage technology plays a role in the decarbonisation, decentralisation, and digitalisation of the value chain as it allows companies to play new roles in the market (see figure 7). The energy supplied can participate in the energy-only market through primary wholesale energy and the operating reserve market through the provision of ancillary service and primary, secondary, and minute reserve energy. Additionally, improved storage technologies will make grid expansion more efficient for grid operators and expand the share of self-consumption from a decentralised generation for end users.

The energy transition has brought new technological and commercial ways of delivering power to people decentralised (see figure 8). Traditional utilities in mature markets are trying to find their places in this new energy world to avoid becoming stranded with significant infrastructure investment. Most African utilities are not burdened with such infrastructure sunk costs. Therefore, they have an opportunity to make a quantum leap over some of

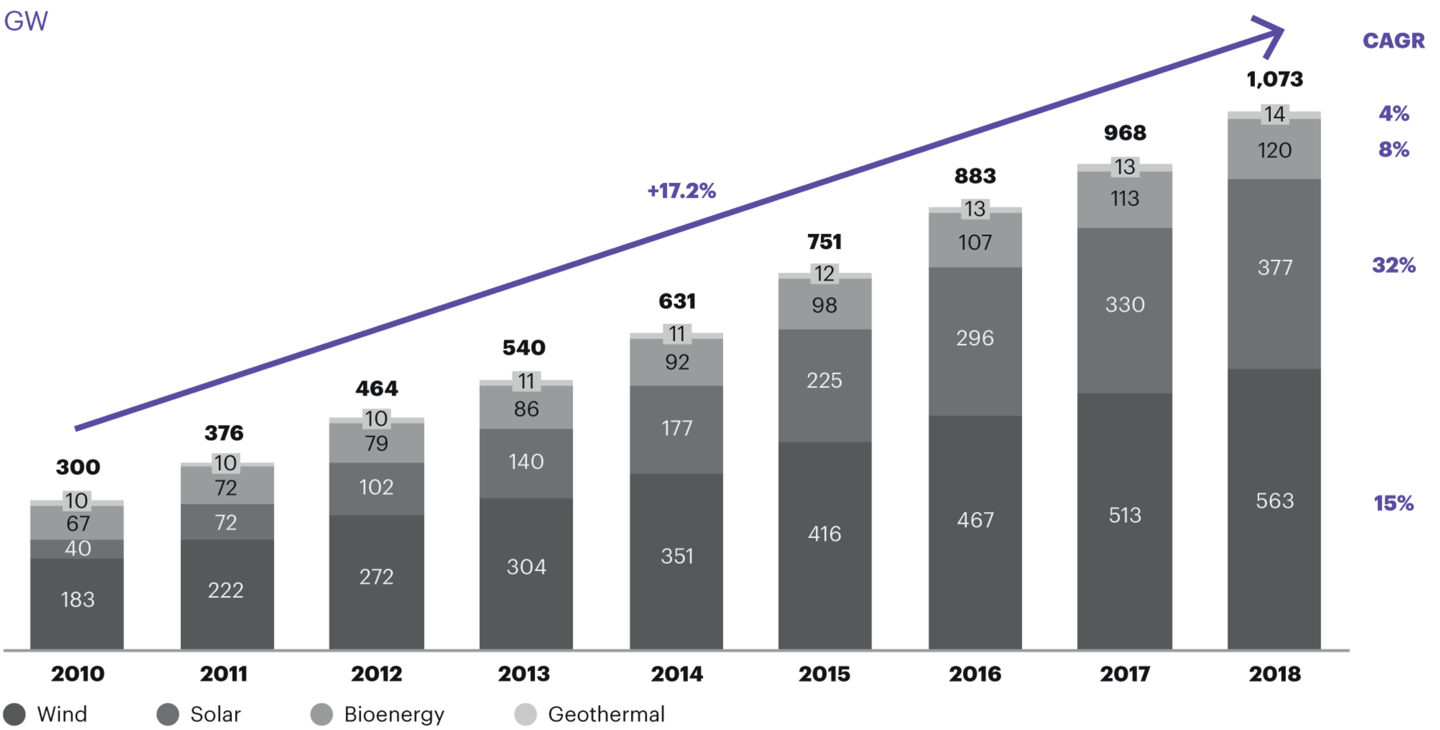


Figure 6: Alternative sources of energy are fuelling the world's decarbonisation.

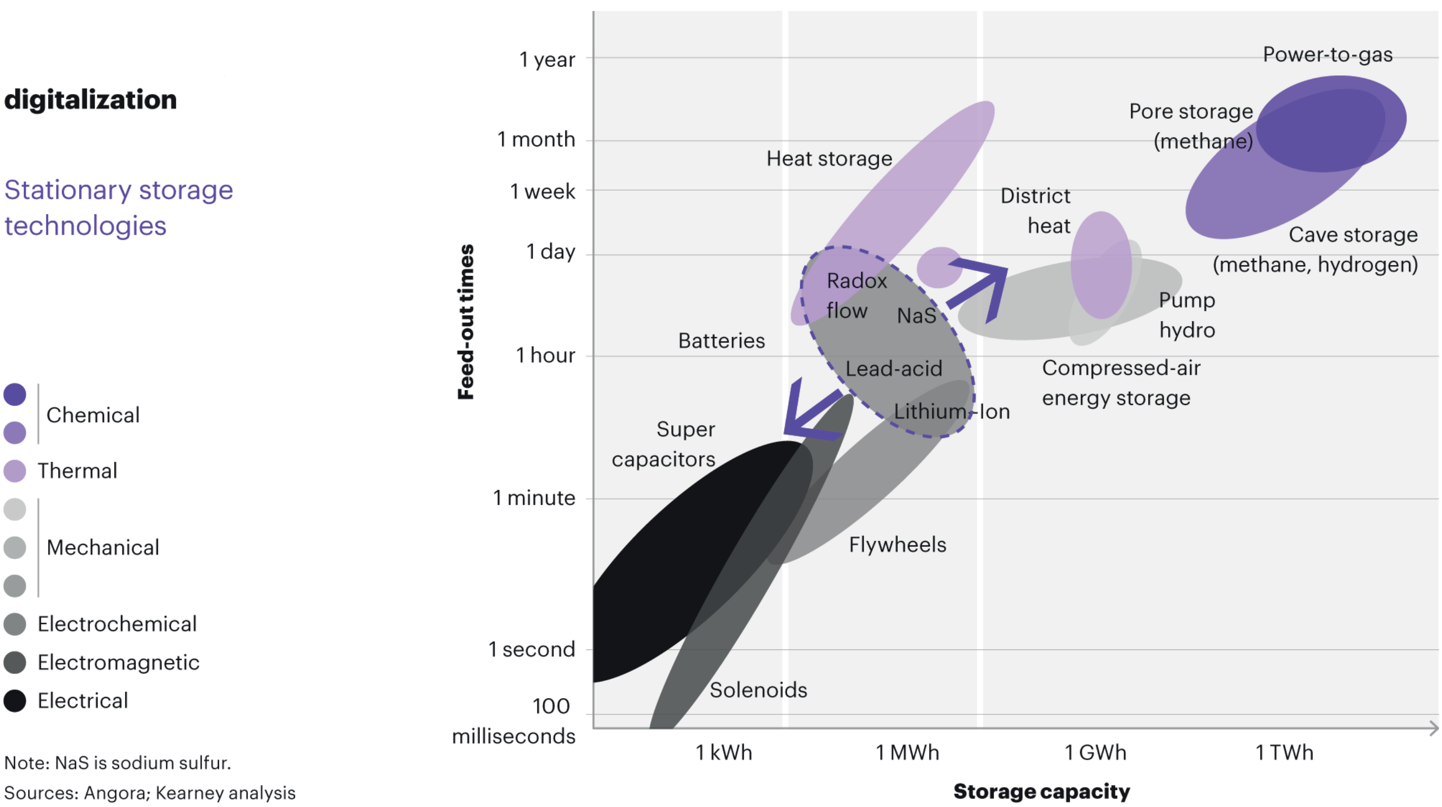


Figure 7: decarbonisation, decentralisation and digitalisation

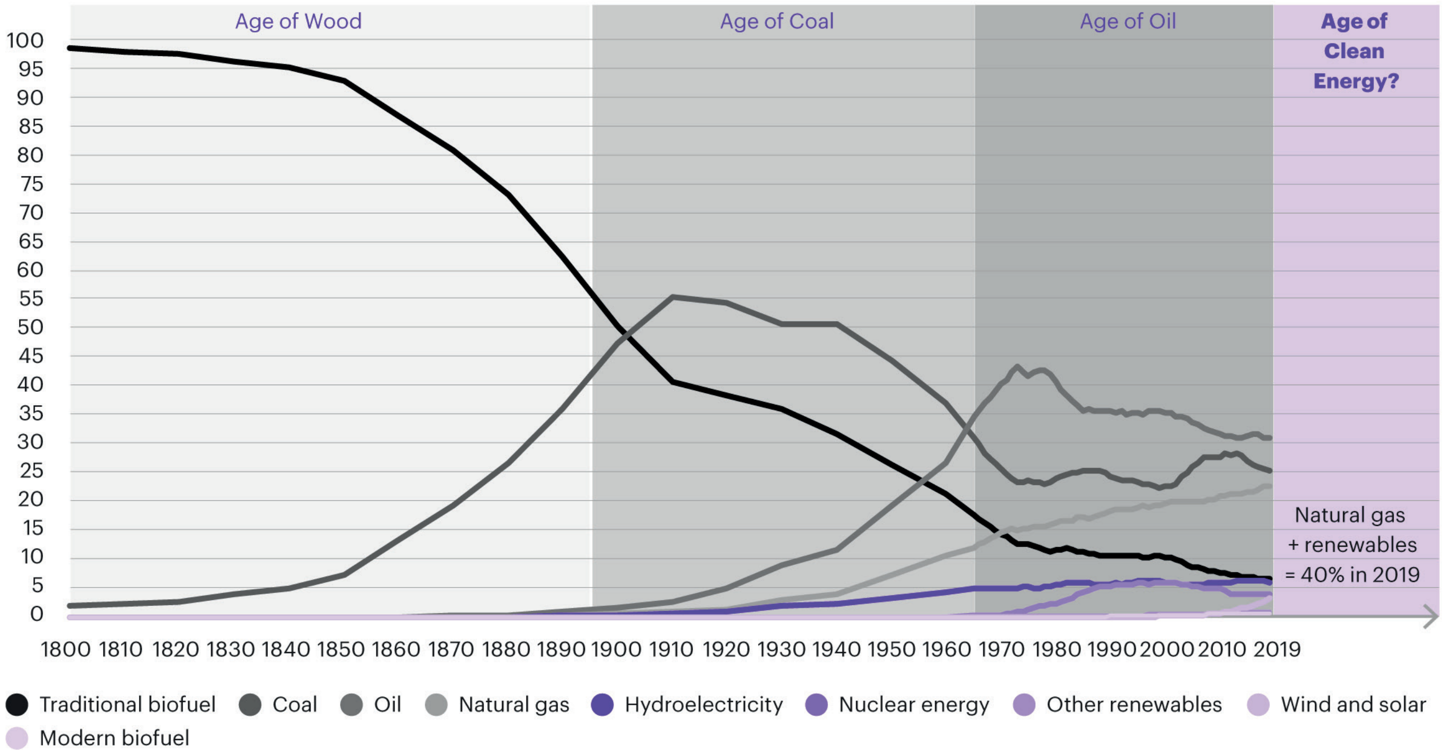


Figure 8: The world is moving toward a new age for energy.

the development stages that utilities in mature markets went through and target a model that best fits the realities of the energy world.

The new energy world offers many advantages: it is cleaner, decentralised, and in some aspects cheaper. Africa has natural benefits in solar irradiation and wind density to explore the cheaper aspect of the new age of energy. Hence, the continent could also enjoy the benefits of a cleaner and decentralised energy world. Decentralisation is particularly worthwhile to consider in countries and economies plagued by corruption because decentralisation is as powerful a cure for corruption as is the perfect competition for economic inefficiencies.

So how can Africa do that? Give utilities the right incentives and tools. Unbundling is just one component of the solution. A vertically integrated monopoly would typically have the capacity to take a powerful defensive stance to protect its business lines from threats from the new energy world, such as distributed generation eating away at its centralised capacity load factor and the respective take-or-pay capacity costs. But the unbundled power landscape would have different incentives for the various players. An independent distribution grid operator will be as commercially attractive to offtake power from the transmission grid as it would be from a community solar PV installation to increase grid utilisation. Hence, the operator will be incentivised to connect distributed sources rather than prevent them from ramping up their capacities.

Concepts from the new energy world are not restricted to one segment of the value chain, nor are they necessarily substitutes for traditional utilities. Would a mining company be willing to rely entirely on distributed renewable sources for its power supply? Probably not. Would it be more cost-effective to set up renewable source-based mini-grids to electrify remote rural areas? Probably yes. What does each solution require? A significant upfront investment, technical expertise to operate and maintain the infrastructure, and customer management expertise to connect and serve customers and commercially-run the business to recover the investment. Which organisations have this combination of expertise and capital? The utilities: traditional, new, or private. The traditional utilities have the opportunity to embrace the new energy world by capitalising on their expertise and resources to expand their product and service portfolio in a customer-centric way.

ADOPT A HYBRID MODEL THAT COMBINES TRADITIONAL UTILITY ROBUSTNESS WITH NEW ENERGY AGILITY

African utilities will need creative ways to use their traditional robust unbundled business model with the new opportunities of the energy

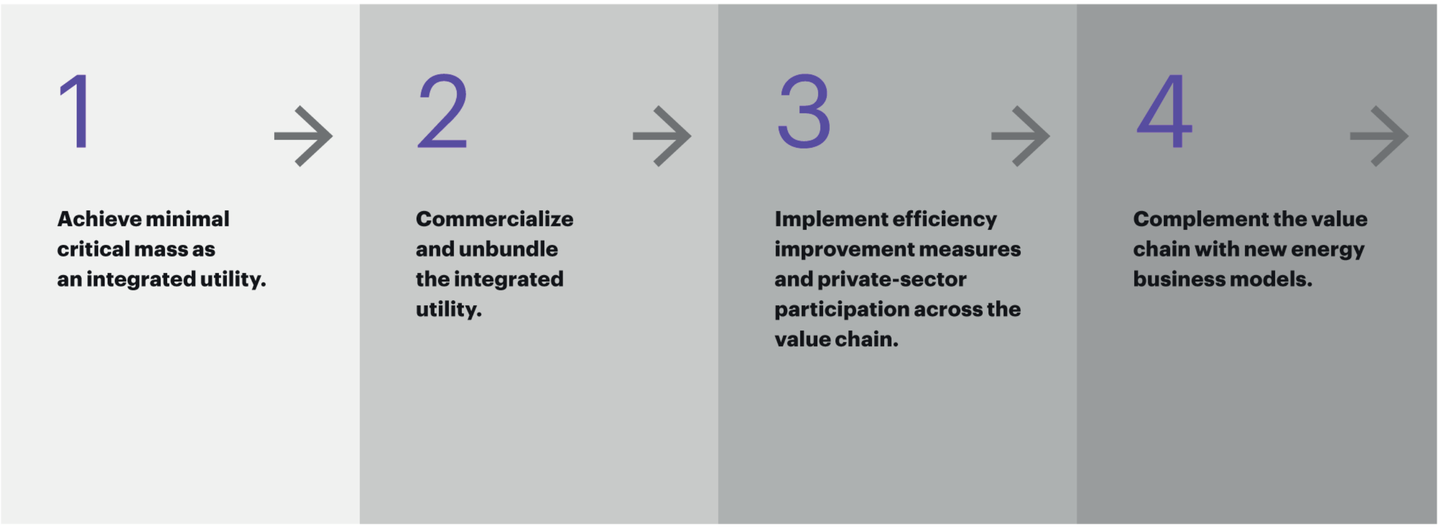


Figure 9: African utilities can take four steps to effectively and affordably supply power to industry and society.

transition trends of decentralisation, decarbonisation, and digitalisation to serve their dual mandate of effectively and affordably supplying power to industry and society.

We recommend a four-step approach (see figure 9):

Achieve minimal critical mass as an integrated utility. Critical mass is achieved when the combined criteria have been met: 30 per cent of the population has access to electricity, and local generation sources are meeting at least half of the demand. Critical mass needs to be achieved before unbundling an integrated utility. This will typically require substantial government intervention and funding, and recurring subsidies.

Commercialise and unbundle the integrated utility. After the critical mass has been achieved, commercialise operations and unbundle the value chains. First, establish a sound legislative and regulatory framework to grant utilities the right to charge for their services and regulate how they measure and price their services. Second, legally and functionally separate transmission and distribution from generation, wholesale, and retail, and establish an independent and competent regulator to monitor the performance of the unbundled utilities and set cost-reflective tariffs. This requires establishing an independent system and market operator (ISMO) responsible for planning generators' supply, buying electricity from generators, and selling electricity to distributors. The ISMO must remain independent of industry participants.

Implement efficiency improvement measures and private-sector participation across the value chain. After unbundling the foundation of the utility sector, the road is cleared for efficiency improvements and private-sector participation. The wholesale market should be structured in a way that removes impediments to competition and stimulates efficiency improvement in generation and sales to improve retailers' collection rates and expand generators' capacity and availability factors along with reducing their operating expenditures. This creates an opportunity for regulatory frameworks to evolve from a rate of return to incentive-based regulation for transmission and distribution to reduce network losses and operating expenditures. To enable this, clearly defined and legally separated entities are needed to ensure no cross-subsidisation of the tariff vertically along the value chain.

Complement the value chain with new energy business models. Once the unbundled structure of the power sector has been finalised, and a sustainable degree of efficiency improvement has been achieved, create the legal infrastructure and enablers for utilities to engage in alternative business models across the value chain. These do not necessarily need to be financial or in the form of outright feed-in tariffs or any forms of subsidies. Instead, focus on non-financial factors that minimise the transaction's costs of operating the alternative business models. For example, rural electrification needs to have well-defined legislation that regulates the creation of mini-grids as well as enforceability for the rights of utilities to collect payments from customers once the utilities have constructed the mini-grids.

Another example is in generation: governments can stimulate the development of utility-scale renewable energy sources by making it possible for such sources to offer guaranteed dispatch for industrial customers, thus making customers immune to the intermittent nature of such sources and overcoming the obstacle in being able to deliver a baseload profile to customers. This can be done by coupling state-owned fossil-fuel generation with renewable sources into baseload packages for industrial customers. This is typically done only for renewable energy sources that have otherwise achieved cost parity or even an advantage over fossil fuel generation. Their intermittence is the remaining obstacle for their marketability on competitive terms.

CLOSE-UP: SUB-SAHARAN AFRICA JOURNEYS TOWARD THE NEW ENERGY WORLD

South Africa: Eskom's imminent unbundling

Eskom is a fully integrated state-owned power utility established in 1923, consisting of generation, transmission, and distribution to end customers.

The utility generates 95 per cent of South Africa's power and 45 per cent of Africa's power and has a power station fleet capability of producing 45,000 MW. It is the largest power utility on the continent. However, Eskom's operations have become unsustainable, requiring additional state funding to ensure ongoing operations. The utility has implemented rotational controlled power cuts to safeguard the electricity system as demand exceeds supply. The lack of supply has been largely the result of inefficient operations due to inadequate maintenance of the generation fleet, delays in the new build program, and ageing power stations. Eskom is also burdened with significant debt in its new power station build program, with cost and schedule overruns. In December 2020, Eskom had ZAR 488 billion of debt.

