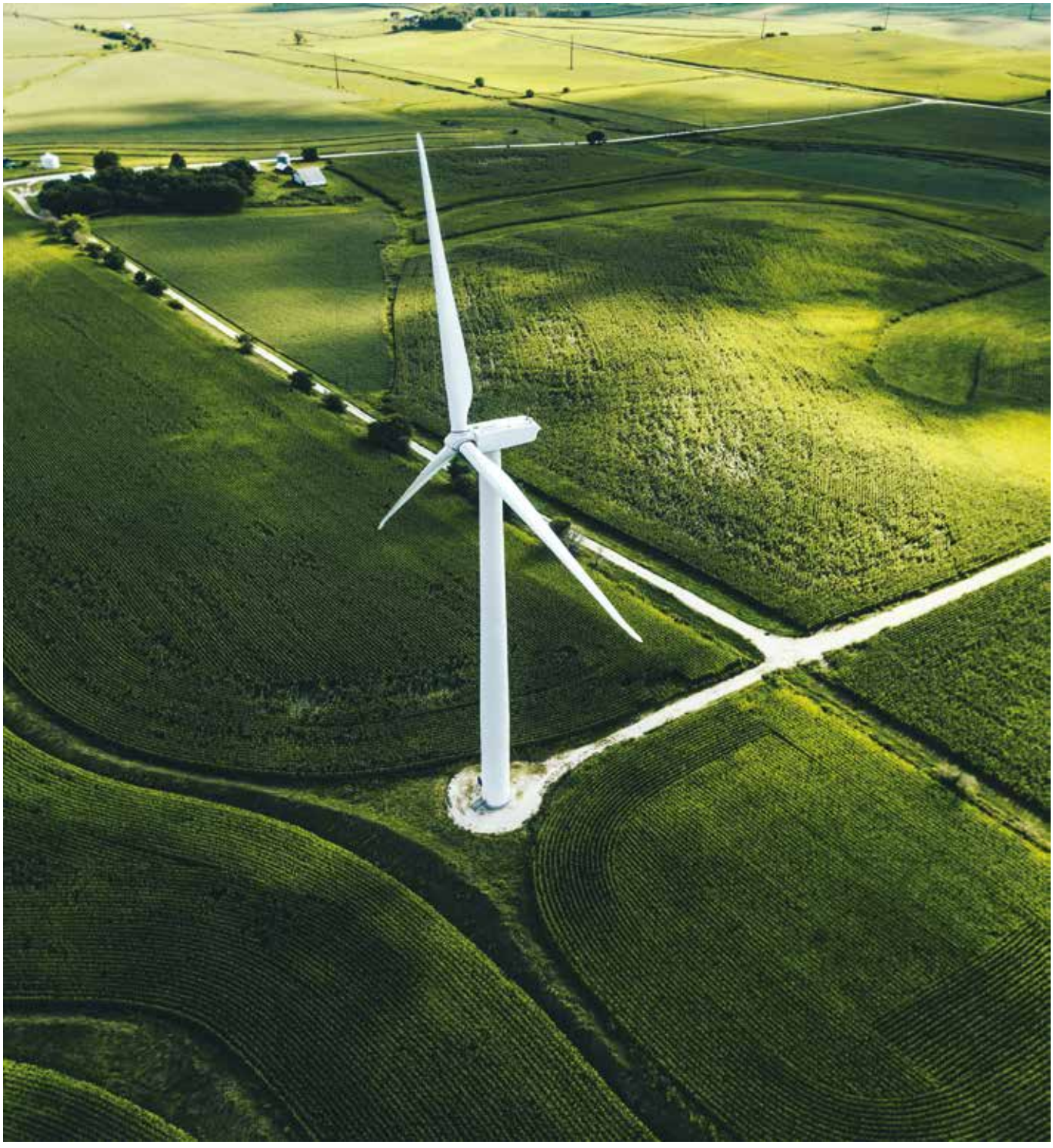
RENEWABLES+ RINA

RINA MAGAZINE - RENEWABLES EDITION



LEADING FIGURES
on their low-carbon visions

NEW TECHNOLOGIES
driving renewable energy

EXPANDING MARKETS
offer opportunities worldwide

It is an exciting time for the energy sector: new technologies are now available and implemented, growing awareness of the importance of sustainability and preserving our environment, smart grids and new energy management systems are driving the energy mix transition from fossil fuels to cleaner sources. New energy transmission models are influencing the possibility for a wider population to benefit from electrical power. With a worldwide coverage, RINA is actively engaged in promoting this shift by supporting Clients in the implementation of sustainable energy generation, transmission and distribution projects. With a strong focus on clean energy and sustainability, RINA's energy group consolidates a wealth of multidisciplinary consulting engineering experience and has advised on some of the biggest renewable energy deals in the last 18 months. We look forward to helping our partners and customers - from Australia to Mexico, Spain to Singapore and US - drive the clean energy transition in 2018 and beyond.

