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Transforming Infrastructure for a Better Tomorrow

Empowering sustainable investing through next-gen technology

actis

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Clean energy: scaling up output and opportunities

The clean energy revolution is well underway. Fuelled by increasing awareness around climate change and the need to decarbonise, along with government and private sector pledges to deliver meaningful action, alternative sources of power are now experiencing greater levels of investment. That said, it's a trend that urgently needs to scale up: in 2020, over **60 per cent** of global electricity production was still derived from fossil fuels – a situation compounded by the world's major economies, which continue to spend far greater sums **subsidising fossil fuels** than supporting clean energy generation. Continuing reliance on fossil fuels is a situation that must change, and rapidly, if we are to achieve a net zero world by 2050.

By several measures, 2021 was a positive year for sustainable energy and the infrastructure that supports it. An all-time record for new installations of renewable energy technologies such as wind turbines and photovoltaic solar panels was achieved during this period, with growth up 3 per cent on 2020. **The latest data** from the International Energy Agency (IEA) reveals that 290GW of renewable energy has been installed in 2021, taking the total global figure to 3,261GW.

Today, there are far more clean energy generation technologies being installed than fossil-fuel plants. Wind and solar farms in particular are playing an increasingly important role in meeting the world's growing energy needs – along with other types of renewable energy generation, they are set to account for almost 95 per cent of the increase in global power capacity by 2026. The improving competitiveness of wind and solar photovoltaic (PV) is helping to drive their expansion, taking the renewables revolution worldwide. Though China, India, Europe and the US account for the lion's share of new renewable energy, the IEA also expects growth in other parts of Asia, Latin America, sub-Saharan Africa, and the Middle East and North Africa.

It is clear that clean energy tech is heading in the right direction. By 2026, the IEA predicts that global renewable electricity capacity will have risen by more than 60 per cent from 2020 levels to more than 4,800GW. At this level of penetration, the capacity of renewable energy in operation will equal the current total global power capacity of fossil fuels and nuclear combined.

In the wake of more ambitious policy announcements made by governments in the run up to, and at, the United Nations' COP26 climate negotiations in Glasgow during October-November 2021, the IEA raised its growth forecasts for installations of renewable energy – a sign that it sees the announcements as positive evidence of the world taking steps in the right direction.

However, the agency has cautioned that even these high expansion predictions will not be sufficient to meet 2050 net zero targets. Renewable electricity is urgently needed to clean up the power sector, fuel greener heating and transport systems and, at the same time, satisfy the increasing energy demands of growing urban populations. To deliver on targets, the IEA believes that the build-out of renewable power capacity needs to double in the next five years. As such, while 2021 sets us on a more positive course, it is clear that the gulf between where we are headed and where we need to be remains vast.

Empowering sustainability with next-gen technologies

In addition to building vastly more capable energy-production capacity, if global governments and industries are to transition successfully to more renewable sources of energy, the costs associated with production, and the infrastructure that supports it, must continue to fall. With the withdrawal of government subsidies, initially aimed at kick-starting the renewable energy sector, the onus has now fallen upon the sector itself to deliver a more cost-competitive solution.

In a post-subsidy world, performance of infrastructure has never mattered more. As a result, according to Lucy Heintz, head of energy infrastructure and fund head at Actis, the sustainable infrastructure investor, the shift away from subsidies has forced the renewable energy industry to focus far more on improving the efficiency of existing operations.

"All sorts of projects in the late 2000s in Europe were not very well built, because they just needed to be finished on time to qualify for a subsidy. But to deliver high quality operations, that technology needs to become cost-competitive. That's where we are right now"

Lucy Heintz

Head of energy infrastructure and fund head, Actis

The focus on efficiency has the potential to deliver massive returns in the sector. Achieving a full decarbonisation of the global energy system will require between $92 trillion and $173 trillion of investment in energy infrastructure between 2020 and 2050, according to Bloomberg New Energy Finance. Using this assumption, the World Economic Forum concluded in **a recent report** that even single-digit percentage gains in efficiency or capacity in clean energy and low-carbon infrastructure systems can lead to trillions of dollars in value and savings.

In the quest to make existing infrastructure more efficient, new and emerging technology has a game-changing role to play. Enter the Fourth Industrial Revolution technologies – so named because they represent a major disruptive force with the potential to transform our lives and economies. These technologies – which include artificial intelligence (AI), machine learning (ML), sensor-led technologies (the enabler of the Internet of Things), robotics and automation – are delivering step-changes in processes and performance across almost all industry sectors.