In addition, Eskom has faced several other challenges:

- Debt owed by municipalities to Eskom totalling ZAR
- 46.1 billion, of which ZAR 31 billion was overdue as of July 2020
- Corruption
- Higher coal costs
- Higher maintenance and operations costs
- Use of expensive feedstock, such as diesel, to avoid rotational power cuts (known as load shedding)
- Skills and capacity erosion at technical and governance levels

Step one of the four-step approach to transforming traditional utilities has been accomplished: Eskom has achieved critical mass as an integrated utility. This moves the company toward step 2 - commercialisation and unbundling of the integrated utility - and puts Eskom on a path of transforming from a traditional state-owned integrated power utility toward a more sustainable model.

In 2019, the South African government announced restructuring Eskom and the electricity supply industry to ensure reliable and affordable power.

The government decided to unbundle Eskom in response to the vertically integrated utility declining to a state with a significant disadvantage. In more developed markets, utilities are typically unbundled from a position of strength, which among other benefits, allows for a shorter timeline for this challenging process.

However, it is not possible to stabilise Eskom in its current state. Although unbundling is not necessarily the complete solution, structural changes to Eskom and the market are needed to solve the utility's issues (see figure 10).

Eskom aims to make the market more attractive for independent power producers (IPPs) to increase generation and competition by allowing access to the national grid. Although legal separation allows for a better focus for each function, each subsidiary is still under Eskom's influence. Maintaining each subsidiary's independence will require having independently-run boards that govern each with no conflicts of interest. Ideally, the flow of energy generated by Eskom Generation and IPPs should be purchased at arm's length by an ISMO and then sold to distributors with Eskom Transmission paid a tariff and only purchasing energy to cover system losses.

HOW DOES ESKOM'S PLANNED APPROACH COMPARE WITH UNBUNDLING IN MATURE MARKETS?

Eskom's approach is similar to how the energy sector transformed in Europe several decades ago. Unbundling was implemented in two stages: functional unbundling and legal unbundling.

Then, the transmission segment of the value chain embarked on a third stage: ownership unbundling. To avoid confusion in terminology, we use a broader meaning for functional unbundling to encompass accounting, organisational, and IT system unbundling, which are typically performed during pre-legal unbundling, as well as management separation, independent decision-making, compliance, and separate identity and confidentiality for commercially sensitive information aspects, which are typically implemented during post-legal unbundling.

During Eskom's operational separation phase, accounting and IT system unbundling will only be the starting point to create transparency into the economics of various value

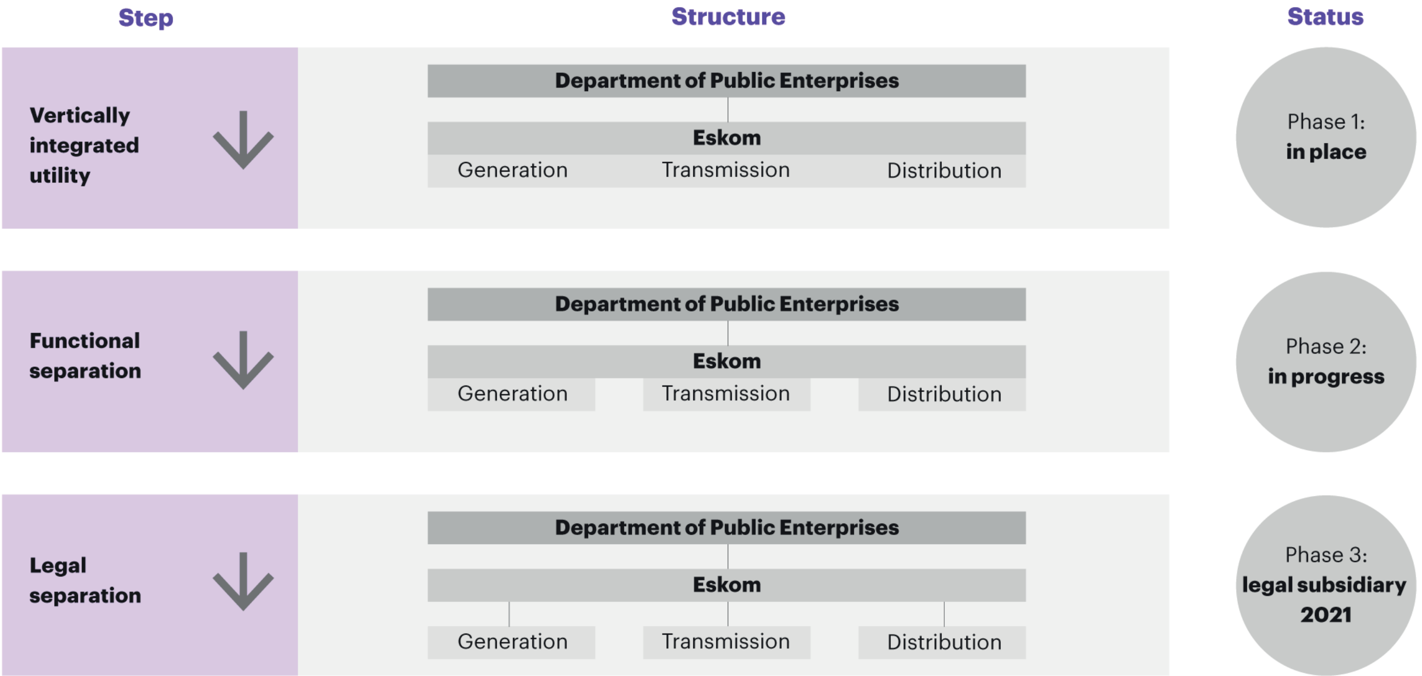


Figure 10: Eskom plans to unbundle over a two-year period.

chain segments. However, for legal unbundling to be successful, the internal organisational separation of the complete operations between value chain segments must already be prepared at this second phase, albeit within the single entity but internally operating as if entirely independent. This can be achieved by creating the requisite separate organisational verticals with allocated management competencies, staff, and resources and clearly defined processes to ensure their autonomy and shared governance converging only at the top of the board level.

The legal unbundling phase has two challenges that Eskom will need to address. One is the complexity of the transaction in terms of establishing different companies and transferring assets, staff, and customer and supplier contracts to the respective entities. The second challenge, perhaps even more important, is to ensure that the resulting legal entities are fully operational and will not threaten the continuity of delivery services to customers. Successfully tackling this second challenge will be underpinned by preparation during the operational separation phase, namely that the different value chain segments are already functioning independently within the single entity. Once the legal unbundling is implemented, the governance rules will be modified to be performed via the statutory bodies of the separate legal entities. But in terms of operational functionality, very few changes will ensure the continuity of delivery services to customers.

WHICH LESSONS AND GOOD PRACTICES CAN ESKOM LEVERAGE FROM MATURE MARKETS TO ENSURE EFFECTIVE UNBUNDLING?

The essence of successful unbundling is to achieve the targeted independence of value chain segments in substance regardless of the chosen form. Even though legal unbundling may be perceived as a way to end the unbundling process, lessons from mature markets indicate that additional steps are required to achieve the targeted benefits. Those steps can be grouped into two blocks: competition in generation, wholesale, and potentially retail, along with functional unbundling of transmission and distribution.

Starting with competition in generation, wholesale, and retail, which is the ultimate goal of unbundling, legally separating the value chain will not guarantee competition. The regulatory framework needs to evolve in parallel to ensure that the critical enablers for effective competition are in place, including the following:

Wholesale market infrastructure. In parallel with Eskom's transformation, South Africa's energy regulator needs to establish a framework for a competitive wholesale market, including the necessary players and their licenses (such as market operators, generators, traders, balancing responsible parties, and bulk customers). Various components of the chosen wholesale market model could evolve, such as bilateral contracting versus organised, day-ahead, intraday, and balancing markets.

Transition plan. Considering that transitioning to a competitive wholesale - and potentially retail - market will not happen overnight, there needs to be a well-designed transition plan for both the customer and supplier sides.

On the customer side, a typical approach has been to adopt a minimum threshold in the form of capacity or annual consumption, which would define the group of customers that will transition to the liberalised market and this capacity to gradually decrease until customers transition. On the supplier side, it will be essential to consider any constraints, such as how long-term power purchase agreements can be mitigated to ensure the functioning of the wholesale market.

Private-sector participation. Last but not least, competition requires multiple players, so it will be crucial to ensure private-sector participation on the supplier side, such as in the form of IPPs, to achieve the benefits of unbundling.

Continuing with the functional unbundling of transmission and distribution, the path to success does not end with the legal separation. The ultimate goal for those value chain segments is to provide indiscriminate access to the respective networks, especially without any preference to any legal entities part of Eskom's vertically integrated undertaking.

To achieve this, several best-practice tools as adopted in developed markets such as the European Union internal energy market can be used post-legal unbundling for Eskom's transmission and distribution subsidiaries, including the following:

Management separation. The subsidiaries must have separate management that has no conflict of interest with the vertically integrated entity (VIE), such as management compensation depending on the results of the VIE or appointment procedures with representatives from other entities in the VIE participating.

Independent decision-making. The subsidiaries must have independent decision-making, with the VIE's role limited to very high-level steering in approving the annual financial plan, the level of indebtedness, and any dividend payout without any involvement in the subsidiary's operational decision-making.

Compliance. The subsidiaries should adopt compliance programs and appoint compliance officers authorised to monitor the compliance with unbundling requirements.

Separate identity. The subsidiaries will need to adopt separate identities in their communications with customers and third parties, making clear their distinction from the VIE.

Confidentiality of commercially sensitive information. The subsidiaries will need to share with other entities of the group only the commercially sensitive information they are entitled to, based on their commercial interactions between the subsidiaries in the context of their licensed activities and not based on common ownership within the VIE.

HOW CAN ESKOM ADAPT ITS TRANSFORMATION PATH TO TAKE ADVANTAGE OF THE NEW ENERGY WORLD?

In mature markets, unbundling was implemented when the traditional energy world was prevailing: fossil-fuel centralised generation and unidirectional networks. But we are now living in a new energy world. So how can Eskom channel this for its transformation?

Looking back at our four-step approach for adopting a hybrid business model, we see that Eskom is on edge between steps two and three, having embarked on the path of value chain unbundling and introducing private-sector participation in generation through IPPs.

Additional opportunities may lie in the transmission and distribution areas from the point of view of adapting them to the needs of the new energy world. Distributed generation can benefit immensely from smart grids—smart both in terms of hardware and operations and available business models and counterparties.

Eskom can position itself as a systemic counterparty to enable and facilitate the adoption of distributed generation by complementing any market or tariff mechanisms with structural enablers, such as integrating storage capacities into the grids and designing and offering the service of flexibility to mitigate the profile and intermittency aspects of renewable energy sources.

In conclusion, Eskom has taken on a challenging but fundamentally right transformation path to enable South Africa's power sector to move to the next level. Eskom's transformation path is not new to the energy world; many mature markets have followed it over the past decades. Now Eskom can take advantage of their lessons to mitigate the inherent risks, embrace the opportunities of the new energy world, and become a strategic enabler for an accelerated path to capture benefits.

GHANA: MOVING INTO A SUSTAINABLE FUTURE WITH A TRACK RECORD OF POWER-SECTOR INNOVATION

Ghana has been a pioneer in advanced power-market reforms, tackling significant changes in the second half of the 1990s to improve efficiency and attract private investments. Ghana unbundled the vertically integrated entity the Volta River Authority into separate generation and transmission utilities. In parallel, the country created two regulatory bodies: technical regulation and licensing and economic regulation and tariff setting.

Ever since, Ghana has stayed at the forefront of reform and innovation in the power sector, including introducing private-sector participation in electricity distribution. Even though this initiative has not yet succeeded because of deficiencies in the private partner's financial credentials, this particular transaction's lack of success does not undermine the fundamental rightness of the course the country is pursuing.

Ghana established its wholesale electricity market by adopting the Electricity Regulations 2008 (LI 1937) to facilitate wholesale trading of electricity and the provision of ancillary services in the National Interconnected Transmission System. The electricity transmission utility operates the wholesale market on a non-discriminatory basis, and market participants include wholesale electricity suppliers (generators), electricity distribution utilities, and bulk customers. Since its introduction, the wholesale market evolution has been focused mostly on allowing more customers to qualify as bulk customers and thus to participate in the deregulated market.

The Energy Commission has gradually reduced the requirement for being classified as a bulk customer to the current maximum demand level of 500 kVA for three consecutive months or minimum annual energy consumption of 1 GWh. (As a point of comparison, the 2008 thresholds were set at 3 MVA and 6 GWh respectively—six times higher.)

The wholesale market has operated primarily through bilateral contracts, both in regulated and deregulated segments. There is limited application of a spot market due to the legislative requirement that the country's low-cost hydro capacity is provided on an equitable basis to all customers, so it cannot be the subject of bilateral contracts.

The Electricity Market Oversight Panel approves how much of the low-cost hydroelectricity will be generated in any given year and how it should be allocated among the competing markets: regulated, deregulated, export, and the VALCO smelter. Naturally, the price discovery mechanisms used in the wholesale market are tightly linked to its dominant forms.

For bilateral contracts, average total costs (rather than marginal costs) are used to determine price; a form of short-run marginal cost is used only for low-cost hydroelectricity. In effect, Ghana's spot market functions as a balancing market equivalent to the mature markets with the additional country-specific factor of ensuring equitable allocation of low-cost hydroelectricity.

Another aspect of the direction of Ghana's power sector is the excess generation capacity under take-or-pay arrangements that have accumulated in the system, the development of which can be found in the Energy Commission's annual Energy Outlook for Ghana Reports. Over the past decade, Ghana suffered several severe load-shedding periods, which led to a fast ramp-up of generation via long-term take-or-pay arrangements with IPPs.

By 2019, the pendulum had swung to the opposite extreme, where the already operational and dependable capacity is more than 50 per cent higher than domestic demand. This has created a heavy financial burden on the energy sector and accumulated deficits because of the large number of charges incurred for capacity that is neither dispatched nor used for ancillary services.

In this context, Ghana has declared its plan to move its wholesale market development toward a fully functioning organised market. Sector regulators and the independent market operator are preparing the regulatory frameworks to enable such a transition.

HOW CAN GHANA ADAPT ITS TRANSFORMATION PATH TO TAKE ADVANTAGE OF THE NEW ENERGY WORLD?

Ghana has navigated the first three steps in our framework. The question now is how it can take advantage of the fourth step in establishing hybrid business models from the new energy world.

How is that possible? The answer can be as simple and radical as this: Ghana's last fossil fuel power plant has already been built. Ghana's ample solar and wind resources would allow sufficient renewable energy capacity to be built to meet the demand for decades to come.

Moreover, under take-or-pay arrangements, the country has substantial conventional capacity to balance the intermittent renewable energy sources until the combined cost of renewable energy and storage reaches parity with conventional generation and large-scale storage can be deployed. Low-rise construction also allows a significant rooftop solar PV capacity to be deployed concerning customer demand—on the grid in areas that have access to the distribution grid and off the grid in rural areas that have not yet been electrified, such as in the Northern Region, where the solar PV yield is the highest in the country.

Making this vision a reality rests on the existing sector players and advanced market structures:

Government. Create a new vision for a renewable-only energy future.

Regulators. Create a technical and commercial framework for balancing and pricing the intermittence of renewable energy sources combined with conventional generation. Create a framework for the competitive acquisition of renewable energy capacity.

Generation utilities. Lead the development of new utility-scale renewable energy capacities based on their experience in constructing and operating large-scale generation capacities—in addition to operating their fossil fuel and hydro fleets.

Transmission utility. Lead the integration of renewables in the dispatch schedules through conventional and new energy means, such as storage, and operating and modernising the transmission grid.

Distribution utilities. Become champions of rooftop solar PV and community micro-grids based on the utilities' experience working closely with a large number of customers, in addition to operating and modernising the distribution grid and serving customers connected to them.

In conclusion, Ghana has all the natural endowments, policy experience, and sophistication needed to realise such a vision—even faster than many mature markets. A future based on new energy is primarily a matter of choice and ambition to continue pioneering West Africa's power sector.

MAKING THE BEST OF BOTH WORLDS WITH HYBRID BUSINESS MODELS

Africa's power sector is poised to evolve, but this evolution needs to be supported by a fundamental change in how utilities are organised and how they operate. Africa needs electrification to boost its economy and enable its social development.

At the same time, a new energy world is dawning—creating new opportunities for African utilities to make a quantum leap in their development to catch up and even surpass their counterparts in mature markets. To make this leap, utilities will need to adopt hybrid business models to make the best of traditional utility and the new energy world. wn

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Further Beyond Four Hours

The growth of energy storage shows no sign of abating—quite the opposite. In November 2017, Bloomberg New Energy Finance predicted the global energy storage market would double no fewer than six times between 2016 and 2030, rising to a total of 125 GW and 305 GWh of installed capacity.

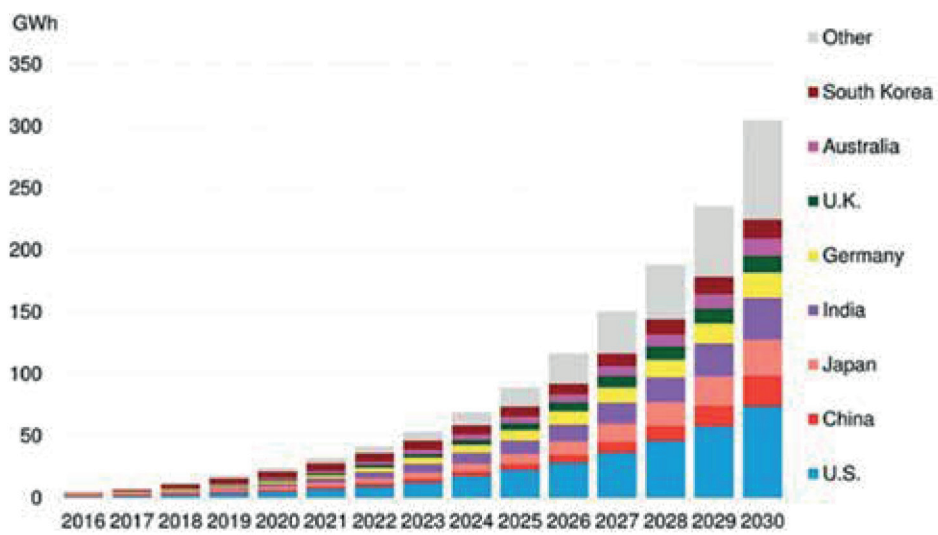

Figure 1: Global cumulative storage deployments. Source: Bloomberg New Energy Finance.

This is a similar trajectory to the remarkable expansion that the solar industry went through from 2000 to 2015, in which the share of photovoltaics as a percentage of total generation doubled seven times.

The growth is set to eat up USD 103 billion in investment and will be led by eight countries: the US, China, Japan, India, Germany, UK, Australia and South Korea. These will account for 70% of all the capacity installed.

The implication is that many other nations will be waiting in the wings to further power growth when these major markets reach saturation.

And looking at Bloomberg New Energy Finance's data (figure 1), it seems as though the global market for energy storage will barely have begun to ascend the S-curve by 2030.

It is also logical to expect long-duration storage to make up an increasing proportion of overall capacity, if only because short-duration assets have a narrower range of applications.

This is affirmed by the International Renewable Energy Agency (IRENA), which points out: "With the very high shares of wind and solar PV power expected beyond 2030, the need for long-term energy storage becomes crucial to smooth supply fluctuations."

Long-duration storage has traditionally been served through pumped hydro which, as of mid-2017, still accounts

for 96% of the total installed storage power capacity of 176 GW installed globally.

However, despite a rush of recent proposals in the US, pumped hydro remains a challenge for project developers. It requires high upfront investment and the right kinds of geography, permitting flexibility and market setup.

For this reason, the power industry is still grappling with what technologies could best be deployed at the scale required for bulk long-duration energy storage.

Attempts so far have tended to focus on the scaling up of lithium-ion battery systems. Given its susceptibility to potential supply chain problems and various other problems, it is doubtful if lithium-ion is the best fit for megawatt-scale long-duration energy storage tasks.

Building on research from 2016, this study looks to delve deeper into the long-duration energy storage market and uncover some of its players' current preoccupations and preferences.