Many thanks to Cypress Creek Renewables, Low Carbon, Octopus Investments, Renewable World, Tenergie, WIRSOL Energy and the Export-Import Bank of the United States for their valuable contributions to this magazine.

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Chief Operating Officer, RINA

Driving the clean energy transition

Month after month, we are seeing more and more indications that the clean energy transition and global change in the energy mix are well underway. As an example, the UK recently went three days in a row without using coal energy generation, the longest coal-free period since the 1880s.

The renewables market has always been volatile due to its reliance on subsidies and changes in government support for the sector. Obtaining finance for large-scale projects has been a key issue. However, we are now entering a new era of subsidy-free renewable energy, with the first of such projects under construction in several European countries and a record low bid of $0.179/kWh in Saudi Arabia for solar generation. The first offshore wind farm in the south of the UK, Rampion, lies just off the coast from Brighton, where we have one of our main offices of our renewables centre of excellence.

Development and institutional funding is pouring into the sector globally, with solar receiving the most investment of all energy generation technologies in 2017. Renewable energy could make the greatest immediate impact in developing countries. Just as mobile phones leapfrogged the need for expensive communications infrastructure, off-grid and mini-grid renewables can provide electricity without transmission networks. This will reduce the overall cost of providing electricity to those currently without it. A charity that RINA supports, Renewable World, does exactly this, radically improving people's lives.

Sustainability and digitalisation, two of RINA's key strategic pillars, apply to the global energy market and its drive towards clean energy. The reduction of large conventional fuel power generation, the integration of renewables into existing networks, demand-side management and electric vehicles are some of the next big challenges in the industry. Large utilities are facing pressure due to the ever-changing ways of managing energy. A diverse generation mix and improved storage solutions are part of the solution.

Digitalisation provides other solutions, from smart grids and artificial intelligence to distributed ledger technologies such as blockchain. Data and asset management are becoming increasingly important as distributed generation and a consumer-led approach to energy become more mainstream. RINA is at the forefront of new technologies, from early-phase research and the commercialisation of technology to the institutional investment platform.

In this period of changes and transformation in our sector, we are really proud to present the first issue of our RINA Renewables+ magazine. Our aim is to share with all stakeholders of this growing sector our insights into some of these topics, taking into account the valuable contributions of our partners and customers. I would like to thank all contributors, with the hope that the magazine will spark productive dialogue and be the first of a long sequence.

■ fabio.bagnoli@rina.org
Executive Vice President
Power

A bright future for solar energy

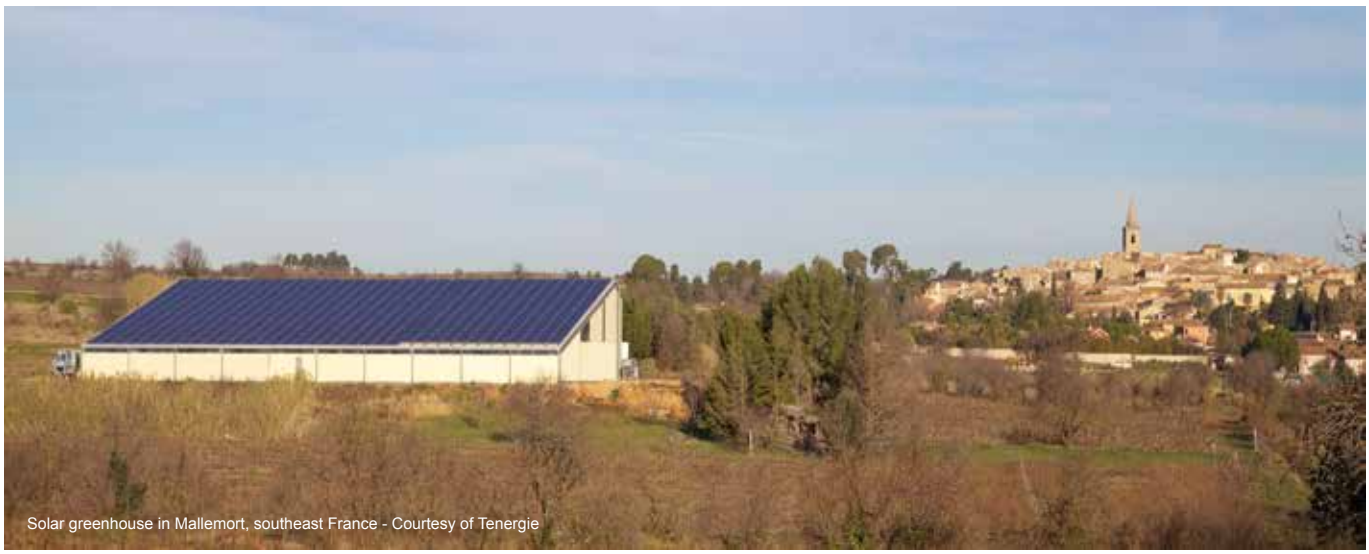
Interview with Pascal Penicaud, CEO, Tenergie