The power sector is no exception and, within the renewable energy industry, there are multiple examples of these technologies moving us towards a more sustainable energy infrastructure. From the use of sensors and drones to monitor and collect real-time data on equipment and operations, to the deployment of machine learning and artificial intelligence to predict faults or aid decision-making in energy trading, the applications are increasing.

For those investing in this sector, the opportunities are significant

As Ralf Nowack, energy and infrastructure operations director at Actis explains, "when we acquire companies, we really try to improve the power generation and make the assets more efficient, which increases generation and reduces CO_2." For Actis, efficiency gains brought about by Fourth Industrial Revolution technologies are central to its investment strategy of delivering long-term growth through continuous performance improvements.

The potential for these technologies to boost the generation of existing assets through operational improvements is significant. According to Nowack, it can equate to an average 2-5 per cent increase in generation: a 200MW wind farm, for example, would see a boost of around 4MW. "This is in the range of the biggest wind turbines you can install onshore, so generation is increased by the equivalent of an extra wind turbine," he says.

Driving energy efficiency with data-led decisions

As relatively new technologies, wind and solar plants were able to integrate sensors into their operations from early on, allowing them to collect vast amounts of data on component performance, generation output, weather conditions and more.

The volumes of data produced by energy generation equipment are typically too high for humans to analyse in any practical timeframe to inform decisions. This is not the case for ML and AI, which can rapidly analyse historical and new data, make predictions, control physical operations, and support faster and more robust decision making.

AI allows renewable energy operators to be much more proactive in managing their assets, Nowack says.

"In the past, we received quarterly reports about technology and financial performance. But if you get a report three months after something happens, there's not much you can do, just react. Now we can see all the data online – what was today's production, what are the trends – and we can make decisions much faster."

Data is sent to the Cloud to be interpreted by engineers on the ground

Predictive maintenance – or the use of data and AI to proactively predict when asset maintenance is required – is helping players within the renewable energy space to rise to the efficiency challenge. In the past, equipment was fixed only once it failed, or at regular intervals based on best-guess scenario planning. This led to needless downtime, or worse, to expensive repairs as well as broader reductions in energy production. Now, AI is flagging when a component is likely to fail and is enabling optimally timed intervention that reduces downtime.

Nowack gives the example of a wind turbine showing signs of vibration or displaying increased oil temperatures in its condition monitoring system. Integrated AI can identify this in the data, and alert the operator to change the gearbox before more serious issues arise.

"We can procure the spare parts early, organise the maintenance teams in advance, and have organised and planned maintenance due to actual data, not assumptions," he said.

Wind-energy operator and Actis investment Echoenergia has reaped the benefits of digital technologies on its wind farms. "We focus on three things to grow the company profitably – people, processes and technology," says its chief executive Edgard Corrochano.

The firm has used big data, AI and predictive maintenance to enhance the performance of its turbines since its launch in 2017. Data produced by sensors attached to its assets is statistically analysed to identify patterns in behaviour and performance that could indicate imminent failure of a component. As Corrochano explains, component failures can cost an operator hundreds of thousands of dollars, meaning that preventing failures creates a lot of value for the company.

"A lot of things happen in the lead up to failure. AI can see when some of these start to happen with the same format, or the same consistency, so we can bring in the manufacturer to investigate," he says.

But it's not just about predicting failure. Data analysis helps the firm maximise the value extracted by its assets, ensuring optimal performance at all times, without putting them at risk over the long term, Corrochano adds. "There's a sweet spot – you could extract as much value as possible in the next two to three years, but if that puts your assets at risk for the next 30, it might not be worth it."

But, as Corrochano stresses, big data and AI are no use without a team of talented people. His team includes experts in statistics and turbine maintenance, and can make modifications to coding and customise operations. "Once you have the data, you need to interpret it, so you need both technology and people working together", he says. Echoenergia is continuously learning from its experiences and tweaking AI-enabled operations as a result. For example, when engineers probing a potential fault conclude it is a false alarm, they know to programme the AI to disregard that particular pattern the next time it is detected.