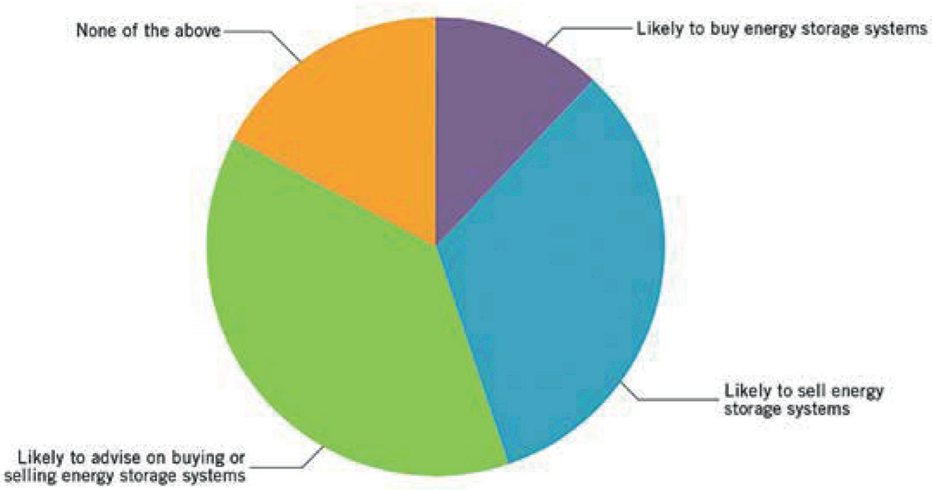

Figure 2: Which of the following best describes your organisation?

Specifically, we asked energy storage experts to disclose:

- How they define long-duration energy storage
- How important it is for their business
- What applications do they think to offer the most significant potential for a return on investment
- in long-duration storage
- What criteria do they use for evaluating long-duration energy storage systems
- Which technologies they might consider for long-duration storage
- What their biggest worry is regarding long-duration storage
- When they think long-duration might outstrip short-duration storage

A NOTE ON METHODOLOGY

The findings in this paper are based on research carried out in November 2017 among the readers of Energy Storage Report, a specialised industry intelligence platform.

The survey drew 58 full and ten partial responses, 50% of which respondents identified as likely to buy or specify energy storage systems (figure 2). The sample included analysts, energy storage system vendors, solar installers, industry bodies, consultants, engineering groups, supply chain providers and project developers. This quantitative data was supplemented with in-depth discussions with industry figures.

Where relevant, the findings in this study have been compared to those of our 2016 report. However, the data set for the first study was considerably less robust and should be seen as offering indicative results only.

In the discussion, percentages have been rounded up to the nearest whole number.

DEFINING LONG-DURATION STORAGE

Since the timeframe of long-duration storage remains somewhat subjective, in this research, we gave respondents ten options to choose from, with discharge times ranging from 30 minutes to 24 hours.

In the 2016 study, 20% of respondents expected assets to run for longer than 10 hours. However, a combined 25% were looking for a discharge time of 12 hours to a full day (figure 3). It is clear, then, that the mindset has shifted to expect long-duration storage to last even longer than before.

There does, however, appear to be greater consensus around the idea that the transition point from short to long-duration is around four hours. Only 10.5% of respondents argued for discharge times of less than four hours, compared to 40% in the previous study. This implies a maturation of the industry and a broadening understanding of those working within it.

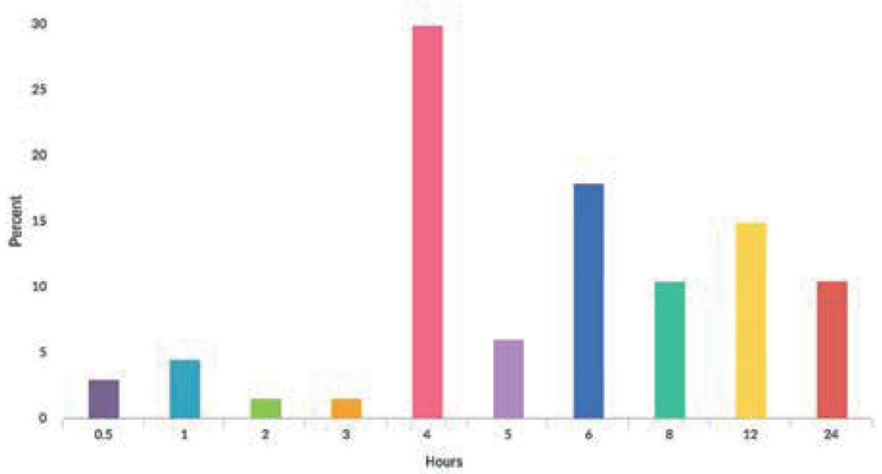

Figure 3: What is the minimum storage duration (in hours) that you would say qualifies as 'long-duration storage'?

THE IMPORTANCE OF LONG-DURATION STORAGE

Although this question cannot be directly compared with our previous research, it appears that long-duration storage has increased in importance within the industry.

In 2016, 30% of respondents said long-duration storage did not apply to their business or might become necessary, but was not currently.

In the present study, which went out to a more diverse base of respondents, 47% said they were considering long-duration storage concerning some projects, while 27% said they were looking at it for most (figure 4).

APPLICATIONS FOR LONG-DURATION STORAGE

In contrast to generation technologies, energy storage can be used for many applications. However, the exact number and the definition of each one are not standardised. Thus, we used a categorisation developed by Everoze Partners in the UK for this study.

Although the categorisation is designed for the British energy storage market, which is currently set up to favour frequency response-related services, it has the advantage of being quite granular, covering 14 clearly-defined applications:

- Renewable energy self-consumption
- Backup power in the event of grid failure
- Capture spilt energy: storing energy that would otherwise be lost due to grid constraints
- Red Zone Management: shifting consumption to avoid periods of high network cost
- Capacity Mechanism: to guarantee capacity for any given year
- Wholesale markets arbitrage: buying energy cheaply and then selling when prices are higher
- Black Start: to recover from a total or partial shutdown of the transmission system
- Triad Avoidance: reducing consumption at periods where peak demand is forecast
- Retail markets arbitrage: based on customer's retail tariff, not prevailing wholesale price
- Fast Reserve: large blocks of reserve energy to respond within 2 minutes
- Enhanced Frequency Response: requiring a complete response in less than a second
- Firm Frequency Response that can

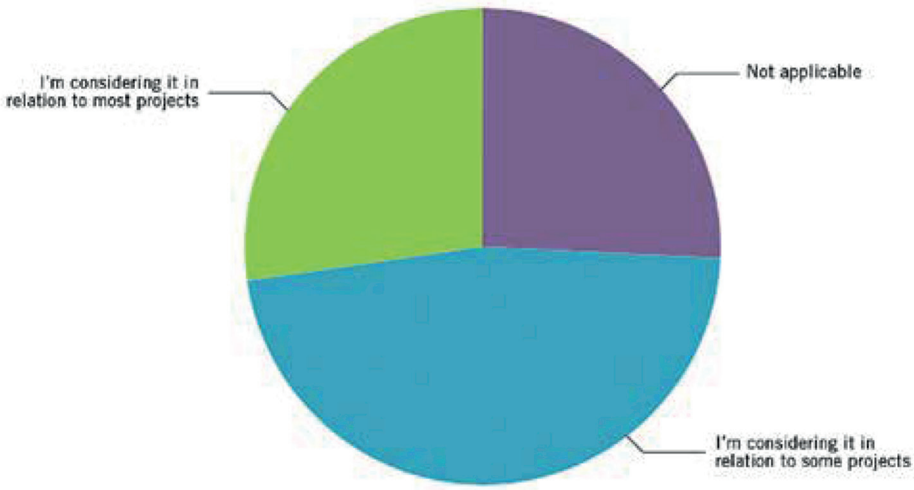

Figure 4: How important is long-duration storage for your business?

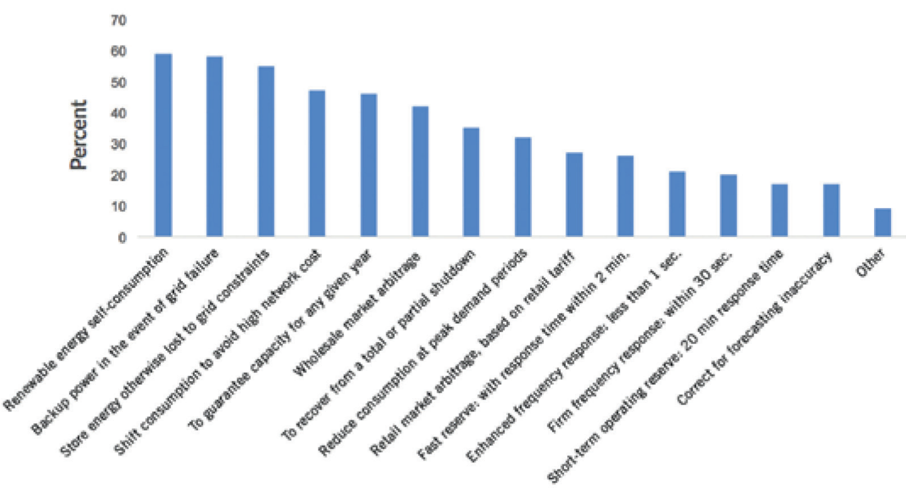

Figure 5: What applications offer the most significant potential for a return on investment in long-duration storage?

respond within 30 seconds

- Short-Term Operating Reserve: where a response time of up to 20 minutes is required
- Correct for forecasting inaccuracy: when generation is out of line with forecasts

These energy storage applications range from enhanced frequency response services which require sub-second response times, to wholesale market arbitrage, where lengthy discharge times may be needed to maximise profitability. Remarkably, all 14 options were seen as potential targets for a long-duration energy storage application stack (see figure 5). The applications our survey respondents favoured most were:

- Improving renewable energy self-consumption, cited by 59% of respondents
- Providing backup power (58%)
- Capturing energy otherwise lost due to grid constraints (55%)

The least popular applications, meanwhile, were:

- Delivering short-term operating reserves, with a response time of up to 20 minutes, and correcting forecast inaccuracies, both cited by 17% of respondents
- Providing frequency response services within 30 seconds (20%)
- Offering enhanced frequency response services within a second (21%)

Respondents' top choice of application in this study mirrored the results in 2016 when renewable energy self-consumption was cited above all other use cases. Similarly, frequency response services also had a low rating in 2016.

Nevertheless, the fact that no application was ignored points to significant potential for revenue stacking in long-duration energy storage assets.

In addition to the 14 categories listed above, respondents offered several other potential applications for long-duration storage, including microgrids, mini-grids, solar-plus-storage systems and the covering of long demand charge windows.

CRITERIA FOR SELECTING LONG-DURATION STORAGE

Our respondents were presented with a dozen criteria for long-duration storage technology selection, ranging from capacity fade to management software quality (figure 6).

The top choice was Levelised Cost of Storage (LCOS), which offers an objective, transparent methodology for comparing the cost and performance of various energy storage technologies across a range of illustrative applications.

It was cited by 27% of respondents, compared to the 24% that chose capital cost or the 10% that selected the system's usable life. The importance of capital cost, which mirrors our finding in 2016, is unsurprising.

This is, after all, a 'permission to play' factor: if you cannot afford to buy technology, then none of the other selection criteria will make a difference.

But while capital cost may be the most preeminent among financial considerations, others, such as operations and maintenance costs, are also high.

Since LCOS can aggregate these factors into a single number, it trumps even capital cost in the final analysis. However, roughly half the sample chose neither capital cost nor LCOS as the most critical technology selection criterion.

Instead, these respondents selected many factors, such as capacity fade, environmental friendliness, usable life and safety (the latter also highly cited in 2016), as significant in today's market. These factors are perhaps the most significant inhibitors for lithium-ion technologies, which lose a portion of their lifespan on each cycle and pose a fire risk.

Thus, long-duration energy storage procurement depends on a complex balance of many factors; there is no single key metric for energy storage success. The only one of the dozen potential selection criteria that was not key to anyone was the energy density or footprint of the technology.

For technology vendors, the implication is that there can be no one-size-fits-all approach to long-duration energy storage system sales. Cost is essential, but even that will be the deciding factor only half of the time.

To summarise the findings from this portion of the research, an ideal long-duration energy storage technology is, not surprisingly, likely to be cheap,

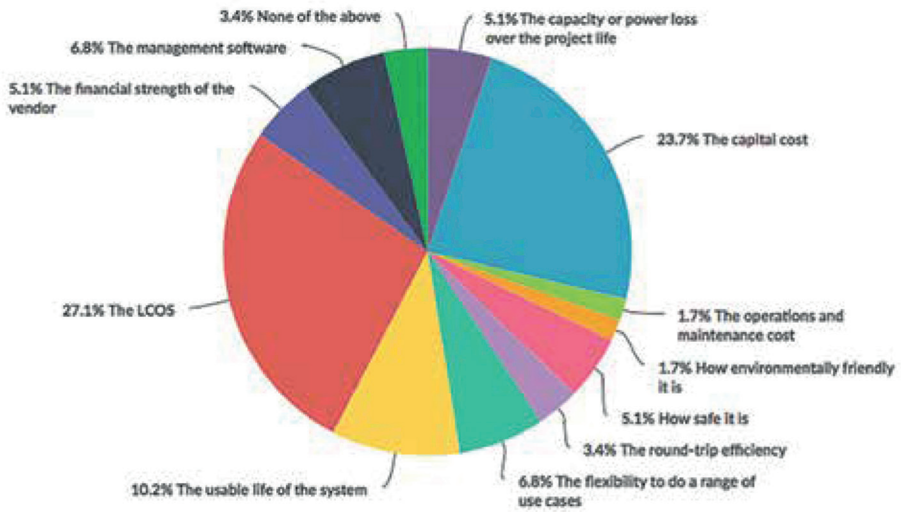

Figure 6: When evaluating a long-duration energy storage solution, how important are the following criteria?

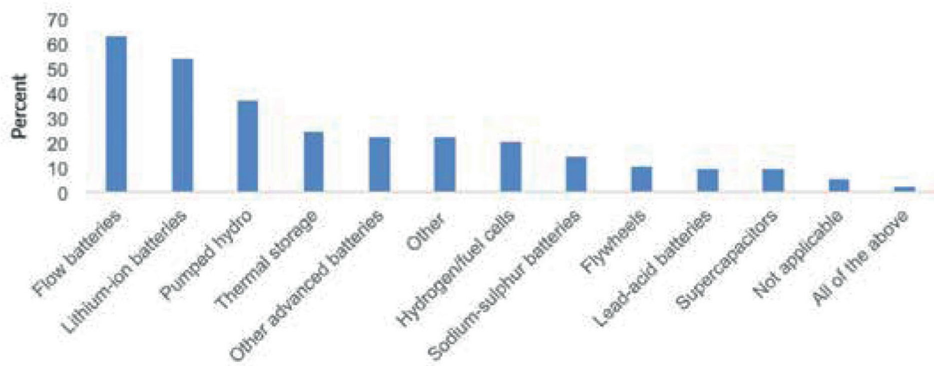

Figure 7: Which technology or technologies are you most likely to consider for long-duration storage?

safe and lasts a long time without degradation.

THE BEST TECHNOLOGIES FOR LONG-DURATION STORAGE

As mentioned, one of the challenges facing the long-duration energy storage market is that there is no single evident technology to deliver services.

This is unlike short-duration energy storage, where lithium-ion batteries are increasingly preferred based on cost, scalability and bankability.

Lithium-ion is an option for long-duration storage, but we've already discussed why it may not be the best option. Other technologies range from alternative battery chemistries or fuels, such as hydrogen, to pumped hydro, the current market leader. To determine which technologies might be at the top of procurement lists today, we asked respondents to identify what options they would most likely consider for long-duration storage.

We provided a list of 10 storage technology families, adapted from the classifications used by IRENA in its "Electricity storage and renewables:

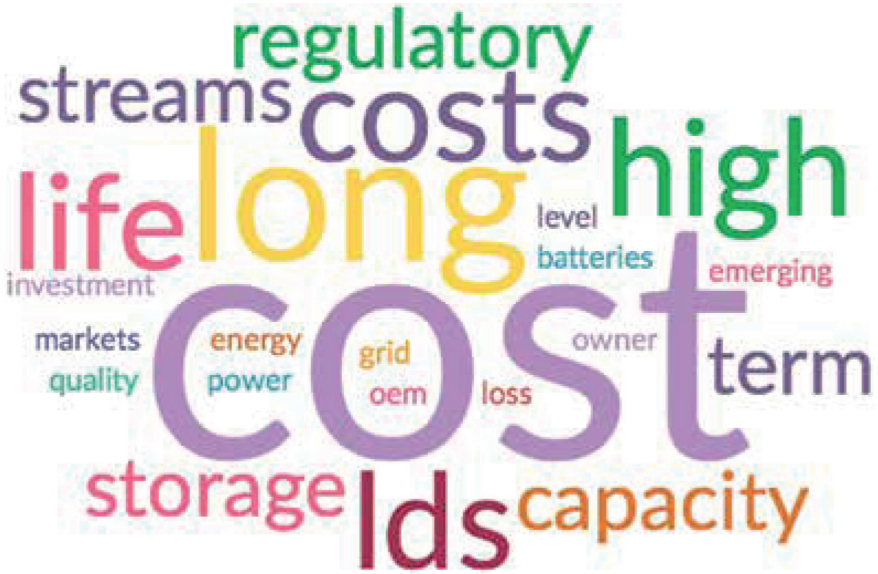

Figure 8: What is your biggest concern/worry about implementing long-duration storage?

Cost and markets to 2030" report. The top three technologies selected, in order of preference, were (figure 7):

- Flow batteries, cited by 63% of respondents
- Lithium-ion batteries (54%)
- Pumped hydro (37%)

Interestingly, this selection potentially represents a gradation from smaller-scale, shorter-duration assets, typified by lithium-ion battery systems, to very large-scale, long-duration storage, typified by pumped hydro.

Flow batteries sit neatly between these two extremes, providing storage durations that can go from a few hours to a few days and capacities of up to (potentially) hundreds of megawatts.

LONG-DURATION STORAGE IMPLEMENTATION CONCERNS

Reflecting the technology selection criteria outlined previously, the biggest worry in implementing long-duration energy storage projects was cost (figure 8).

In particular, some respondents were concerned about the cost of storage assets concerning their potential lifetime return on investment. Behind this obvious worry, though, were further queries including:

- Would storage assets live up to manufacturers' promises around quality and performance?
- Would market regulation favour the use of assets over time?
- Would the assets be easy to source, run and recycle?

While the presence of numerous, valid concerns should not be underplayed, most of the worries that were voiced were indeed ones that might be expected to diminish as technologies and markets mature. In the power supply inadequacy of my environment, there is no debate that long-duration storage has a market if the cost is reasonable and the service is available.

CONCLUSION: A WELL-DEFINED MARKET IS EMERGING

The research carried out in this report was completed against a backdrop of discussion around the ability of renewable energy to replace traditional generation fully.

Nobody doubts that this task will be challenging. Nor is there any doubt that energy storage could play a critical role. The question is how critical.

Studies show that despite high hopes for energy storage, even vast pumped hydro reserves would struggle to maintain a decent wind and solar-based electricity supply in temperate latitudes during long spells of calm, cloudy weather.

This suggests that a fully decarbonised grid may rely on some form of non-intermittent, firm power, for example, biofuels, hydrogen, or new nuclear technology.

At the same time, energy storage is increasingly seen as a valuable aid to increasing renewable energy penetration to take the most significant possible advantage of wind and solar resources.

In this evolving market and policy scenario, we are seeing discussions around long-duration storage. These are assets that perhaps will not deliver power for weeks on end but can at least satisfy a grid's load for hours or perhaps days.

Since our previous report on this issue, we have seen growing consensus around what should be defined as 'long-duration' (more than four hours) and what assets could deliver it (flow batteries, flanked by lithium-ion and pumped hydro).