The key elements of a strong solar energy sector are finally coming together. Rising demand and social acceptance among consumers. Commitment and support from governments and investors. Technological developments that lower the cost and improve the efficiency and competitiveness of solar energy. As a young, agile company that develops, finances, constructs, operates and maintains solar energy projects in the south of France and Italy, Tenergie is at the heart of the clean energy transition. Our challenge – and goal – is to continue working one by one with customers, investors and communities to help build a strong base for solar energy across France and the rest of Europe.

Rising customer demand is a positive sign for any young industry, but what's most interesting is the shift in where that demand is coming from. Until recently, central government has usually been considered responsible for electricity provision. As long as their lights turned on, machines worked and bills were reasonable, people rarely considered where their electricity came from. Now, individual businesses and local communities – not governments – have become a major driving force behind demand for solar energy projects.

Many of these projects are on a small scale, but they provide significant benefits directly to consumers. Farmers, for example, can vastly reduce their long-term energy costs with solar greenhouses and agricultural barns with PV roofs. Companies are installing solar carports for charging electric cars and e-bicycles. This type of demand will rise as e-mobility increases and the way society consumes electricity changes. As a relatively small company with 60 permanent employees, we are close to local communities and have direct contact with our customers. So we are seeing these evolutions at first hand and can respond quickly to changes in demand.

Agility is one advantage we have over our larger competitors, the traditional utility and energy companies who have now entered the solar market. They appear to have strong ambitions, and it is not easy to compete against giants. However, we welcome their entry into the market as we recognise that their investments – along with continued support from government and financial



Solar greenhouse in Mallemort, southeast France - Courtesy of Tenergie

Roof-mounted PV plant near Montpellier – Courtesy of Tenergie

institutions – are crucial to achieving France's ambitious renewable energy targets. We must all contribute to reaching our shared goal of a low-carbon economy.

Involving communities in solar energy projects will accelerate the green energy transition, because social acceptance is a major success factor in renewable energy projects. As people engage with our solar projects, they come to understand the benefits of producing electricity locally and sustainably. Not only do communities gain easier access to competitive, carbon-free and locally produced energy, they enjoy a boost to regional tax revenues and employment.

That is the philosophy behind our recently launched crowdfunding campaigns. In collaboration with Lendosphère, we aim to raise €800,000 over three months for 71 solar plants located in 24 16 regions. The French term for crowdfunding is "financement participatif", or "participative financing". For us, the "financing" side is less important than the "participation" side. At this stage, the campaigns represent less than 5% of our capital expenditure. Our main purpose is to mobilise citizens to invest side by side with larger lenders, benefiting financially once the project matures and helping shape their region's future energy scene.

It has been quite an adventure since Tenergie started in 2008 in Aix-en-Provence. By the end of this year, we expect to have around 600 solar plants representing 250 MW of capacity, along with three wind power plants. As we acquire each new plant, we have the challenge of bringing them up to our standards. Each plant has been developed, constructed and financed by different groups at different times. So although harmonising our growing portfolio is a nice problem to have, it is not an easy one to solve.

As with any young industry, the main issue is that standards are neither international nor stable. We are always chasing them, updating our systems to incorporate new technologies, guidelines and best practices. This is one area in which RINA has been invaluable, providing solid technical and financial advice to solve each new challenge as it arises. I'm really proud of our internal team, but I'm also really happy to have built up a relationship of trust with RINA's advisors. They have played an important role in our success so far and will continue to support us as we expand over the border into Italy.