Echoenergia also uses AI to analyse weather data – meaning it can more confidently predict upcoming output from its wind turbines and, as a result, better plan trading. In the electricity trading market, generating companies are contracted to sell a specified amount of their output in advance. If the wind farms are predicted to generate less than planned, the firm could consider buying energy from another seller on the market in advance if the price is likely to be better, rather than waiting to see what the actual generation is. Conversely, if it predicts generating more than planned, it can sell that ahead of time if it believes it will obtain a better price by doing so, Corrochano explains. "It helps us optimise our revenue stream in a very economical way."

The automation advantage: drones, robots and self-maintaining systems

Robotics, AI and drone technologies are proving increasingly popular in the renewable energy industry for deployment on surveillance and maintenance tasks on assets that are often in difficult environments and remote locations.

Chilean solar plant operator and Actis investment Pelicano uses such technologies to support operations and maintenance of its solar farm, which is located in a remote desert in the north of the country. As a result of its innovative approaches, Pelicano has consistently driven up the efficiency of its solar plant over time.

Infrared (IR) technology inside drones is used to conduct aerial inspections of Pelicano's solar plant, explains Hugo Vits, the firm's general manager. In this way, problems or defects that could impact the plant's performance can be more easily detected. The IR drone technology can spot a potential issue, and AI can classify what it is, such as bird droppings or dirt. Maintenance crews can then be sent out, as required, to find a solution.

The drone surveys also support decisions on when and where to focus cleaning, something that reduces the use of scarce water resources and makes the plant more sustainable. On a large plant, there are likely to be areas that soil faster than others, such as those closest to a road, or where there is more wind. A crew can be sent in overnight to focus on cleaning only the PV modules that need it, while others can be left to continue working, Vits says.

Conducting surveys via drone is cheaper than the traditional method of measuring plant performance with sensors on every string of photovoltaic modules. As Vits explains, the company installs sensors on the inverter (the part of the solar plant that converts DC voltage to AC) which collect performance data that can be sent to the energy grid, along with supplementary data from the IR-enabled drone survey. Aggregating this data over time helps support decisions on future investment in operations and maintenance.

Drones and solar field sensors work in tandem to detect potential problems

It is clear that IR drone technologies are driving significant value. Pelicano can operate the plants remotely from a control centre 100km away, which reduces the number of people required on site. "We're saving at both the instrumental end of the plant, and by doing fewer surveys on plants that don't need much work," says Vits. And, as Vits points out, value is only set to increase. "Use of this technology is getting more and more widespread. IR drone surveys are more common, so costs are becoming more competitive because there are more providers," he says.

As a next step, Pelicano is considering whether it can clean with robots that are fully automated – something that would increase efficiency while further saving on both people and water, Vits adds.

Balancing the grid without leaning on legacy fuels

Fourth Industrial Revolution technologies are an essential companion to renewable energy. The integration of digital technology with physical assets unlocks data and enables the analysis of elements that were previously too big for humans to make sense of, thereby driving operational efficiency. But the deeper understanding gained from big data analysis has the potential to create substantial value for the global energy transition in another area that's just as important as generation – grid stability.

Power grids need to become far more complex as increasing amounts of renewable energy comes onstream, and herein lies further challenges. Energy transmission systems were typically designed to transport energy from a small number of centralised and fossil-fuel based energy generation sources which output consistent levels of energy to a large number of users. However, they now also need to take in power from a large number of renewable energy sources whose output varies according to the weather. In order to be able to maintain grid stability and prevent problems such as blackouts, grid operators need to know how much energy is likely to be generated, and when.

The demands placed on grids are set to increase further. Future transmission of energy will also see it being produced by homes and businesses, and stored in batteries and electric vehicles. On top of this, grids will also need to be able to deal with high voltage power from offshore wind farms coming to load centres on land.

Lucy Craig, vice president of growth, innovation and digital at independent energy experts DNV believes that grids will only be able to handle this complexity with the aid of digital technologies. "This is not just about how AI and machine learning will accelerate the transition," she says. "Without the ability to undertake real-time control, and carry out real-time calculations and decisions, the operation of such a complex grid will not be possible."