One final question in our research provides insight into how quickly this market is maturing. We asked when respondents thought long-duration storage deployments might outstrip short-duration ones (figure 9).

For almost 9% of the sample, this is already happening. Another 9% expected it to happen within the next

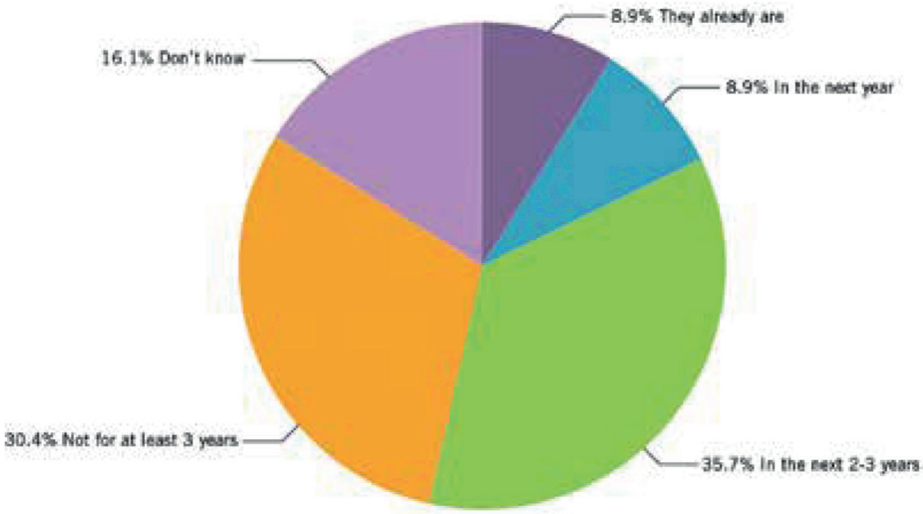

Figure 9: When do you think long-duration storage deployments might outstrip short-duration storage deployments?

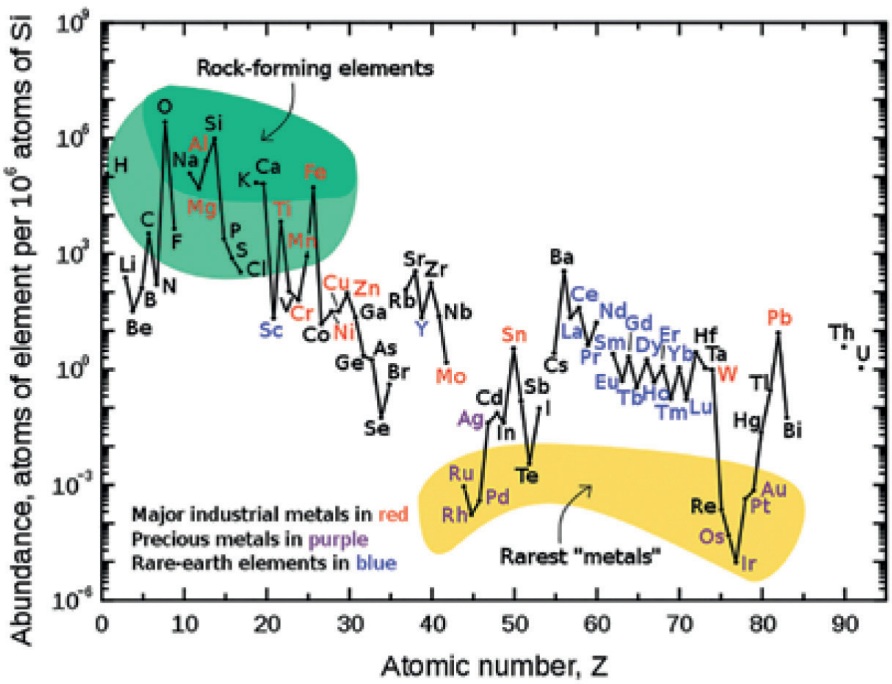

Figure 10: Abundance (atom fraction) of the chemical elements in Earth's upper continental crust as a function of atomic number.

year. And around 36% said within two or three years.

Less than a third (30%) thought the switch might not happen for another three years at least.

One key, if predictable, finding from our research is that the actual rate of change is likely to be strongly related to capital cost.

This finding echoes other research. A recent white paper, for example, concluded that "capital costs must decrease for a given system as durations are scaled beyond those typically utilised for daily cycling."

This focus on capital costs naturally favours flow batteries, an increasingly mature and technically unchallenging technology.

The cost issue also puts the spotlight on materials: ultimately, as we head towards ever-greater amounts of long-duration storage, the advantage will most likely lie with those technologies that use the cheapest, most plentiful materials.

In practice, these are likely to come from one of two groups: the rock-forming elements, which include sodium, silicon and carbon, and the primary industrial metals, such as aluminium, magnesium and iron (figure 10).

Relatively few energy storage technologies are based on such materials today. But for tomorrow's bulk long-duration storage applications, they will be increasingly critical. wn

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Global Energy Trends 2022

- POWERING THROUGH DISRUPTION

Without a doubt, the early 2020s have been unusual. The global effects of Covid-19 deservedly dominated headlines worldwide for much of the last two years. But the pandemic was not the only topic of significance. The move towards a more sustainable future continued to gather momentum, and some key trends for the industry worldwide came into sharper focus.

Here, we examine the key trends that commentators agree will be at the forefront of discussions about and developments in the energy sector in 2022 and beyond.

As the energy landscape is constantly changing, other topics will appear or gain importance in the coming months and years. Even so, we can safely assume that sustainability will continue to impact the industry heavily.

Technology themes such as artificial intelligence (AI), big data, the internet of things (IoT), and digitalisation will be paramount as the industry looks to function with the highest efficiency and reliability levels.

Along with the electrification of other sectors, such as heat and increasing levels of renewables, electric vehicles (EVs) are expanding fast in several of the world's largest markets. We can also be sure that renewables will play an increasingly important role in energy generation with, consequently, an equally increasing need for grid balancing services and energy storage.

Several new technologies on the horizon could gain traction over the coming years, such as increasing peer-to-peer trading and innovative new green generation technologies.

LOOKING BACK | THE IMPACT OF COVID-19 ON THE ENERGY SECTOR

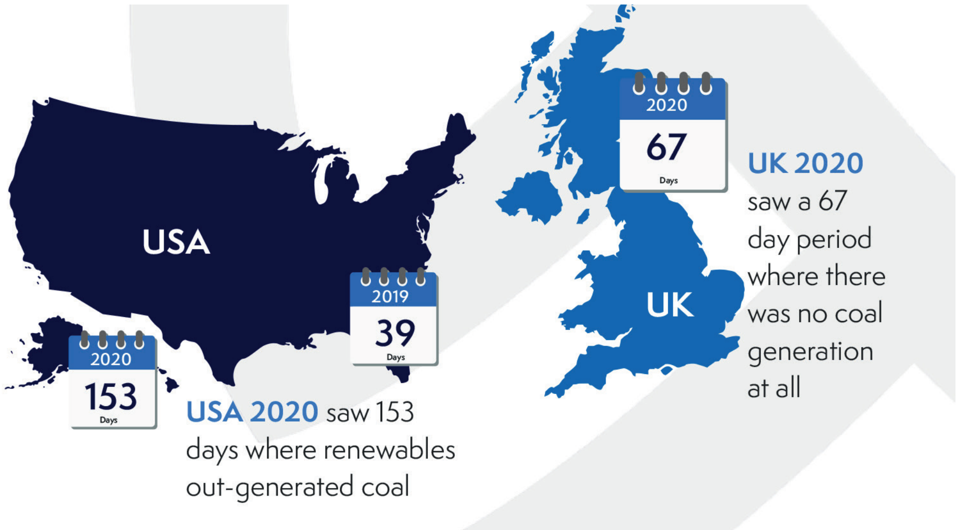
Around the world, measures to combat the spread of Covid-19 ranged from simple bans on public gatherings to lockdowns that halted all but the most essential social and economic activity.

The impact on the energy sector was immediate, with electricity demand dropping significantly. The 11% (YOY) fall in demand in China in February 2020 - one of the first countries affected - was later matched by similar figures in other markets.

By mid-April 2020, weekly energy demand had fallen 25% for countries in complete lockdown and 18% for those in partial lockdown. Global energy demand contracted some 6% for the year, over seven times more than during the 2008-09 financial crisis, as cuts in commercial and industrial demand outweighed higher residential usage.

RISING RENEWABLES

At the same time, the energy mix shifted towards a more significant share of renewables.



In Europe, renewables' share of total power generation hit 41% in the first quarter of 2020, 16% higher than the first three months of the previous year.

For the year, renewables saw a 10.3% growth in global capacity, with wind and solar accounting for more than 90% of the increase. In the UK, 2020 saw 67 days when no generation from coal occurred at all. In the USA, there was a similar picture where renewables out-generated coal on 153 days in 2020, compared to 39 days in 2019.

Low levels of demand and high renewables generation led to a collapse in electricity prices. In Q1 2020, Germany registered 172 occurrences of negative wholesale prices, compared with 212 for the whole of 2019, and Spain saw its lowest average prices in four years. In the UK, negative electricity prices were recorded 66 times in April 2020.

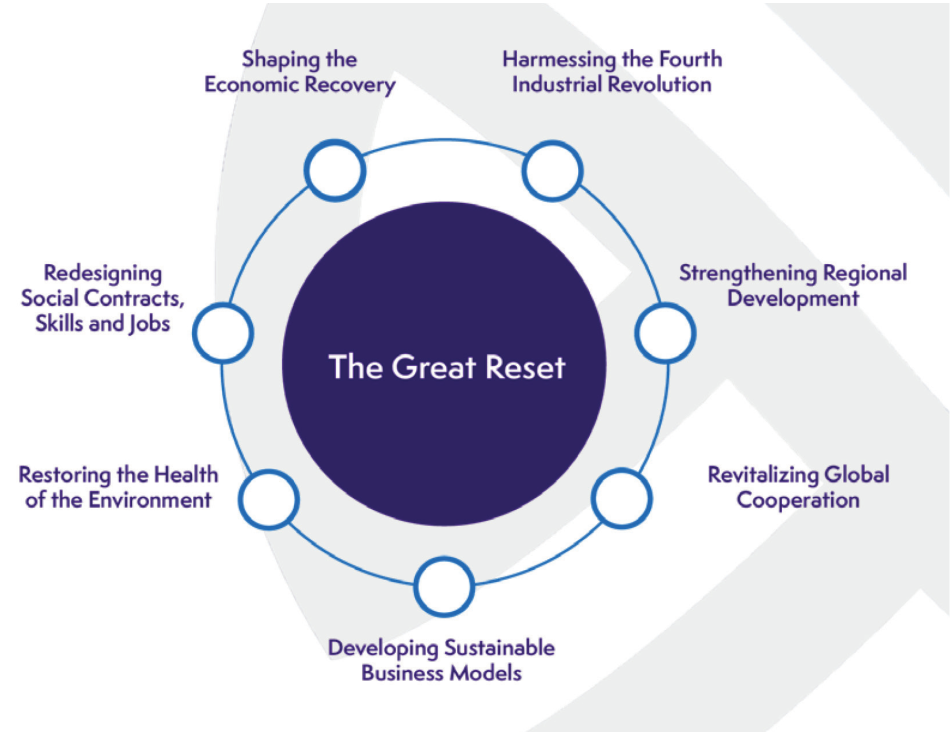
The pandemic has also affected stakeholders across the value chain to varying levels. Decreased cash flows, limited workforce availability, and changes in consumer behaviour affect the sector.

THE GREAT RESET

"Governments will play a significant role in shaping the energy sector's recovery from the Covid-19 crisis, just as they have long been in the driving seat in orienting energy investment.

In particular, the design of economic stimulus packages presents a significant opportunity for governments to link economic recovery efforts with clean energy transitions – and steer the energy system onto a more sustainable path.

"While the clean energy transitions and stimulus discussions are gathering momentum, a coordinated policy effort will be needed to harvest its opportunities and lead to a more modern, cleaner and more resilient energy sector for all."
- *International Energy Agency, June 2020*



OPPORTUNITIES

The pandemic accelerated a fundamental review of future global priorities. This was reflected in "the Great Reset" strategy - the 2020 World Economic Forum theme in macroeconomic and social terms.

A move away from fossil fuels was an essential part of the strategy, mirrored by a call from the Head of the International Monetary Fund to "end subsidies for fossil fuels". Already, we are seeing governments responding to the challenge by increasing their commitment to net-zero targets and the expansion of renewables.

When developing this paper, the global health crisis is continuing. Accelerating vaccine rollouts and major stimulus packages in many economies provided a beacon of hope in mid-late 2021, leading to a rebound in energy demand, which is expected to increase by 4.6% in 2021. This more than offsets the 4% contraction in 2020 and pushes demand 0.5% above 2019 levels.

As the IEA's Dr Fatih Birol says, it may be "still too early to determine the longer-term impacts" of the pandemic. But that shouldn't stop us from looking ahead.

In a paper on the effects on the pandemic published in the MDPI journal Energies, the authors point to the "priceless" lessons and new data that Covid-19 impacts provided, which may help them "better understand the power systems of tomorrow."

The impact of Covid-19 on the energy sector will be far-reaching. The spike in the share of renewables in the energy mix during lockdown periods provided a glimpse into a future where low-carbon energy will dominate.

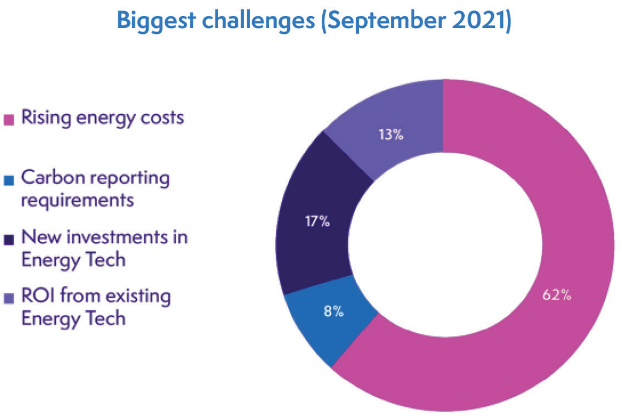
Notably, the incidences of negative market prices in many countries evidence the need for flexibility on the demand side. At the same time, greater investment in energy storage technologies is required to enable further integration of renewables while maintaining the reliability of the energy networks.

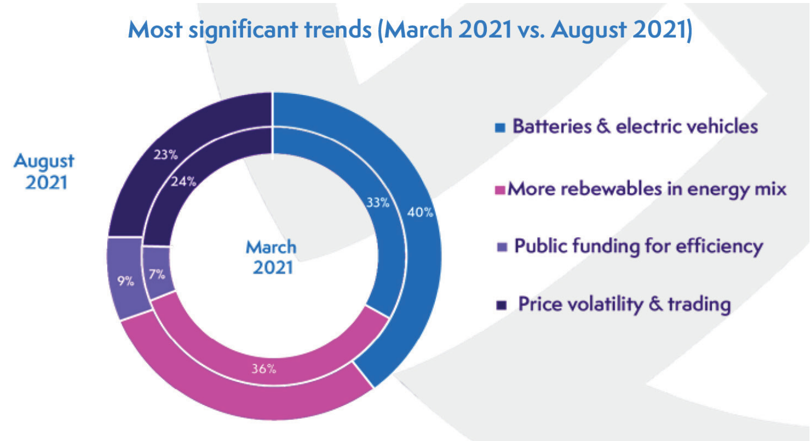
LOOKING AHEAD | KEY TRENDS FOR 2022 AND BEYOND

A recent poll (March 2021 and August 2021) shows some trends that industry players believe will have the most significant impact.

In March 2021 and again in August/ September 2021, opinions were sought of industry stakeholders, from suppliers and retailers to generators and end-users, which will have the most considerable impact on energy markets in the future.

Between March and August, one fundamental change between the outcomes is the significant uptick in views that batteries and electric vehicles will bring about significant changes for energy markets – a 21% rise between March and August 2021 – and replaced rising renewables in the energy mix as the key challenge for the future.





THE CLIMATE AGENDA

From countries and companies to individuals, tackling climate change is at the top of the agenda. There has been a renewed focus on sustainability and environmental reporting; the introduction of net-zero targets, combined with the "Greta effect", means that people are taking more notice regarding climate change and carbon emissions.

In addition, the post-Covid-19 reset of national economies is providing governments with opportunities to link their recovery programmes to climate change strategies that include rebalancing their energy systems towards a greener future. The result is that governments and businesses worldwide are imposing carbon reduction goals and net-zero deadlines.

Some net-zero pledges deal with a company's direct greenhouse gas (GHG) emissions from their activities (scope 1) and consumption of electricity (scope 2). Others are all-encompassing and deal with (scope 3) emissions generated by consuming a company's products.

The most common form of net-zero pledge commits to cancelling out current and future emissions, generally by 2050. The mid-century time frame was based on evidence that net-zero emissions needed to be achieved by this date to limit the global temperature increase to 1.5°C above pre-industrial levels. But the Intergovernmental Panel on Climate Change (IPCC) 's Sixth Assessment Report, Climate Change 2021, indicates that climate change is occurring much faster than previously predicted.

The most recent estimates show that the global temperature could exceed 1.5°C of warming, relative to 1850-1900, by 2030. Consequently, some companies are choosing to reconsider their existing pledges in light of this.

THE ROAD TO NET-ZERO

In the UK, for instance, in April 2021, the government announced a target to reduce greenhouse gas emissions by almost 80% by 2035 compared to 1990 levels.

In the USA, the Biden administration's energy plan proposes a net-zero power system by 2035. In addition, at the Leaders Summit of Climate Change in April 2021, the President set a target for reducing emissions in the USA by 50-52% by 2030 compared to 2005 levels.

As tracked by the Energy and Climate Intelligence Unit, over 130 countries have committed to carbon neutrality to date by making pledges to the Carbon Neutrality Coalition and by introducing new internal net-zero regulations.

But the IEA's 2021 World Energy Outlook notes that the recovery from the Covid-induced recession is putting significant strains on parts of today's energy system, sparking price rises in gas, coal and electricity markets. For all the advances made by renewables and electric mobility, 2021 is seeing a considerable rebound in coal and oil use, resulting in the second-largest annual increase in CO_2 emissions in history.

THE UNSTOPPABLE RISE OF RENEWABLES

The trend towards a greater role for renewables has been growing for several years. However, the latest data indicates that the integration of green energy is now accelerating faster than ever, driven by a mixture of government policies, public pressure for environmental action, and market dynamics.

In 2020, the renewables industry grew at its fastest pace in two decades, despite the disruption caused by the Covid-19 pandemic. In its 2021 Renewable Energy Market Update, the IEA reported that renewable capacity increased by 45% in 2020 to 280 GW, the most significant year-on-year increase since 1999. The report also predicted that the increase in 2020 is set to become the "new normal", with about 270 GW of renewable capacity on course to be added in 2021 and almost 280 GW in 2022.

In Europe, annual capacity additions are forecast to increase 11% to 44 GW in 2021 and 49 GW in 2022.

Germany is expected to deliver the most extensive renewable capacity additions in Europe, followed by France, the Netherlands, Spain and the UK. This growth stems from multiple countries extending their policies to meet climate targets and several countries' corporate power purchase agreement (PPA) markets booming.

In the USA, renewable capacity growth this year and next is mainly spurred by the extension of federal tax credits, which last until the end of December 2025. While fossil fuels account for 85% of generation, the introduction of renewables is likely to see a massive acceleration under the presidency of Joe Biden, who recently announced that the country is targeting a zero-carbon power grid by 2035.

The US Energy Information Administration estimates that of the 41.9 GW of electric generating capacity additions planned, 44% would be wind, 32% solar PV, 22% natural gas-fired, and 2% from other sources.