As the industry matures, we need to develop robust international standards and stop seeing energy provision as a purely national issue. We are passionate about involving local communities in their energy future and will continue to pursue our initiatives in this area. We look forward to further developments in solar technologies that will make the industry even more competitive, as well as fresh demand from consumers at the ground level. Despite the challenges, the future looks bright for solar power.

PASCAL PENICAUD

Pascal Penicaud has been Chief Executive Officer of Tenergie since 2016. Supported by a team of 60 staff members, Pascal's strategic vision and commitment have helped Tenergie become the sixth largest independent solar power producer in France.

Pascal joined Tenergie in 2010, two years after the company's foundation, and was made a partner in 2011. In his first role as Chief Financial Officer, he grew Tenergie's solar portfolio by purchasing operating PV plants on the secondary market and managed all M&A and investment activities. Pascal started his career at Enedis in Paris, formerly ERDF, the French DSO subsidiary of utility giant EDF. He has a Masters in Management Science from EM Lyon Business School.

www.tenergie.fr

Financing renewables: risks & benefits

Interview with Michael Sams, Senior Electrical Engineer, Export-Import Bank of the United States

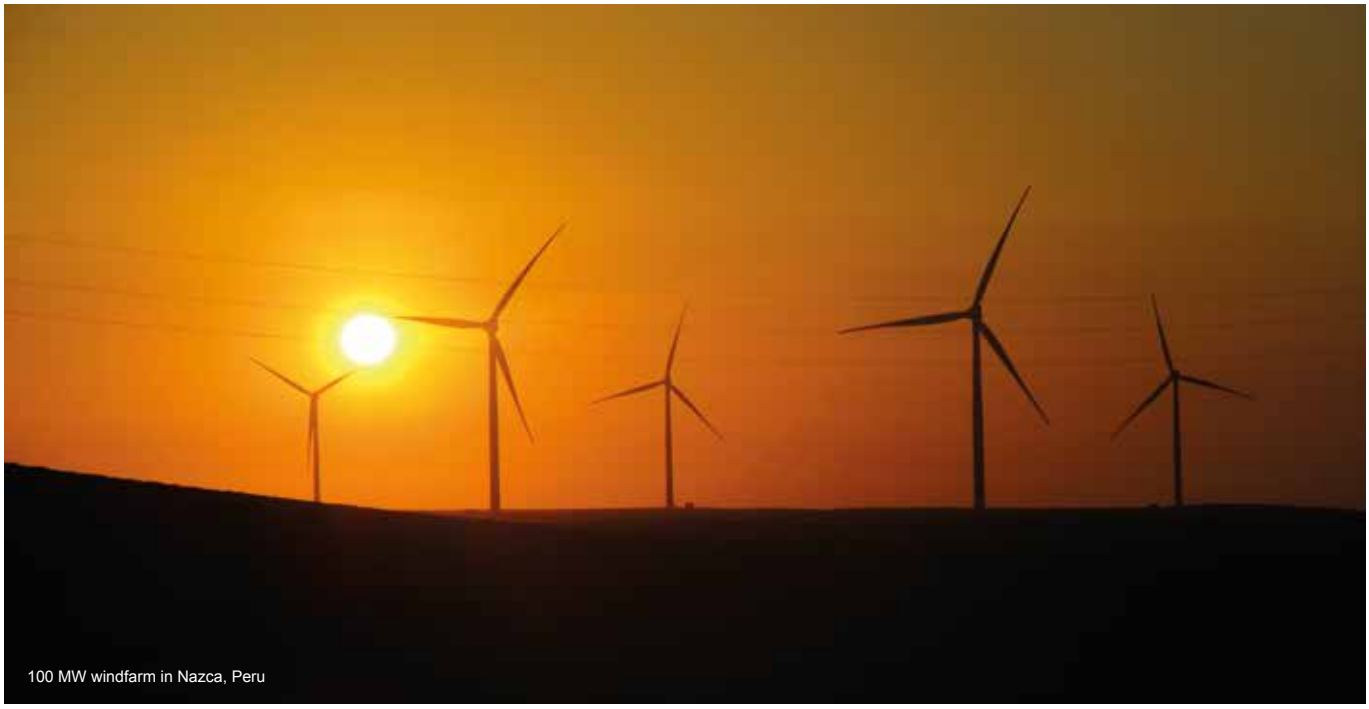
It can be difficult for large renewable energy projects to obtain financing from the private sector. Although the situation is improving, commercial lenders may still be unable or unwilling to accept the perceived credit or country risks. Thankfully for renewable energy providers worldwide, and for US companies developing technologies in this sector, these are exactly the types of project that the Export–Import Bank of the United States (EXIM) helps to finance.