Nowack agrees with this assessment of the critical role AI will have to play in the industry. In his view, the biggest limiting factor to the much-needed, massive-scale clean energy transition is distribution – but this is another area that can be significantly enhanced by technology, and in particular AI. "There will be significantly more investment in wind, but some potential generation will be lost due to grid operators turning off wind turbines in order to prevent excess energy being put onto the network," explains Nowack. "Artificial intelligence, machine learning and battery storage can be used to stabilise transmission lines and reduce curtailments of renewable energy. This in turn allows more renewable energy to be connected to the grid, while the use of fossil fuels to provide back-up power can be cut back."

Batteries are another critical component of sustainable infrastructure – and the technology is a further area of investment for Actis. In particular, in countries where grids are not sufficiently robust to handle the variability of wind and solar power, battery technology has become a critical component in energy supply stability and efficiency. According to Heintz, "adding a storage project can be totally transformational in terms of being able to manage costs more effectively. You don't need backup generation because you can store the energy when there's too much."

Hydrogen is another candidate for dealing with the variable output from renewables, and offers a storage capability for when batteries are impractical. Rather than storing excess electricity produced from wind and solar plants in banks of batteries, this energy can instead be used to power electrolysis in order to produce hydrogen. This, in turn, can power fuel-cell vehicles, be used for power generation, or be injected into natural gas pipelines. The cost of this production process is high, acting as a barrier to more widespread adoption – however, **the IEA predicts** that with technological advances and economies of scale, production can become cost-competitive, making it a much more feasible option to stabilise grids. "There's an enormous opportunity for green hydrogen, using renewable energy to create it, and we're seeing projects happening across some markets already," Heintz says.

The future of sustainable, efficient energy infrastructure

"We're at the beginning of how we see the energy sector changing in the decades up to 2050," says DNV's Craig. "Renewable energy technologies have developed rapidly and the learning around digital technologies is even faster. In ten years' time, there will be a much greater uptake of digital technologies across the energy sector, and grids will be operated in a much more automatic way."

In a sector in which decarbonisation is paramount and efficiency gains will be essential in delivering this, those energy businesses that are not looking at digital technologies to improve their operations, and deliver more sustainable outcomes, do so at their peril.

Those who rise to the challenge will look to blend different technologies to deliver greater value, push prices down and gain a competitive edge – renewable-energy storage optimised by AI, for example. Innovation from companies outside the energy sector will also influence how new technologies integrate with hardware and operational processes to drive positive change. Google, for example, has committed to using 100 per cent renewable energy with no carbon offsetting by 2030, and is investing billions of dollars to that end.

Of course, new innovation will continue to emerge as use cases of technologies develop and today's solutions are taken to the next level. Robotics is one such area in which the innovation journey is well underway, and the potential for enhanced efficiencies is huge. Crawling robots – which currently exist, but are less developed commercially than drones – can stick to vertical surfaces such as that of a solar panel or a wind-turbine tower. However, in the future, these will be able to use microwave and ultrasonic transmitters and receivers to penetrate into the structure they are touching to reveal faults in materials. Robots that can sail, drive or even travel underwater are all under development, all of which could be controlled by AI to support the construction, inspection and maintenance of renewable energy technologies.

What is clear about the innovation required to help us meet net zero targets is that much of the underlying technology needed to deliver this step-change in decarbonisation is already in existence – it simply needs to be adopted, improved or better deployed.

As a case in point, the World Economic Forum (WEF) concluded in its **recent report** that there is far greater potential for AI and other digitalisation technologies than is currently being realised. "AI isn't a miracle cure, but it's a key to the energy system we need in the future, which is much more decentralised, digitalised and decarbonised," said Espen Mehlum, head of knowledge management on shaping the future of energy at the WEF, and co-author of the report. "We're at the early stage of the s-curve of the application of AI in the energy sector. Whether that s-curve is kicking in fast, or slow and then fast, is unsure, but in reality this is coming – it makes not only climate sense, but business sense."

While the main focus of AI is currently on more intelligent use of data, the applications of AI could also lead to enhancements in infrastructure by improving the hardware itself, such as by making materials lighter, longer-lasting and more efficient.

Nowack's vision of the future is one in which Fourth Industrial Revolution technologies will become both more widespread in the energy industry and more sophisticated. By 2050, countries will need to run completely with renewable energy in order to hit net zero targets, he says. "I believe it is possible. There will be a combination of renewable energy technologies, AI, hydrogen, batteries and more intelligent operation – a more integrated energy system. I think it's right to improve the old, look at the new, and enable a decentralised system that can include all of this. That's the future," Nowack concludes.