STIMULATING INNOVATION

Other key developments in the USA include the September 2020 decision by the Federal Energy Regulatory Commission (FERC) to allow Distributed Energy Resources (DERs) to gain easier access to wholesale energy markets.

This decision will stimulate innovation and give the green light to energy technology developers, aligning with the strategy of other advanced energy markets such as those in the UK and Ireland. Greater competition and market openness are seen as essential to developing new energy technologies and services needed to advance the clean energy transition.

Japan and Australia are strong growth markets for solar PV. Around 21 GW of PV projects in Japan received approval under the Feed-in Tariff scheme but were not operational as of September 2020.

IEA noted that Australia exceeded its large-scale renewable energy target (LRET) in 2020, and the resulting oversupply of LRET certificates negatively affected the business case for utility-scale PV projects. As a result, some developers seek to sign corporate PPAs to ensure stable remuneration.

In the Republic of Ireland, at least 80% of all energy is targeted to be from renewable sources by 2030. In an exercise in February 2021, system operator, EirGrid, run several trials to gauge how the energy system would operate with this mix. Figures for a 24-hour average during the trials showed that wind power generated 3,065 MW, while demand was 3,887 MW.

THE PATH AHEAD

In many markets, renewables now represent the cheapest available source of new electricity generation. Clean energy technology is becoming a significant new investment, employment and international competition.

Covid-19 introduced additional challenges for the renewables sector, such as constraints on financing availability, the re-prioritisation of government budgets, and electricity demand uncertainty. But the trend is still clear: renewables are an increasingly important part of the energy mix, and the levels of their generation capacity continue to expand. Cost reductions and sustained policy support will drive strong growth beyond 2021.

As renewable penetration on the grid increases, technologies that can provide ancillary grid services and on-demand supply or demand reduction are expected to follow.

THE GROWING NEED FOR FLEXIBILITY

More renewables in the energy mix mean a need for more flexibility in the system to manage peaks and troughs caused by intermittent generation.

In large power plants using rotating generators, a plant can continue to generate electricity for a few seconds after it begins to fail. This is due to the inertia – the stored energy – released as rotation continues. The window may only exist for a few seconds. Still, it's enough time for the fault to be detected and for the grid to respond – balancing the supply by using other sources if available to maintain grid frequency.

Renewables don't have this level of natural inertia, which means that – as they play an increasing role in the energy system, grids can no longer rely on inertia as a key factor in the system. Another way of managing grid frequency needs to be found.

A 2020 report by the National Renewable Energy Laboratory (NREL) considers that solutions such as fast frequency response, where inverter-based renewable sources can respond more quickly to changes in grid frequency than conventional mechanical methods, may mean that there will be less need for inertia in the energy systems of the future.

Even so, the ability to capture and store energy from renewable sources is still a critical and growing need.

ENERGY STORAGE TRENDS

Around the world, utilities, regulators, investors and businesses are pursuing various approaches to build up the flexible capacity needed to meet demand, with batteries commonly being cited as a critical piece of the jigsaw.

At its most basic level, energy storage ensures that the energy generated is available when needed, not simply when being generated. Large-scale battery storage is often co-located with renewable energy generation facilities for this reason.

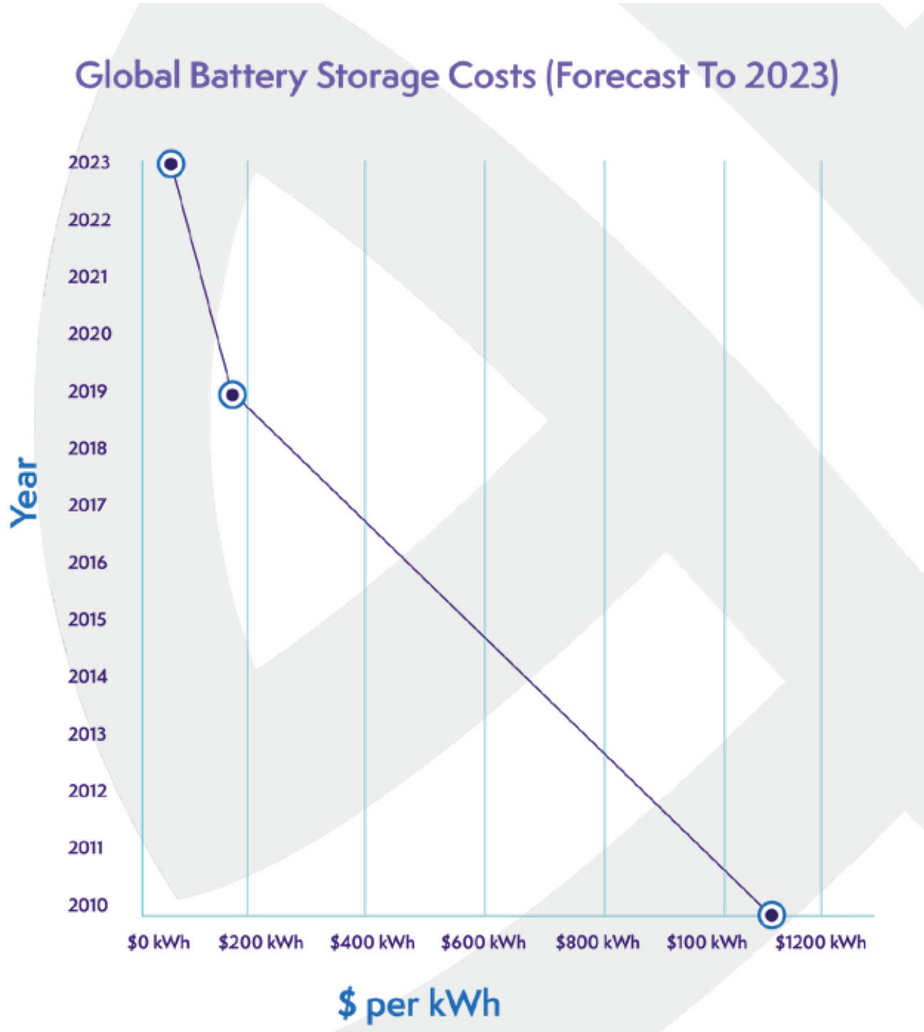
While not being the only energy storage technology available, batteries are currently at the forefront of responding to the need for more storage capacity. All the indicators point to the continuing expansion of the battery storage sector worldwide, especially as prices have seen significant reductions over recent years.

According to Bloomberg NEF (BNEF), real-term costs of $1,100 per kilowatt-hour in 2010 dropped by 87% to $156/kWh in 2019 and are forecast to be around $100/kWh by 2023.

CAPACITY RISING

BNEF also forecasts that 1,095GW of storage will be in place globally by 2040, and the increase in demand for storage is already clearly reflected in markets around the world.

In the relatively small market of the Republic of Ireland, for instance, around 400 MW of projects are already



in place or under construction and ready to go live in 2021-22.

The growth in electric vehicle production and demand is also fuelling higher demand for batteries worldwide, mainly as governments worldwide introduce targets for low-carbon transport.

In its latest report, the International Energy Agency and European Patent Office noted that the use of batteries in the energy sector is also rapidly expanding, albeit at a slower rate than in the field of electric vehicles.

Globally, it found that in 2019, the total installed capacity was at just under 200 GWh – the energy volume equivalent of storing the world's electricity requirements for just six seconds.

The World Bank estimates that up to 45,000 GWh of batteries and storage will be needed across energy systems by 2050, compared to around 200 GWh today.

To meet demand, battery production capacity is growing worldwide. By December 2019, 115 lithium-ion battery mega-factories were due to be built (88 of them in China). They would add 564 GWh to a global capacity of 2,068 GWh by 2028 – enough to power 40 million electric vehicles.

In tandem with the increase in capacity, we can expect to see an increased focus on research into new battery technologies that extend battery life, reduce the threat of lithium-ion flammability, make batteries less reliant on heavy metals such as cobalt, increase the speed of charging, and make them easier to recycle.

GRID-SCALE STORAGE

Grid-connected (or front of the meter - FTM) batteries can provide a broad range of services. These systems can be deployed to replace or defer investments of peaking capacity, provide operating reserves to help respond to changes in generation and demand, or they can be used to defer system upgrades in regions experiencing congestion from load or generation growth.

The need for large scale storage is evidenced by events such as the situation faced by European networks in January 2021, when power interconnection between Austria and Germany was disrupted. As a result, the frequency of the European power system dropped below the critical 50Hz mark for a short time.

The system responded as rapidly and precisely as it should, with flex and Demand Side Response (DSR) automated services quickly dropping demand by 1300MW at 16 industrial and large energy consumers in France.

Meanwhile, in the USA, an unusually harsh winter storm that swept Texas in February 2021 caused power shortages that left millions of people in the dark and without heat. The Texas blackouts served as a wake-up call to diversify energy sources and boost network flexibility.This can be achieved through the increased deployment of batteries and greater participation of demand loads in grid balancing and the broader energy markets.

Governments and grid operators worldwide are acknowledging the benefits that batteries and other storage solutions can bring.

National Grid Energy System Operator (ESO) plans a new suite of faster-acting frequency response services to better manage frequency changes on low inertia and high renewables systems. As part of this transition, existing services (such as Firm Frequency Response - FFR) will be replaced by newer, faster-acting products that will likely prove favourable to batteries. At the end of 2019, battery storage capacity in the UK was 0.88GWh, but it could rise to around 2.30GWh in 2025.

CHANGING MARKETS

In Australia, the Federal Government recently announced up to $215.4M (£118.4M) would support investment in new dispatchable generation and deliver affordable and reliable electricity. This includes $49.3M ($27.1M) for battery and micro-grid projects.

Australia's Energy Security Board has also set out a shortlist of proposed market reforms to ensure grid security is maintained as levels of renewables increase.

The most immediate reform proposed was released on 22 April by the Australian Electricity Market Commission, which communicated its intention to incentivise new, ultra-fast frequency services in the electricity market. But looking further ahead, the ESB set out plans for a spot market approach for valuing and procuring inertia.

In the USA, FERC Order 755 mandated a separate compensation structure for fast-acting resources such as batteries than for slower-acting conventional resources. This incentivised the use of battery storage systems to provide frequency regulation. In addition, last year, FERC issued Order No. 841, which requires regional system operators to remove barriers to participation for energy storage resources in the wholesale electricity markets.

Behind the meter (BTM) batteries - connected on the customer's side of the meter are also gaining in popularity as businesses seek to increase their resilience during system stress events, meet sustainability goals and gain revenue from flexibility services. While BTM batteries are typically beyond the direct control of the grid operator, these assets can still provide many of the grid services that FTM batteries typically target.

Over the short term, the growth of the battery storage market will depend on the proactivity of government's, energy retailers and system operators to introduce tariff structures and incentives that support their installation. In our recent poll, industry participants cited high investment costs as the key issue preventing them from installing battery storage technologies.

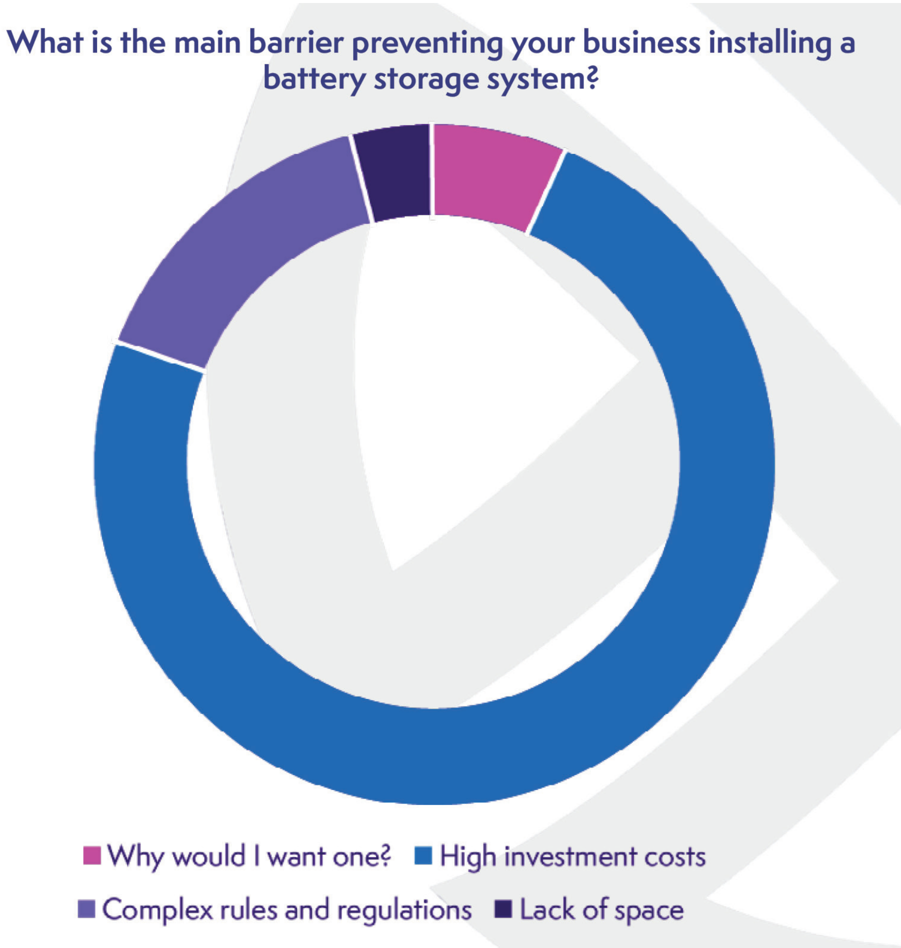
BARRIERS FOR BATTERIES

In a poll (conducted in September 2021), we asked industry experts and businesses what they saw as the key barriers to installing on-site battery storage technologies.

The results were clear. Regardless of recent falls in the cost of a battery storage system, the high upfront costs are a vital barrier for businesses.

ELECTRIC VEHICLES EXPANDING

EV fleets are expanding fast in several of the world's largest vehicle markets, driven by governments and automakers promoting electric vehicles as a pivotal



technology to curb oil use and fight climate change and air pollution.

After a decade of rapid growth, in 2020, the global electric car stock hit the 10M mark, a 43% increase over 2019, representing a 1% stock share.

Battery electric vehicles (BEVs) accounted for two-thirds of new electric car registrations and two-thirds of the stock in 2020. This has been driven in part by the falling cost of batteries. According to the BNEF's yearly survey of battery prices, the weighted average cost of automotive batteries declined 13% in 2020 from 2019.

Notably, 18 of the 20 largest Original Equipment Manufacturers (OEMs) - in terms of vehicles sold in 2020, which combined accounted for almost 90% of all worldwide new car registrations in 2020, have announced intentions to increase the number of available EV models and boost production of light-duty electric vehicles (LDVs).

Several manufacturers have raised the bar to go beyond previous EV announcements with an outlook beyond 2025.

More than ten of the largest OEMs worldwide have declared electrification targets for 2030 and beyond.

Significantly, some OEMs plan to reconfigure their product lines to produce electric vehicles.

SMART OR CONNECTED?

There are two main ways that EVs can support the grid. The first and most straightforward way is through smart charging, but a better way is through Vehicle to Grid (V2G) optimisation.

Smart (also known as managed or intelligent) charging is where an EV is charged in a way that spreads the load across a specific time scale.

This is possible through an EV and a charging device sharing a data connection with a charging operator. It essentially allows the charging station owner to monitor real-time data such as supply and demand on the local electricity network and manage the use of their devices remotely to optimise the charging of the EV.

Consumers can benefit from cheaper power, and operators benefit from an easier to balance system by avoiding all cars being charged simultaneously. Smart meters have the potential to allow more detailed information on consumption to be sent to energy suppliers and more reactive use of power for customers. It could also allow EV fleet owners to access "time of use" tariffs in the future, with potential financial savings or to use on-site energy storage to its maximum potential.

An extension of smart charging, the concept of V2G (vehicle to grid) When supply is low and demand high, EVs connected to the grid to charge can instead release power back into the grid. Owners of the vehicles can then be paid for this balancing service similar to electricity storage unit operators.

SMART CHARGING

As part of its part of a 10-point plan, the UK has set a goal of banning conventional fossil fuel vehicle sales by 2030 and only allowing zero-emission vehicles from 2035 – five years earlier than had been initially planned.

On 14 July 2021, the government set out its blueprint, which includes plans to phase out new diesel and petrolheavy goods vehicles (HGVs) by 2040. Combined with the 2035 phase-out date for polluting cars and vans, the government said this represents "a world-leading pledge to phase out all polluting road vehicles within the next two decades".

In July, the government published its response to the electric vehicle smart charging consultation. It commits to laying legislation to ensure that all private EV charge points meet smart charging standards. The transition to EVs is central to the government's net-zero commitment and will increase demand for the electricity system. Smart charging can help mitigate these impacts.

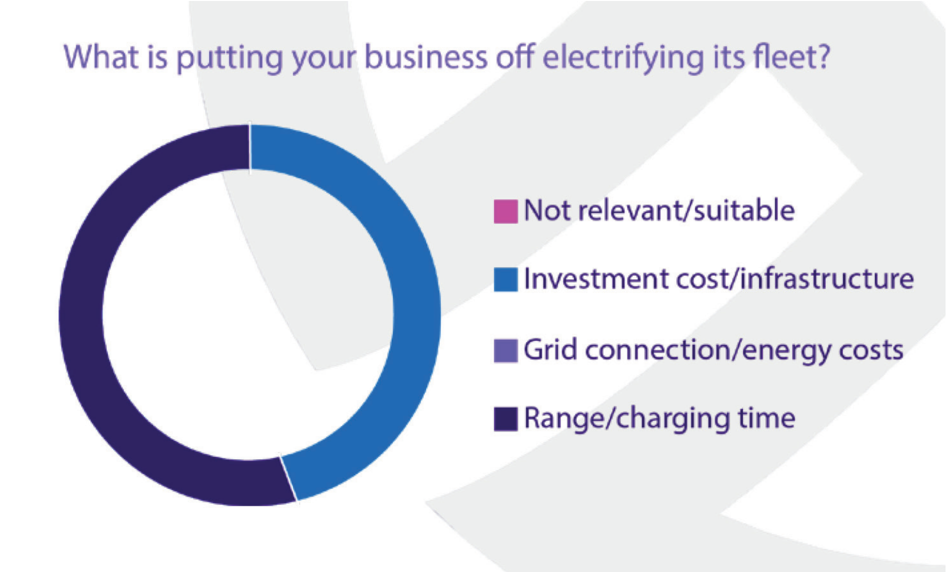
This legislation will play an essential role in driving the uptake of smart technology, which can save consumers money on their energy bills.

In its latest Future Energy Scenarios, National Grid expects some 37.4M EVs to be on Britain's roads by 2050. A study by the UK's Climate Change Committee predicts that the increased electrification of the country's economy, including the widespread adoption of EVs, could lead to a doubling of annual demand, from 300 TWh in 2019 to 610 TWh by 2050.

THE ELECTRIFICATION CHALLENGE

When we asked businesses and industry stakeholders about the critical barriers to the electrification of business vehicles and fleets, the outcome was the upfront cost of the vehicles and associated infrastructure and ongoing concerns over vehicle range and charging time.

But fuel shortages across the UK prompted many consumers and businesses to look at alternative options.



Analysis of Google search data revealed that online searches for electric cars in the UK surged during the period.

According to research by Uswitch, searches for electric cars reached an all-time high (+91%) as the nation queued on forecourts. Autotrader also noted a 65% increase in advert views for electric models on its site.

MANAGING PRICE VOLATILITY

In the pursuit of net-zero, energy markets around the globe are growing in both speed and complexity. Market volatility is the "new normal", and the accelerating growth of renewables generation makes energy planning, trading, and optimisation increasingly challenging.

Markets worldwide are gradually moving towards an environment where real-time pricing is the norm. Real-time trading can be as short as 30 minutes, 15 minutes, or five minutes, depending on the market. A lot of adjustments are made in real-time, primarily by ancillary services. But increasing volatility is likely to put more pressure on systems to shift further towards real-time, possibly down to one minute in advance or even less if technology continues to evolve.