As the official US export credit agency with a mandate to support the export of US goods and services, EXIM has been facilitating finance for potentially risky international projects since 1934. We opened our portfolio to the renewable energy sector back in 2005 and now provide comprehensive short- and medium-term financial services for solar and wind energy projects worldwide. These services include working capital, insurance, loan guarantees and direct loans. I manage EXIM's renewable energy portfolio from a technical perspective. My primary responsibility is to evaluate and mitigate technical risks across the lifecycle of a project, from development to operation to repowering. So what are those risks, and what are the trends?

Firstly, the science and measurement technology for renewable energy resources has improved greatly in the past 10 years. Wind resource measurements have become more sophisticated, allowing wind turbine manufacturers to tailor their designs to a site's specific wind class and conditions. For solar, on-site ground pyrometer and particulate measurements have optimised solar energy resource analysis. The IEC 61215 standard, covering accelerated life testing for PV modules, should continue to develop.

Greater knowledge of technical risks helps us to better assess the financial risks of a renewable energy project. As a bank, our credit risk review is similar to that of international commercial banks. However, since we are backed by the United States government, we have no fiscal exposure limits in any markets or technology. With our years of experience operating in developing countries and our careful vetting processes, we have had great successes working in these markets while sustaining an active default rate of less than 0.5%.

100 MW windfarm in Mekong Delta, Vietnam



100 MW windfarm in Nazca, Peru

We tend to react to the needs of the market rather than promote market development. However, in general, EXIM has been most needed in markets in transition from sovereign lending (shouldered or guaranteed by multilateral development banks like the World Bank or EBRD) to international commercial lending. This transition to commercial lending acceptance does not always run smoothly and in one direction: some countries do falter. However long markets remain in transition, we are greatly and continually needed.

One of the factors we look at when evaluating renewable energy projects is the main driver for that project. For most customers, this is some level of energy independence from fossil fuels. In addition to having good solar or wind resources and profitable capital projects, the mix and desire for renewable energy depends on electrical network capacity, the countries' planning and price incentives, and political acceptance across the government.

From an investment point of view, it is interesting to look at specific projects in the context of global trends in the renewables sector. In the near term, I see solar PV energy generation growth increasing relative to onshore wind energy generation. Solar PV manufacturing costs are falling, while new technologies such as PERC cells are increasing energy conversion efficiencies and scalability. These factors are making solar generation more compelling than ever.

The long-term goal is for renewables to eclipse thermal generation as baseload generation. For this to happen, we need a parallel and complementary system of energy storage. In addition to renewable energy, I also evaluate energy storage transactions for EXIM, including applications for transportation and electric utilities. So I can confirm from personal experience that the US is home to many promising electrochemical and mechanical energy storage technologies.

Every project is a new adventure with its unique personalities, location and challenges. These complexities require experienced people to resolve them. Classification societies, certification bodies and consulting engineers are of great help in evaluating renewable energy projects. EXIM is a relatively small organisation of 400 employees supporting, on average $20 billion in US exports annually. Within these 400 there is a very small group of engineers, each specialised in a particular sector. When a project has extensive technical and environmental risks, we turn to internationally recognised engineering consultants for their support. As well as their expertise and resources, we also value their independence and reputation.

In addition to working in sectors that I believe contribute to humanity's stewardship of the planet, I relish the constant variety, challenge and collaboration that my work involves. Otherwise, if every project were equal, my colleagues at EXIM and I could simply be replaced by ATM machines.

MICHAEL SAMS

Michael Sams is Senior Electrical Engineer at EXIM Bank and the Sector Lead for over 500 megawatts of renewable energy and energy storage projects. He has over 15 years' experience analysing technology and environmental risk in the development, construction, acceptance and operation of infrastructure projects around the world. Prior to his career at EXIM, he obtained extensive leadership experience as an active duty military officer in the US Navy. In the Navy, he supported combat operations, supervised a 50-person engineering construction team in the Middle East, led a decommissioning team to remove a floating generator in the South Pacific, managed a public works division and project managed many facility construction projects at various Naval stations.

www.exim.gov

Driving growth in renewables

Interview with Ian Larivé, Investment Director, Low Carbon

The continued growth of the renewables sector presents significant opportunities for Low Carbon and other companies committed to investing in and managing established renewable technologies. Last year saw record contributions of solar and other low-carbon technologies to electricity generation in the UK, and we expect that upwards trend will continue.