This raises several challenges, not least of which is when to take storage and other assets to market. The need to make informed forecasts of critical factors and respond accordingly requires an enormous investment in constant human monitoring, analysis and management of assets or investment in artificial intelligence (AI) technology that enables robotic – that is automated – trading.

This trend is that in markets that are reliant on renewables, you need more efficient balancing services. Not just real time balancing services but market-balancing services to address pricing volatility.

An example of this was seen in Texas in early 2021. The state was subject to a rare and extreme cold weather event that overwhelmed the local grid, not equipped to cope with the conditions.

Consequently, energy prices rocketed, resulting in huge bills – running to hundreds of dollars per day – for households and businesses who bought their energy from the wholesale market through a tariff that, in normal circumstances, produced highly competitive prices.

AI IN ENERGY MARKETS

The price shock was inevitable without constantly monitoring and reacting to a highly volatile pricing environment. The situation was exacerbated by the fact that even the small scale market balancing services in the region were more focussed on price than the more holistic real-time found in other parts of the world.

The Texas example is an unusual and extreme case, but the primary lesson is clear. Where price volatility is built into the system, it needs to be managed pro-actively.

AI can analyse the market from several different perspectives – demand levels, the effect of weather on the generation capacity of renewables, and so on – to learn from experience and make more accurate forecasts of probable pricing levels. Robotic trading can then automatically bring assets to market at a time when the best price can be achieved – on the day ahead or the intra-day market, for example.

The importance of AI/Robotic trading is referenced by the World Economic Forum's Expert Network (curated in partnership with Scott Burger, Research Affiliate, Massachusetts Institute of Technology). They say that AI is one of several factors that will help unlock finance for renewables, storage and associated technologies.

THE IMPORTANCE OF ROBOTIC TRADING

If we're more reliant on energy-producing technologies that are harder to predict, such as solar and your wind, we're going to get situations where we're going to have volatility. This could, for example, be a last- minute change, where the grid has to take an action to balance the system. That could come at a heavy cost to the system and to end consumers, but obviously profitable for those who are there ready to take that opportunity.

Increased time granularity in electricity markets, both regarding market time units and nearer to-real-time gate closure times, helps system operators manage the grid more effectively.

The challenge is that in volatile and real-time markets, the market signals occur in too short intervals for human traders to keep up and respond effectively to.

Based on AI and machine learning, robotic actions and decision-making can be completed much faster than a human can achieve.

Where many trades are happening at speed, a manual operator will inevitably miss some opportunities. For example, an energy asset owner may have a position in the day-ahead market, but there may be an opportunity to sell back the position, buy that position back later, and so make small amounts of profit on the original day ahead price versus predicted prices across the day.

The ability to predict these potentially fleeting and small fluctuations in the market and then set the prices for whatever assets can be brought to the market at the most appropriate times will require increasingly sophisticated AI solutions.

NEW AND EMERGING TECHNOLOGIES

It's an exciting time for energy. The ongoing need to decarbonise leads to the development of new technologies designed to support the global energy transition. Here are five innovations which we think will be essential in the future.

POWER-TO-X

One of the game-changing new technologies, power-to-X, is an umbrella term that covers different processes that turn electricity into heat, hydrogen or renewable synthetic fuels. It offers a significant opportunity to speed up the shift to renewables by ramping up synthetic fuel production and rapidly reducing fossil fuel emissions in sectors ranging from steel and food production to chemical industries and fertilisers. The technology can also play a key role in solving long-term energy storage challenges, regulating the ups and downs in supply from renewable sources.

"Power-to-X is needed because re-investing in whole infrastructures and technologies (aviation, shipping, heavy-duty, and even electric cars) is not possible in the coming two decades during which we need to accomplish the transition" - Petteri Laaksonen, Research Director at the School of Energy Systems at Finland's Lappeenranta-Lahti University of Technology (LUT).

CARBON CAPTURE AND STORAGE (CCS)

Carbon capture is key to many plans for a net-zero future, and governments are reviving development plans.

In the UK, the government has included CCS in its green 10 point plan31 and stated its aims to have at least one CCUS (carbon capture use and storage) project operational by 2030. In the US meanwhile, Elon Musk recently launched a $100M competition to find the best carbon capture technologies.

There has been some push-back from industry, as most existing CCS approaches impose heavy energy and carbon penalties in construction and deployment. It seems that nature-based solutions are likely to prove more practical for many. Yet, proponents claim that CCS/CCUS is the only way that emissions-intensive industries such as steel and cement will be able to operate in a low-carbon future.

HYDROGEN

The hydrogen industry has gone through many cycles of popularity, but many observers feel that this time is different and expect to see significant change.

The number of countries with policies that directly support investment in hydrogen technologies is increasing, along with the number of sectors they target.

To date, there are over 50 targets, mandates and policy incentives globally in place that directly support hydrogen, although, for the most part, these strategies are aimed at the transport sector.

In addition, several European states (including Portugal, Spain, France, Germany, Netherlands and Norway) have unveiled heavily investment in hydrogen technologies to speed up decarbonisation in line with the Paris Agreement.

Green hydrogen is a renewable energy source to watch. It provides a way to accelerate decarbonisation efforts, particularly for hard-to-abate sectors where electrification is not a cost-effective or viable option.

The UK recently unveiled its long-awaited hydrogen strategy, which set out the government's plans for "a world-leading hydrogen economy" that could generate £900M and create over 9,000 jobs by 2030.

The strategy document, published in August 2021, is centred around a vision where, by 2030, the UK will be a global leader in hydrogen, with 5 GW of low-carbon hydrogen production capacity in place and clear plans for future scale-up towards the Sixth Carbon Budget and the UK net-zero target.

Low-carbon hydrogen is set to be essential to achieving both, with analysis for the government finding that between 250 TWh to 460 TWh of hydrogen could be needed in 2050, accounting for 20%-35% of final energy consumption.

FLOATING WIND

The concept is relatively simple: floating wind uses turbines located at sea but not drilled into the ocean floor. The turbines are towed out to sea and then assembled on floating platforms and can be towed back to shore for maintenance whenever required. The possibility to float turbines regardless of sea depth and the potential for standardised manufacturing (compared to offshore fixed-bottom wind power) could be a game-changer in terms of cost.

Floating wind has several key advantages compared to traditional onshore or fixed-bottom wind parks. They cannot interfere too heavily with local communities and wildlife. Bottom-fixed offshore wind sites are limited by water depth and existing maritime infrastructure; meaning turbines can only be installed in depths of up to 60 metres. On the other hand, floating wind can be installed regardless of sea depth, opening up vast tracts of the oceans, which could be used for energy generation.

It is estimated that floating wind has roughly double the potential capacity of bottom-fixed offshore wind, and this only considers areas located up to 200 kilometres from shore.

As well as generating electricity, there is also an opportunity to leverage floating wind technology to produce green hydrogen, potentially even transforming existing oil and gas assets (e.g. platforms in the North Sea) into decentralised hydrogen production units.

Theoretically, if the shipping industry is powered by hydrogen, decentralised fuelling units for ships could also be created.

SPACE-BASED SOLAR POWER

Space-based solar power is the concept of collecting solar power in a high earth orbit, which is converted into high-frequency radio waves and beamed to a receiving antenna on the earth.

According to a study commissioned by the UK government, it is technically feasible to develop a substantial space-based solar power capability for the UK and complete this well before 2050.

The technology could deliver clean, baseload energy day and night throughout the year and in all weathers with a competitive Levelised Cost of Electricity – an estimated value of £50/MWh.

BLOCKCHAIN

The technology behind Bitcoin and other cryptocurrencies – blockchain – has significant potential to transform our energy system.

Blockchain technology intends to unite all energy stakeholders under a single decentralised network. Electricity producers, distribution network operators, metering operators, providers of financial services, and traders potentially benefit from utilising smart contracts.

How? Think of the historical grid model, which distributed energy from one centralised source in one-way power flows to utilities and customers.

Today's grid incorporates two-way power flows, with growing distributed generation and storage.

The development of microgrids, the networks where consumers with their own energy generation or flexible demand can sell to peers better than supply tariffs and grid buy-back rates, challenges the traditional energy model.

Utilities in today's system use complex software platforms to manage the demand, supply, and reliable delivery of electricity on the power grid. It is difficult to scale these systems to interoperate transactions between thousands of homes and businesses, let alone the millions of connected assets on those sites. This is where blockchain comes in – providing a mechanism by which every participant in a network can transact directly with every other network participant without a third-party intermediary to validate and secure transactions.

This has the potential to bring about a radical change in the industry. By directly linking producers with consumers, we could see a simplification of today's multi-tiered system, where generators, transmission system operators, distribution system operators and suppliers transact on various levels.

IN CONCLUSION

The appetite for renewables, associated energy storage and digital management systems continue to grow as the move to net-zero gains pace and governments worldwide set robust strategies and targets.

The focus of investors is turning away from fossil fuels to investment opportunities built around carbon reduction and the environmentally responsible use of resources. The opportunities are clear, evolving rapidly, and becoming increasingly attractively priced.

As a result, energy markets around the globe are growing in both speed and complexity. Market volatility is the "new normal", and the grids need to keep up and actively respond to the changing market landscape.

To support this, the industry needs better price signals that are more reflective of the short-term market conditions and robotic trading technologies to balance the grid. While many solutions are being examined and tested worldwide, ultimately, it is for governments and regulators to design a market that places an appropriate value on flexibility.

Opportunities already exist, whether it's a battery, the ability to ramp up or down your consumption, or to feed in power to the grid. But the investment case can be complex.

While it's understandable that governments don't want to pick winners in the race to net zero, clarity over future policies and clear signals on the way forward for decarbonisation of the economy will be critical, helping guide business models and investment cases going forward. wn

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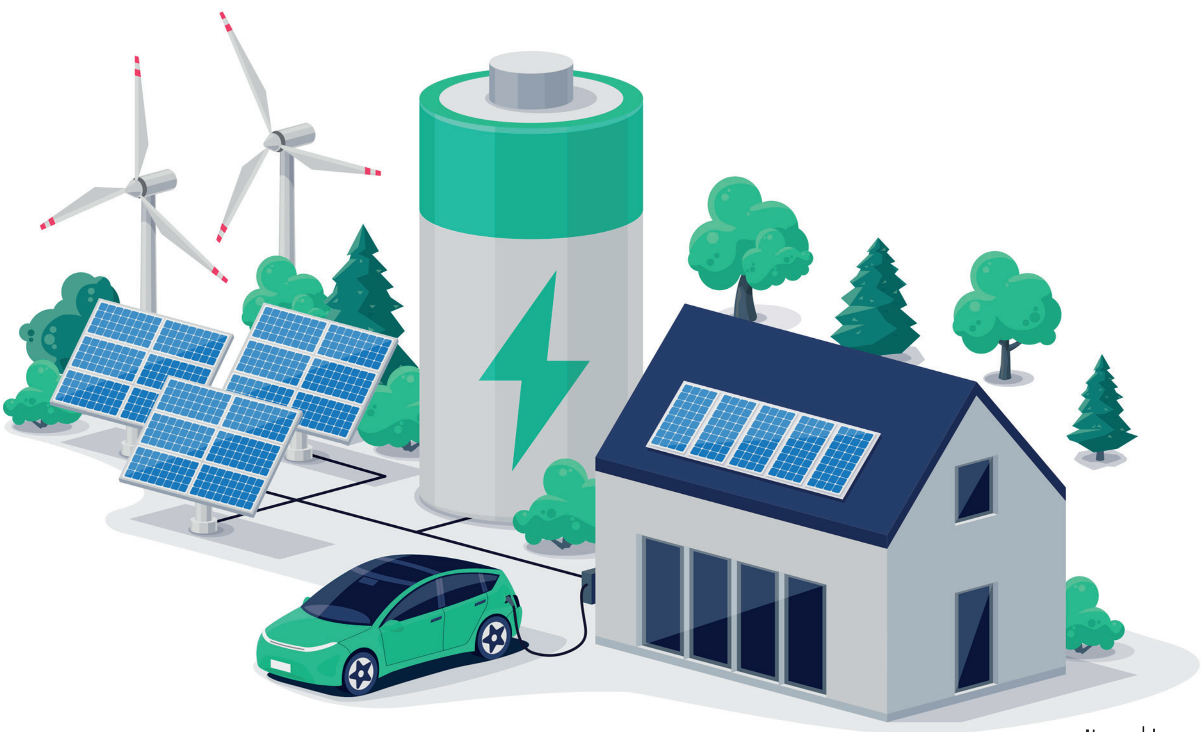


New Perceptions about Nuclear

The United Nations Climate Change Conference (COP26) in Glasgow has heralded a turning point for nuclear energy. Recent extreme weather events provided a backdrop for the greatest ever appreciation of the urgency to transition to low carbon energy sources to avoid catastrophic climate change. The current favourite low carbon electricity generation mode is via renewables. These may be becoming somewhat jaded. There is by now a lot of experience with renewables.

By | Prof Simon Connell

There are many drawbacks. Their load factor is of the order of 30%, but this average value masks the many fluctuations that range from 0% - 100%. Backup, storage or handover must provide a net 100% alternative solution, even if it would only be rarely used at the 100% scale. Those alternatives need to be kept in full readiness, permanently. One must essentially double up on capacity.

The transmission grid dependence is very high, requiring a different grid topology from what is currently established. In addition, the variability stresses the rest of the system that has to compensate. Substantial renewable penetration, therefore, has ever-increasing hidden costs. Choices are few. Hydro may not be available; fossil fuels must be phased out. The greenest fossil fuel, natural gas, has an unreliable and wildly fluctuating price. It also requires considerable infrastructure for delivery and storage. It is therefore not surprising that COP26 has seen subtle changes in the perceived role of nuclear, towards achieving "net-zero".

Some examples are the declaration from China that it will build out its nuclear generation capacity with about ten new reactors per year for 15 years. The critical point here is the size of the nuclear build and the claimed cost, at about \$3000/kW. Lower financing costs achieve this. This brings nuclear into the affordability zone compared to the previously more palatable alternatives.

This is especially interesting considering one also buys reliable, dispatchable, baseload generation capacity. One also buys three times the load factor of renewables and three times the plant's lifetime. Add to this the growing hype around Small Modular Reactors (SMRs). The plan is to lower costs and shorten delivery times essentially by mass production in factories, with shorter installation times. The SMRs have similar low power outputs to renewable farms. So, like the renewables, they can also be placed where local grid loads are relatively small due to poor grid establishment or penetration (like in Africa). So when price, delivery time and

applicability are now comparable, the drawbacks of renewables compared to the advantages of nuclear, in dispatch ability, security of supply and grid stability, now give nuclear the edge.

Of course, once you can claim that nuclear energy is affordable and applicable, the renewables lobby will introduce the three usual anti-nuclear arguments of last resort: proliferation, safety and waste. A modern nuclear reactor embedded in a mature regulatory environment addresses these issues to black swan standards. The remainder of the article intends not to enter this debate, where clearly, the nuclear lobby is satisfied these three aspects are well covered. Instead, a new element will be discussed. It is the element of scaling. This concept comes from understanding Mathematics, Physics and Engineering, as opposed to perceptions. We must put numbers to all parameters and visualise the scaling of these numbers to the full implementation. If imagining these numbers and units is not easy, we can use paradigms that illuminate the matter. What follows is very brief and can't do justice to the subject here; instead, a book is required.

A first example is that the energy content per atom for nuclear compared to fossil fuel is 50 million times higher. That's just how nature is. Chemical energy densities almost vanish compared to nuclear energy densities. Uranium is heavier than carbon and also needs to be enriched. So a 10g fuel pellet has the electricity generation capacity equivalence of between 1 – 20 tons of coal (average or breeder reactor). This has consequences. You can build a nuclear reactor that you refuel once every ten years, whereas keeping a coal plant satisfied with fuel is a logistical nightmare.

You can transport the small amount of nuclear fuel to the reactor, which you can locate wherever you like, rather than being forced to locate the coal plant right at the coalfield. Your waste is a hundred thousand times less. Your relative operating costs are minimal rather than being dominated by your fuel costs. When the cost of gas triples, like it, is doing now, your electricity costs scale significantly, and you have to have a cold winter. If the cost of uranium were that volatile, it would lead only to a fractional increase in the cost of electricity. Nuclear energy represents an extreme amongst the current commercially available modalities, which is hugely abundant and very concentrated, by many orders of magnitude, compared to any alternatives. For example, it's now much discussed in the news that Australia recently preferred a nuclear-powered submarine to a diesel one. Now we know why. If your life is at stake, it helps you make your choices with evidence-based reasoning, respecting numbers.

This energy scaling comparison maps roughly to a battery, too, as both batteries and fossil fuels transform chemical energy into electricity. This somewhat puts batteries into perspective when talking about energy. They represent a vanishingly low energy density storage device once you consider the energy hungriness. We should not confuse our phone in energy requirement terms and energy storage options, where the battery is the biggest single item, with a city.

Now, if we consider other energy source modalities, such as hydro, wind and solar, we can't make the same comparison, as these are not material-based sources of energy. Instead, let's find another metric. The land use of a 1GW nuclear plant is about 3 km2. By comparison, for the equivalent average output, for a wind plant, it's nearly 800 km2, and for a solar plant, it's 150 km2. Hydro is better but still has a large footprint, and it's unfortunately not everywhere available. Africa is not Norway. Indeed wind and solar also harvest a very diffuse source of energy compared to nuclear. As such, the raw material requirements of renewables are thousands of times more than for nuclear energy. If all countries should by democracy have the per capita energy generation capacity of a well-developed country, for example, if Africa should be equivalent to the USA, it would require 3400 GW generation, 20 times more than it has now. If this were to be provided by renewable energy, this would be an enormous budget in the raw materials required to construct these very diffuse energy harvesting devices. Scaling the demand for raw materials to the requirements is very sobering. It is predicted we would need to start mining the coastal shelves of continents.

Let's suppose we do indeed have this enormous penetration of renewables in SA. We will need backup. Suppose Koeberg next to Cape Town were replaced with a solar PV farm. Then suppose we wanted to store its 2GW energy production rate capacity for 10 hours so that we could plan for a day of no sun. Power of 2 GW for 10 hours is an energy content of 20 GWh. In principle, the battery backup is vulnerable to terrorist attacks. If nuclear must be safe, black swan safe, then so must batteries. To understand the enormity of 20GWh, this equates to the energy content just over one times the size of the Hiroshima explosion of 15 kilotons of TNT. The purpose here is not to be alarmist. It is to help you, the reader, understand how to visualise a large amount of stored energy, the amount of energy needed to power a city for a day. We want to illustrate that a city requires considerable energy per day. It does not make sense to store this energy. Storing large amounts of energy is an accident waiting to happen. You can't be against nuclear energy because of safety considerations and then store a Hiroshima-sized bomb next to your city each night. What will happen when the city grows to 10 times its size and the poor become middle class? This is why utility engineers talk of load following. One makes electricity at the rate required. If you need less electrical energy, produce less; if you need more, produce more. This discussion helps one understand the concepts' baseload' and 'dispatchable'. Nuclear is a baseload supply, and it's dispatchable. The renewables are not.

In this article, we noted the new interest in nuclear following COP26. Then we noted that nuclear exhibits the highest energy density source by many orders of magnitude. We looked at the positive consequences of this. Energy is always going to scale upwards. Our solutions must cope with scaling. wn

Transforming businesses and the customer experience in 2022

- 4 MARTECH TRENDS TO LOOK OUT FOR

Technological innovation is taking place at an incredible rate. And with the ongoing pandemic, businesses of all shapes, sizes, and sectors are turning to digital marketing and marketing technology (martech) to recover, keep their companies afloat, and continue to be agile in the face of change. Martech can help you automate, optimise, and ideate your marketing efforts - the right tools can unlock elevated marketing capabilities and campaigns, improve customer experiences, and ultimately transform your business.

By | Kelvin Jonck
CEO at YOUKNOW Digital

But what brilliant tech solutions do your specific business need to thrive? And what trends will make an impact in the marketing industry in 2022 and beyond? Here are four martech trends and tools I believe you can use to your competitive advantage.

THE OVERWHELMING IMPORTANCE OF CUSTOMER EXPERIENCE

A recent study profiling 1,920 business professionals found that almost 46% have named customer experience (CX) their top business priority for the next five years, beating product and pricing. The same research also revealed that 86% of customers are willing to pay more for a great CX – emphasising that their loyalty is now directly linked to the experience they receive. The logic behind this is simple: A happy customer is a returning customer. As there is a saturation of brands that offer similar products and services on the market, businesses that want to stand out need to invest time and money into getting their CX to the highest level possible to retain and build long-lasting customer loyalty. Therefore, personal touchpoints between the brand and consumer should constantly be amplified. When this is done correctly, it can create loyal brand advocates – customers who will happily return for more without being reminded and refer their friends and family to the brand.

As these touchpoints increase and customers come to expect more from their chosen brands, technology plays a critical role in shortening the distance between the consumer and the business, enhancing these relationships, and dramatically improving CX. Martech solutions make processes more effortless, more effective, and more efficient. Ultimately, these tools simplify how you connect with your customers, building personal, considered customer journeys that keep them coming back for more.

MARTECH TRENDS AND TOOLS FOR CX SUCCESS

The following four technologies all hinge on how customers experience your brand. By adding these concepts and tools to your martech stack, you'll be prioritising CX and setting your business up for growth.

TREND 1: INCREASED PERSONALISATION - TREATING CUSTOMERS AS INDIVIDUALS FIRST

As more customers expect tailored experiences, there's rising pressure on businesses to deliver engaging and personalised content that builds a connection with them, treating them as individuals rather than just another number. In fact, according to Salesforce, 66% of customers expect brands to understand their individual needs and expectations, with only 34% feel that companies treat them as unique individuals. The value of personalisation in today's changing world can't be overemphasised enough – McKinsey projects it has the potential to create trillions of dollars in business revenue.

But throwing together personalised emails and calling it a day is not enough anymore – more needs to be done to connect with your customers and make them feel genuinely valued. An omnichannel approach is one personalisation tactic that can help your customers feel more connected to your business. Creative automation tools can also assist marketers in managing, tracking, and understanding customer data to then create more personalised campaigns and unique product recommendations.

Whichever personalisation tactics or tools you opt for, be sure to clarify that you're not just after a customer's money but are there to keep them happy and improve their lives.

TREND 2: DATA AND ANALYTICS - FUNDAMENTAL BUILDING BLOCKS FOR PERSONALISATION

Customising customer experiences start with data and analytics. If you're not taking advantage of learning more about your current and prospective customers, you're missing out on massive business opportunities. Not only on reaching them more strategically but also on nurturing relationships with them and building loyalty.

From insights into buyer behaviours and preferences to better-informed decisions for improved lead generation and conversion rates, marketing data and analytics tools can help you unlock a host of benefits. Most importantly, data is the only business resource that can keep up with customers in real-time, translating to predictive analytics that empowers your brand to be proactive rather than reactive.

TREND 3: THE SHIFT TO A SINGLE VIEW OF CUSTOMERS

Just as your customers are connected to each other and your brand, your data should be too. Siloed customer data prevents you from tapping into true personalisation because the different puzzle pieces of customer relationships aren't put together, and ultimately, the end-to-end CX puzzle falls short. To solve this, businesses need a central repository for customer data that combines, collates, and analyses various sources of information (social, survey responses, chatbot conversations, and voice transcripts). An effective customer data platform (CDP) can go a long way in providing a unified, complete view of your customers, helping you understand their changing needs and serve them more effectively. This also means personalised engagement and more meaningful connections.

TREND 4: MORE INVESTMENT IN MARTECH ARCHITECTURE AND RESOURCES

Many organisations already use martech solutions, yet only 33% feel that their current stack is practical and meets business needs. This calls for examining existing tools and evaluating their place and benefit to your company. Now is the ideal time to audit your marketing solutions to maximise, improve, or even replace them. If you want to improve efficiencies, you'll need to invest in the right technologies and build a formidable martech stack to future-proof your business. This also means hiring the right people to exclusively perform within this martech role – something that isn't really a focus in our local market but should be.

THE ROLE OF HUMAN EXPERTISE IN INNOVATION

While these tech trends and innovations can help grow businesses and take CX to a new level, it's important to remember that there will always be a need for human guidance. Technology is meant to help scale and automate human tasks while improving and streamlining experiences, but it will never replace human ingenuity. In the world we live in, it's about adapting to the advancements of technology, and this is especially true for roles within the marketing and CX spaces.

To leverage these martech trends and tools, business leaders must realise that not every technology may work for them – there's no one-size-fits-all stack across all organisations. In other words, they need to determine which tools can help them gain consumer insights, engage with customers, and deliver business outcomes according to their unique needs and objectives. That's why partnering with the right CX technology partner and integrator is crucial – they'll be able to advise on the best-in-class global solutions and hold your hand throughout the entire martech journey. wn

Fire Ice Methane

There remains a vast reserve of untapped methane energy on the ocean floor and under Arctic permafrost, which is estimated to exceed the Earth's fossil fuel energy reserves. If this fuel can be economically harvested, it could hasten the end of using coal and petroleum fuels and aid in buffering the vagaries of solar and wind power and play a significant role in the use of hydrogen-powered road vehicles and trains also in the storage of energy.

By | Dudley Basson

Methane hydrate (fire ice) has been found in vast quantities on the ocean floor, where it is stable at low temperature and high pressure. Methane (CH_4), like all hydrocarbons, when burned, produces CO_2 and water, so that using this fuel will do little to reduce CO_2 emission directly but can do much to reduce global warming indirectly. It is much less polluting than coal or oil, containing no sulphur or other pollutants, and removes the need for collieries and oil refineries.

The total volume of methane on continental margins and expanded to standard temperature and pressure has been estimated at 4,4 x 1016 cubic metres.

Fire ice has the appearance of ice crystals, but the methane molecules are caged in by the water molecules at a molecular level. Known as methane clathrates or hydrates, they are formed at low temperatures and under high pressure, where they can be found in sediments under the ocean floor and permafrost on land.

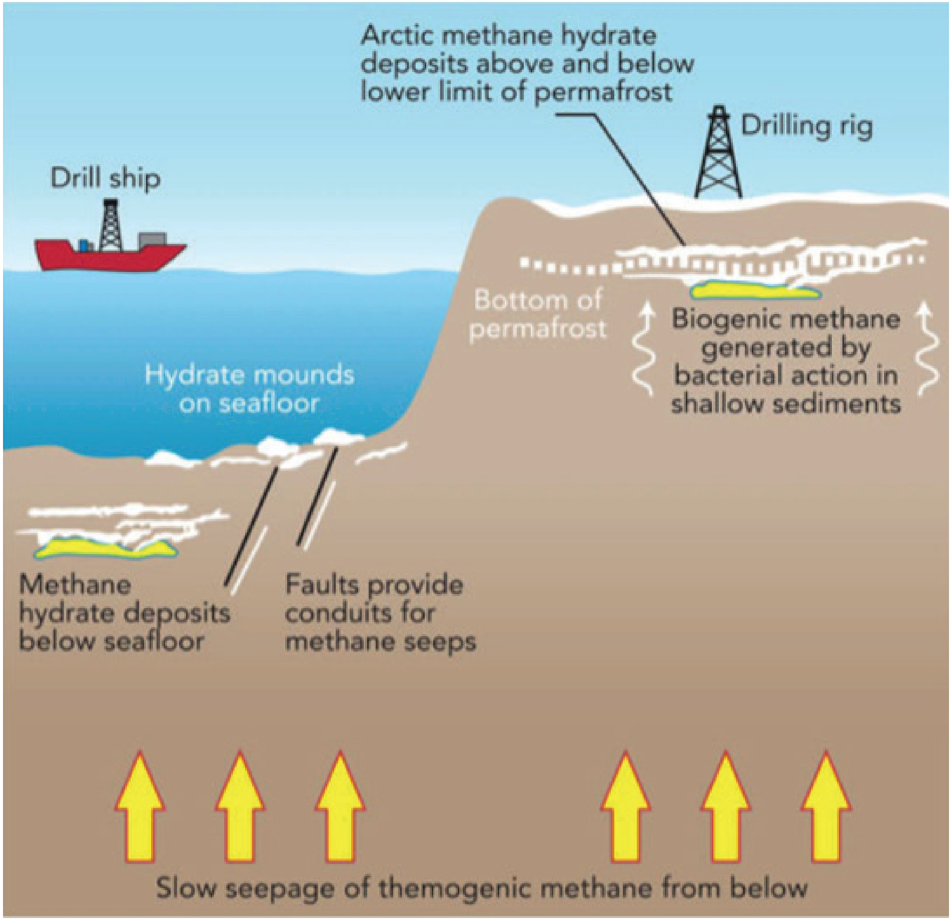
By lowering the pressure or raising the temperature, the hydrates break down into water and methane. One cubic metre of the fire ice releases about 160 cubic metres of gas, making it a highly energy-intensive fuel.
If the fire ice is taken to atmospheric pressure, it can be set alight and produce a gentle flame.

If it is to be exploited, new technology will be required to separate the methane underwater and not allow it to escape the atmosphere.

If methane were to be released in large quantities into the atmosphere, the result would be disastrous as it is many times worse than CO_2 as a greenhouse gas. It is feared that this may happen anyway from the permafrost due to global warming.

If global warming results in methane release from the permafrost, this will cause a significant irreversible escalation of global warming.

Despite the pandemic, 2020 saw the most incredible one-year jump in atmospheric methane concentrations on record. The causes of the recent spike are unclear but could include natural gas fracking, increased output from methane-producing microbes spurred by rising temperatures, or a combination of human-caused and natural processes.



Extracting the gas from fire ice is at present difficult and energy-consuming.

Methane hydrates were discovered in Russia's north in the 1960s, but research into extracting gas from marine sediments only began in the last 10 to 15 years.

As a country lacking any natural energy fuel resources, Japan has been a pioneer in the field. Other leading countries are India and South Korea, which also do not have their own oil reserves.

While the US and Canada are also active in the field, they have focused on hydrates under permafrost in the far north of Alaska and Canada.

Vast deposits exist beneath all oceans around the globe, especially at the edges of continental shelves. Several countries are scrambling for a way to make the extraction safe and profitable.

In 2017 China described its latest results as a breakthrough, and Mr Linga agrees. "Compared with the results we have seen from Japanese research, the Chinese scientists have managed to extract much more gas in their efforts. So in that sense, it is indeed a major step towards making gas extraction from methane hydrates viable."

It is thought that there is as much as ten times the amount of gas in methane hydrates than in shale, for instance. "And that's by conservative estimates," says Prof Linga.

Most naturally occurring clathrates are methane hydrates, like those found in the South China Sea. Sometimes, methane hydrates have formed in manmade situ and caused complications. London South Bank University water scientist Martin Chaplin explains:

Flammable Methane Hydrate

"Clathrates are notable due to their hazardous formation in natural gas pipeline blockages and their occasional hazardous release of large volumes of gas from underwater natural reservoirs. They are also notable for their potential for the production of natural gas from deep-sea sources and their potential in the entrapment and removal of the global-warming gas, carbon dioxide."

"China was the first country to exploit gas hydrates using a horizontal well-drilling technique," says China's Ministry of Natural Resources via the Chinese state press. The technology could represent a way forward for gas lines clogged by clathrates, even if demand for natural gas doesn't require further commercialisation of undersea gas hydrates soon. More development in the field could also mean technical leaps forward in the realm of trapping CO_2.

In a month-long trial in 2017, China set two world records: one for the most significant total volume extracted, 861 400 cubic metres, and another for the most produced – 287 000 cubic metres of methane – on a single day.

The Japan Oil, Gas, and National Metals Corporation (JOGMEC) announced that it had successfully extracted the fuel from a deep-sea bed of methane hydrate located off the coast of Shikoku Island. This particular deposit of methane hydrate contains an estimated 40 trillion cubic feet of natural gas, equal to 11 years' worth of gas consumption in Japan.

As the world's largest importer of natural gas and a country still recovering from the Fukushima nuclear disaster, it could see this natural gas as a significant part of its energy consumption over the next decade.

Methane has several uses:
- Used as a general-purpose combustible natural gas.
- Powering gas turbines for large scale power generation.
- Powering containerised Stirling engine power generation.
- Generating large scale hydrogen production.
- Providing ample scale energy storage as methane (CH_4), hydrogen (H_2) or ammonia (NH_3).
- Trapping and sequestering CO_2 to reduce atmospheric content.

In the 1890s, London's methane-powered street lamps were installed to provide both light and burn off the

Methane Hydrates recovered off the cost of Mexico.

offensive gases emanating from the sewers below. Only one of these lamps remains, which can be found in the vicinity of the Savoy Hotel.

Cattle farming also releases large quantities of methane into the atmosphere.

In 2015, the dairy industry's emissions equivalent to more than 1 700 million tons of CO_2 made up 3,4% of the world's total of almost 50 000 million tons that year. That makes the dairy's contribution close to that from aviation and shipping combined (which are 1,9% and 1,7%, respectively).

A considerable contribution to reducing atmospheric methane can be made by stemming leaks from landfills, oil fields, natural gas pipelines etc. Thanks to rapidly advancing technology, a growing fleet of satellites aim to help close the valve on methane by identifying such leaks from space. The mission is critical, with a series of recent reports sounding an increasingly urgent call to cut methane emissions.

Around 60% of the world's methane emissions are produced by human activities – with the bulk coming from agriculture, waste disposal and fossil fuel production. Human-caused methane is responsible for at least 25% of today's global warming, the Environmental Defence Fund estimates. A new Global Methane Assessment by the United Nations Environmental Programme stresses staunching those emissions is the best hope for quickly putting the brakes on warming.

A cluster of satellites launched by national space agencies and private companies over the last five years have considerably sharpened our view of what methane is being leaked and from where. New satellite projects are headed for launch in the next couple of years – including Carbon Mapper, a public-private partnership in California, and MethaneSAT, a subsidiary of the Environmental Defence Fund – that will help fill in the picture with unprecedented range and detail.

MethaneSAT will focus on the global oil and gas industry and aims to be sensitive enough to reveal the multitude of minor methane releases that can account for most emissions.

Experts say these efforts will be crucial not just for spotting leaks but also for developing regulations and guiding enforcement – both of which are sorely lacking.

Powerful new eyes in space include the European Space Agency's Sentinel 5P (launched in 2017), the Italian Space Agency's Prisma (launched

2019), and systems operated by private Canadian company GHGSat (with satellites launched in 2016, 2020 and 2021). Companies like French Kayrros use artificial intelligence to enhance satellite imaging, paired with air and ground data to provide detailed methane reports.

CLICK HERE - For an extensive report on methane leaks.

METHANE LEAKS DETECTED BY SATELLITE

Gas turbines provide a convenient way of generating backup electrical power. Using costly Diesel fuel makes this form of power production more suited to emergency use than regular production. Gas turbines are commercially available, ranging from 34 MW to 1600 MW. Using methane or hydrogen would make this form of power generation economically more viable.

The National Institute of Advanced Industrial Science and Technology (AIST), Japan, has for the first time realised ammonia-air combustion for powering a 50 kW micro gas turbine system.

This was achieved using recent advances involving gas-turbine technologies, such as heat-regenerative cycles, rapid fuel mixing using swirling solid flows, and NO_x reduction using selective catalytic reduction (SCR).

Research is underway for developing ammonia/hydrogen blends for gas turbines by the catalytic cracking of ammonia. Current research shows that stable flames are achieved with 70:30 NH_3/H_2 blends for swirl combustion under rich fuel conditions.

Studies are also underway researching the use of ammonia/methane blends. Research confirms that pure NH_3 flames have high ignition delay times and relatively low flame speeds.

Adding H_2 to NH_3 flames increases the flame speed exponentially and significantly reduces the emission of nitrogen oxides.

CLICK HERE - For a paper on the use of methane-hydrogen blends in internal combustion engines.

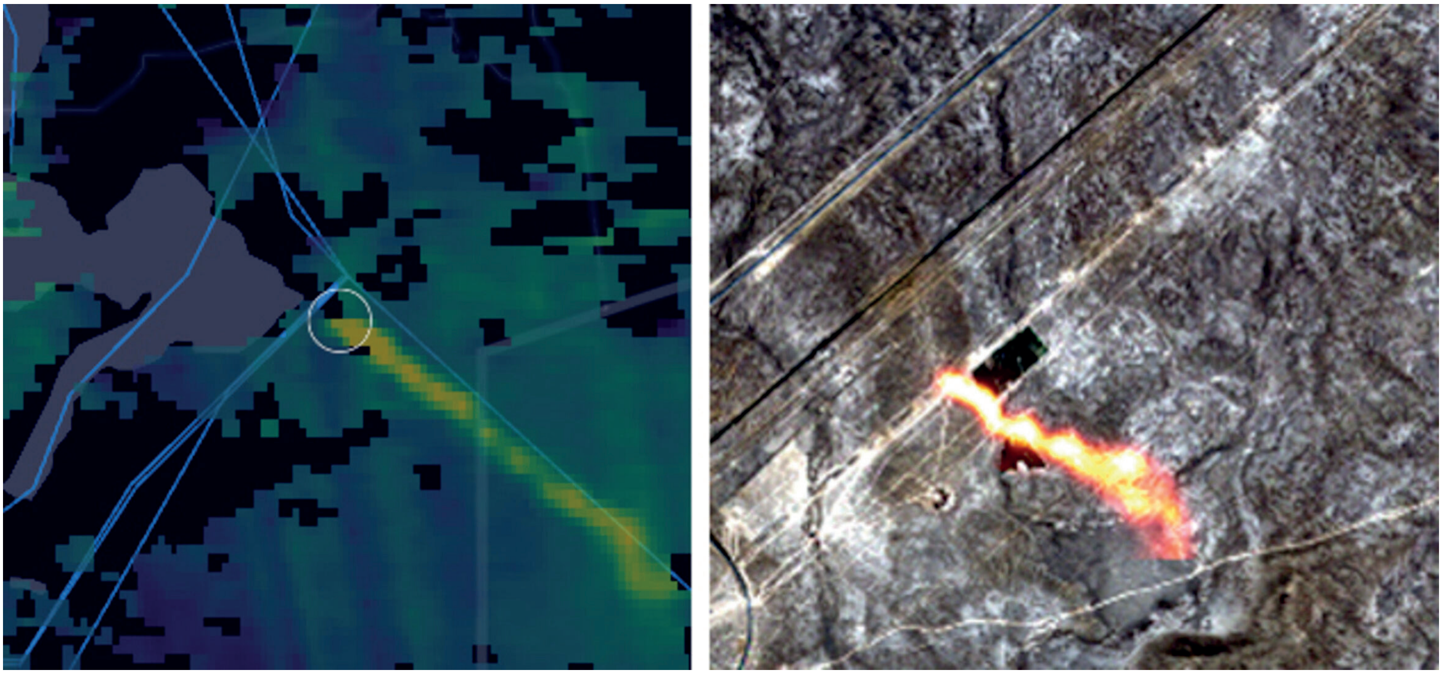
CLICK HERE - For a paper on the control of the production of nitrogen oxides.

On a smaller scale, methane could be used as backup gas for powering containerised Stirling engines to generate power from industrial flare gas, thus providing uninterrupted power from the containers. The container modules are rated at 400 kW per container.

These can also be used as standalone gas-powered generators and can conveniently use other combustible waste gas if available.

With the expected large scale use of hydrogen-powered road vehicles and trains, methane could provide an economical source of hydrogen.

Colours designate the various processes for generating hydrogen:



Methane leaks detected from Space

Blue Hydrogen: This is a relatively new concept and can refer to hydrogen made through SMR (steam–methane reforming) of natural gas, methane or coal gasification, but with capture and storage of CO_2 and other waste products. As of 2021, only two blue-hydrogen facilities globally used natural gas to produce hydrogen commercially, and this process is not substantially better than that of grey hydrogen.

Green Hydrogen: Produced by polymer electrolyte membrane (PEM) electrolysis of water using renewable wind, hydro or solar energy. This produces no waste products but is not yet cost-competitive with grey hydrogen. If nuclear-generated electrical energy is used for electrolysis, the hydrogen produced is known as pink hydrogen.

Brown Hydrogen: Produced from brown coal gasification using SMR but without capture and storage of CO_2 and other by-products. Black hydrogen is made from black coal. These are the least favoured processes for producing hydrogen.

Grey Hydrogen: Produced by SMR using fossil fuels such as natural gas or methane but without capturing CO_2 and unfortunately accounts for 95% of all hydrogen produced.

CLICK HERE - For an extensive report on industrial hydrogen production.

Methane is an important chemical feedstock for grey hydrogen production. In the United States, more than 95% of the hydrogen is produced by steam–methane reforming (SMR) with an annual hydrogen production of 10 million metric tons. SMR is a mature industrial catalytic process to harvest H_2 from a methane source under high-temperature steam (700-1000 ˚C) with a 3–25 bar pressure range. Besides H_2, carbon monoxide (CO) and a relatively small amount of carbon dioxide (CO_2) are also produced by SMR. The efficiency is improved by recycling the CO_2 output.

Although SMR is a mature technology, it still suffers from several disadvantages caused by the reactant properties and reaction thermodynamics: High energy consumption, high production cost, harsh reaction conditions, low reaction efficiency, and low process stability.

The Shell Blue Hydrogen Process claims improved cost-effectiveness of greenfield blue hydrogen production and critical advantages over auto-thermal reforming.

The PEM electrolytic process is rarely used in industrial applications as grey hydrogen can be produced more affordably from methane and other fossil fuels. It has been proposed that gigantic tidal hydroelectric power stations be built in remote locations to produce vast quantities of oxygen and hydrogen. Still, it remains to be seen if this can be viable.

One proposal for the Russian Penzhin tidal power station was for two gigantic plants of 21,4 GW and 87,1 GW.

The total tidal flow of the Penzhin basin is estimated at 360 to 530 cubic kilometres.

As early as the 1970s, researchers were investigating the possibility of using solar energy to generate hydrogen directly. Still, the inability to find materials with the combination of properties needed for a device that can efficiently perform vital chemical reactions has kept it from becoming a mainstream method.

Researchers from The University of Texas at Austin have found a low-cost way to solve one half of the equation, using sunlight to split off oxygen molecules from water efficiently. The finding, published recently in Nature Communications, represents a step forward toward greater hydrogen adoption as a crucial part of our energy infrastructure.

The US National Science Foundation funded this research through the Directorate for Engineering and the Materials Research Science and Engineering Centres (MRSEC) program.

Researchers of the Australian National University and the University of New South Wales have set a new world record in efficiency for producing renewable hydrogen from solar energy using low-cost materials. The team of scientists achieved a solar-to-hydrogen conversion efficiency of greater than 20 per cent. The researchers combined tandem solar cells with low-cost catalyst materials to split water into hydrogen and oxygen through electrolysis.

Hydrogen production directly from sunlight would be a breakthrough indeed, eliminating electrical power generation as an intermediate process followed by PEM electrolysers.

A remarkable new process being developed in Australia by Douglas MacFarlane, a chemist at Monash University, Melbourne, will utilise surplus renewable electricity to produce ammonia from water and nitrogen. This is similar to a fuel cell but operates in reverse. This could have significant implications for the storage and transport of energy as liquid ammonia. Ammonia is mainly used for agricultural fertiliser production and can be used for energy storage, fuel, and hydrogen production. Hydrogen can be produced from ammonia using a catalytic-cracking process.

CLICK HERE - For a 23-page paper on ammonia-hydrogen production.

CLICK HERE - For an excellent video on storing hydrogen energy as ammonia (12:17 mins.).

Ammonia may not seem like an ideal fuel, and the chemical used in household cleaners smells foul and is toxic. Still, its energy density by volume is nearly double that of liquid hydrogen - its primary competitor as a green alternative fuel - and it is easier to ship and distribute. "You can store it, ship it, burn it, and convert it back into hydrogen and nitrogen," says Tim Hughes, an energy storage researcher with manufacturing giant Siemens in Oxford, UK. "In many ways, it's ideal."

Another method of generating hydrogen, proposed in 2007, allows an alloy of aluminium and gallium to react with water. It is necessary to first remove any oxide coating on the aluminium.

A liquid eutectic mixture of gallium and indium is used to prevent oxidation of the aluminium from the air during the process. The aluminium will oxidise by removing oxygen from the water and releasing hydrogen. The gallium dissolves but does not react with the aluminium and can be quickly recovered for further use. This process requires no energy input and can make use of scrap aluminium.

After treating aluminium with gallium-indium, it becomes friable. The output flow and duration of hydrogen production is influenced by the presence or absence of silicon and magnesium in the aluminium. Using this method, hydrogen can be stored without pressure vessels by storing aluminium instead.

CLICK HERE - For the effect of gallium on aluminium beverage cans (5:36 mins.).

CLICK HERE - For details of hydrogen production from aluminium-gallium.

The world's burgeoning hydrogen industry is set to cause an increase in the production of COPVs (Composite overwrapped pressure vessels).

A most significant development in the drive to reduce global warming will be the expanded production of methanol from CO_2 and hydrogen. Methanol, CH_3O_H, also known as methyl alcohol or methyl hydrate or methylated spirits, is a light, volatile, colourless, toxic flammable liquid. Some 20 million tons are produced annually for use as a precursor in the chemical industries. It is also sold in small quantities for household use with additives to make it unfit for human consumption.

Methanol is produced by letting CO or CO_2 react with H_2 over a catalyst.

A.P. Møller – Mærsk A/S is a Danish integrated shipping company, active in ocean and inland freight transportation and associated services, such as supply chain management and port operation. Maersk has globally been the largest container shipping line and vessel operator since1996.

Maersk has identified its partners to produce green fuel for its first vessel to operate on carbon-neutral methanol. REintegrate, and European Energy will establish a new Danish facility to produce the approx. Ten thousand tons of carbon-neutral e-methanol that Maersk's first vessel with the ability to operate on green e-methanol will consume annually. Maersk will work closely with REintegrate and European Energy on the development of the facility.

The vessel will be capable of carrying 2000 containers and will be deployed on one of the line's intra-regional networks.

The world's first methanol feeder will be 172 metres long, and it is expected to join the Maersk fleet in mid-2023. It will sail in the network of Sealand Europe, a Maersk subsidiary, on the Baltic shipping route between Northern Europe and the Bay of Bothnia, and it will fly the Danish flag.

"Energy/REintegrate brings us on track to deliver on our ambition to have the world's first container vessel operated on carbon-neutral methanol on the water by 2023", says Henriette Hallberg Thygesen CEO of Fleet & Strategic Brands, A.P. Moller – Maersk.

The methanol production facility will use renewable energy and biogenic CO_2 to produce e-methanol. The fuel production is expected to start in 2023. The copious quantities of CO_2 required will be provided by a paper mill, which would have otherwise have been vented to the atmosphere. The energy needed for the green hydrogen production will be provided by a solar farm in Kassø, Southern Denmark. Methanol will also provide a convenient form of energy storage.

In November 1776, Italian physicist and electrical pioneer Alessandro Volta, methane were first scientifically identified in the marshes of Lago Maggiore in northern Italy. Volta was inspired to search for the substance after reading a paper written by

Maersk first carbon neutral ship

Benjamin Franklin about "flammable air". Volta collected the gas rising from the marsh, and by 1778 had isolated the pure gas. He also demonstrated that the gas could be ignited by using an electric spark.

Following the Felling mine disaster of 1812, in which 92 men perished, Sir Humphry Davy established that the feared firedamp occurring in mines was predominantly methane.

At that time, the young Michael Faraday was employed by Davy and made the life-saving discovery that coal dust blown into air suspension by a methane explosion could be a worse explosion hazard than methane.

Davy was asked to find a means of lighting coal mines safely. In an intense period of work from mid-October to December 1815, Davy made various prototype lamps. The final design was effortless: a basic lamp with a wire gauze chimney enclosing the flame.

The holes let light pass through, but the metal of the gauze absorbed the heat. The lamp is safe to use because the flame cannot heat the flammable gas sufficiently to cause an explosion, although the flame itself would change colour.

The lamp was successfully tested in Hebburn Colliery in January 1816 and quickly went into production. The introduction of the lamp had an immediate effect, decreasing the incidence of gas explosions.

It has been proposed that CO_2 could be sequestered in underground storage as liquid and an associated hydrate phase in conjunction with methane hydrate mining. See the following link for a 22-page paper on this matter. The abstract reads as follows:

The sequestration of CO_2 in the deep geosphere is one potential method for reducing anthropogenic emissions to the atmosphere without necessarily incurring a significant change in our energy-producing technologies.

Containment of CO_2 as a liquid and an associated hydrate phase under cool conditions offers an alternative, underground storage approach compared to conventional supercritical CO2 storage at higher temperatures.

We briefly describe conventional approaches to underground storage, review possible approaches for using CO_2 hydrate in CO_2 storage generally, and comment on the vital role CO_2 hydrate could play in underground storage. Cool underground storage appears to offer certain advantages in terms of physical, chemical and mineralogical processes, which may usefully enhance the trapping of the stored CO_2. This approach also appears to be potentially applicable to large areas of sub-seabed sediments offshore Western Europe.

CLICK HERE - For a 25 page report on the underground storage of CO_2.

Ryo Mukano, a Nikkei staff writer, reported on July 27, 2021:
Japan's largest hydrogen plant powered by offshore wind energy is set to open on the northern island of Hokkaido as part of a national effort to slash carbon dioxide emissions.

Scheduled to begin operation as early as the year ending March 2024, the plant will produce up to roughly 550 tons of hydrogen a year - enough to fuel more than 10 000 hydrogen vehicles, according to plans.

The effort represents a step toward creating a home-grown supply of hydrogen that is "green" or made using renewable energy. Green hydrogen produced with offshore wind power remains rare worldwide - particularly in Japan, which lags European nations in building such wind farms.

The 110 MW wind farm and the hydrogen facility will be built in the coastal city of Ishikari, the site of other planned green hydrogen projects. The new, larger plant is expected to lift local annual hydrogen production to 2 500 tons.

Participating in the project are Hokkaido Electric Power, renewable energy developer Green Power Investment, Nippon Steel Engineering and industrial gas supplier Air Water.

The hydrogen plant and wind farm will be built in the Hokkaido coastal city of Ishikari.

Plans call for selling the hydrogen in Hokkaido and shipping it to other parts of the country in a transport network that could include ports in Kobe, on the Sea of Japan coast and other areas.

The hydrogen will generate electricity to power such infrastructure as data centres, cargo equipment in ports and refrigerated warehouses.

The Japanese government aims to attain net-zero greenhouse gas emissions by the middle of the century, and hydrogen plays a big part in that goal.

The government's Green Growth Strategy announced last year calls for up to 3 million tons of hydrogen production capacity to be introduced in 2030, rising to about 20 million tons in 2050. This plan requires Japan to develop its own hydrogen industry without relying on imports.

The European Union looks to develop a capacity to produce 10 million tons of green hydrogen a year by 2030. In Japan, producing green hydrogen costs more than in other big economies.

It takes $6 to $9 to make a kilogram of hydrogen in Japan, according to data provider BloombergNEF. That far exceeds the US $2 to $4 and $3 to $6 in Germany.

Lowering the costs will require technology to transport hydrogen in bulk, as well as large-scale production equipment. As an island nation, Japan has more than enough space to build offshore wind farms. But costs pose a hurdle.

Offshore wind power's price tag is expected to decrease with the spread of alternative energy. One kilowatt-hour of offshore wind power will cost just over 26 yen (23 cents) in 2030, according to estimates by Japan's Ministry of Economy, Trade and Industry. By comparison, solar energy will cost roughly 8 yen to 11 yen, and onshore wind power will cost about 9 yen to 17 yen.

The government aims to lower the price of hydrogen to 30 yen per standard cubic meter, or less than a third of the current level. Hokkaido Electric and the other investors will lower production costs in line with the government's outlook. This will be accomplished in part by expanding sales through marine routes and making use of financial subsidies.

Debate is unfolding over whether fossil fuels or renewables should power Australia's nascent hydrogen industry.

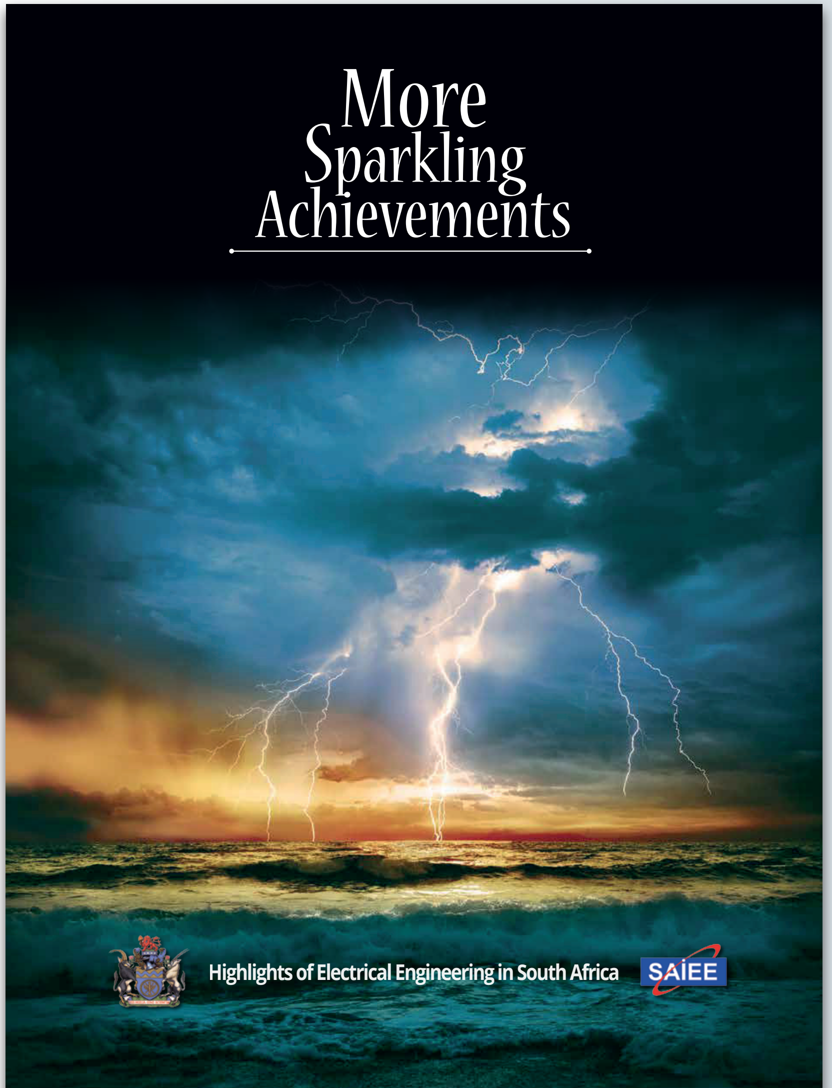
Australia aspires to become a hydrogen superpower in the next decade, but some experts say a push for fossil fuel-based rather than renewables-backed production could undermine its future competitiveness and leave some projects stranded.

The Australian government has rejected an application to build the world's most significant renewable hydrogen and ammonia plant, the 26 GW Asian Renewable Energy Hub in Western Australia.

Australia's ancient, arid landscapes are fertile ground for new growth,

SAIEE Coffee table book

Second Edition



In 2001 the SAIEE published a coffee table book titled "Sparkling Achievements". The book was compiled and edited by Michael Crouch, a Past President of the Institute and published for the SAIEE by Chris van Rensburg (Pty) Ltd.

This first book surveyed Electrical Engineering in South Africa and included material from 43 local organisations. The second edition's objective is to include new companies and their history and achievements during the past two decades from 2001 to 2021.

Work contacting organisations started in February 2019 and went well until the onset of the Covid 19 pandemic, after which it gradually became challenging to entice companies to participate. Numerous companies had retrenched staff and were in serious financial difficulties. However, we eventually gathered together sufficient material to make the book viable.

One of the most outstanding inputs is from the Square Kilometre Array (SKA) Radio Telescope organisation in the Western Cape. All inputs are exciting, and we feel confident that the book will be an outstanding success.

This softcover book is now available at R350 (incl. VAT) from the Institute.

To order your book, please contact Dudu Madondo either via email: reception@saiee.org.za or contact her on 011 487 3003.

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says Douglas MacFarlane, a chemist at Monash University in suburban Melbourne. Vast forests of windmills and solar panels; more sunlight per square metre strike the country than just about any other, and powerful winds buffet its south and west coasts.

All told, Australia boasts a renewable energy potential of 25 TW, one of the highest in the world and about four times the planet's installed electricity production capacity. Yet with a small population and few ways to store and export the energy, its renewable bounty is largely untapped.

The Australian Renewable Energy Agency declared that creating an export economy for renewables is one of its priorities. This year, the agency announced AU $20 million in initial funds to support renewable export technologies, including shipping ammonia.

A new battery has been announced, which could revolutionise the world's large scale battery scene with drastically reduced manufacturing costs. The iron-air battery uses iron in an oxidation-reduction (redox) process and has a very high specific energy. This may seem too good to be true – but let us wait and see.

Another candidate is the sodium-ion battery which may make a come-back with new developments using graphene. The vanadium redox flow battery holds much promise for bulk storage, but its low specific energy and the large quantity of sulphuric acid electrolyte make it unsuited for vehicular use.

The graphene aluminium-ion battery cells from the Brisbane-based Graphene Manufacturing Group (GMG) charge up to 60 times faster than the best lithium-ion cells and hold three times the energy.

GMG plans to bring graphene aluminium-ion coin cells to market late this year (2021) or early next year, with automotive pouch cells planned to roll out in early 2024.

Aluminium–air batteries produce electricity from the reaction of oxygen in the air with aluminium. They have one of the highest energy densities of all batteries. Still, they are not widely used because of problems with high anode cost and by-product removal when using traditional electrolytes.

The battery is not rechargeable requiring the electrodes to be replaced for re-use. An electric vehicle with aluminium batteries can be up to eight times the range of a lithium-ion battery with a significantly lower total weight.

Global warming, CO_2 emission reduction from fossil fuels, an increase of solar and wind energy usage, vehicle energy storage and sizeable industrial-scale rapid-response energy storage present a dire melting pot of urgent problems requiring brilliant and achievable solutions. wn

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JANUARY 2022

DATE	TITLE
19/01/2022	Construction Regulations from a Legal Perspective
25/01/2022	Incident Investigation and Management (Root Cause Analysis)
25/01/2022	SAUPEC 2022 Conference
26/01/2022	SANS 10142-1 Edition 3

FEBRUARY 2022

DATE	TITLE
01/02/2022	Network Frequency Controls
02/02/2022	An introduction to Artificial intelligence for Professionals
08/02/2022	Project Management for Engineers
09/02/2022	Photovoltaic Solar Systems
09/02/2022	Legal Liability: Mine Health and Safety Act
10/02/2022	ARC Flash
16/02/2022	Road to Registration
16/02/2022	Webinar: Nuclear Medicine & Radiation Biology
21/02/2022	Transformer Construction, Operation, Maintenance, Testing and Protection
22/02/2022	New Engineering Contract (NEC)
23/02/2022	Power Systems Protection
28/02/2022	Fundamentals of Financial Evaluation for Projects

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