Developments in battery storage are particularly under the spotlight. The UK government's 2017 Clean Growth Strategy and Industrial Strategy both highlight the need for capacity and demand response capability. There are challenges with the business case for utility-scale battery storage, however. The rapid growth of the storage sector prompted short-duration batteries to be heavily de-rated in the 2018 Capacity Market auction, a competitive bidding process held every four years in the UK with the aim of securing future energy supply while reducing costs to the consumer. It is also unclear whether the UK's National Grid will continue to award long-term Enhanced Frequency Response (EFR) contracts to energy storage companies, as it did in 2016.

However, we do see opportunities in the storage sector in the medium term. Falling battery installation costs, coupled with the changing energy mix (increasing renewables and decreasing thermal generation), mean energy arbitrage models will soon start to make sense. In January 2018, we announced the completion and grid connection of our first two Low Carbon Battery Parks, providing utility-scale capacity of 50 MW in total. The two battery parks - Cleator in Cumbria and Glassenbury in Kent - were developed as part of our VLC Energy joint venture with VPI Immingham, part of the Vitol Group. Both sites were awarded Capacity Market contracts in 2016 and together represent a quarter of the National Grid's EFR capacity. We hold one of the largest storage portfolios in the UK and are looking forward to growing our portfolio.

Along with continued growth and investment, we anticipate further developments in technology. These might include longer-duration batteries and increasing efficiency. The rapid growth of the Electric Vehicle (EV) market will drive these developments worldwide. The UK government's Faraday Challenge, a four-year

Cleator Low Carbon Battery Park™ in Cumbria, UK - Courtesy of NEC Energy Solutions, Inc. © 2017

Glassenbury Low Carbon Battery Park™ in Kent, UK - Courtesy of Low Carbon © 2018

commitment to funding research and innovation in automotive battery development, will boost British companies in that market.

There are two fundamental challenges for the renewables sector. The first is financial. The industry will need to develop innovative funding models for projects as the sector matures. That may involve arbitrage and/or the colocation of storage with renewables. The second challenge is technological. Government programmes such as the Faraday Challenge and the global explosion in the EV market will help, but we need further innovation to improve on the batteries currently in use. The batteries of the future will be longer in duration, but we could also see a shift away from lithium-ion models, given demands on lithium resources.

Throughout all of this, it is important to keep in mind our end goal: tackling climate change. Our extensive sustainability programmes include funding the installation of solar panels at the National Museum of Bermuda and establishing beehives across our solar farms to support the UK's falling bee population. However, it is our business as a whole that displays our deep commitment to the environment. Low Carbon has built a significant asset management portfolio in terms of our solar farms. With our development of utility-scale storage capacity, we have a well-established – and I think well-earned – reputation as experts in the renewables sector.

However, we also rely on external experts to complement the skills and knowledge of our internal teams. In addition to RINA, we have industry associations with Ofgem, National Grid, Energy UK, and STA. RINA was our Technical Advisor for the Glassenbury and Cleator projects, supporting us through all aspects of the delivery. These included early-stage modelling of the EFR product, EPC assessment and procurement, EPC and O&M contract design and negotiation, construction oversight and site handover. We were grateful to have the RINA team by our side throughout this exciting process.

The diversity and speed of change of the renewables sector are what make it so thrilling and yet so challenging. The energy markets are evolving rapidly and there are fundamental shifts taking place. The single biggest trend has been the growth and level of investment in the sector, and that isn't going to change anytime soon. The storage sector will continue to develop and mature, and that will result in new models for the financing of projects. Contributing to these enduring changes in a positive way is very rewarding. Being nimble and ahead of the game are critical for success and this is what we strive for as a business.

IAN LARIVÉ

Ian Larivé has developed and financed a range of energy projects including 220 MW of utility scale solar PV and 50 MW of battery storage. Prior to joining Low Carbon in 2012, Ian was in the Ingenious renewable energy team, where he raised and deployed funds in the rooftop solar and energy-efficiency sectors. Ian began his career at Deloitte, latterly working in their M&A Tax group on numerous private equity-backed transactions. Ian is a chartered accountant and chartered tax adviser.

www.lowcarbon.com

Disrupting the energy industry

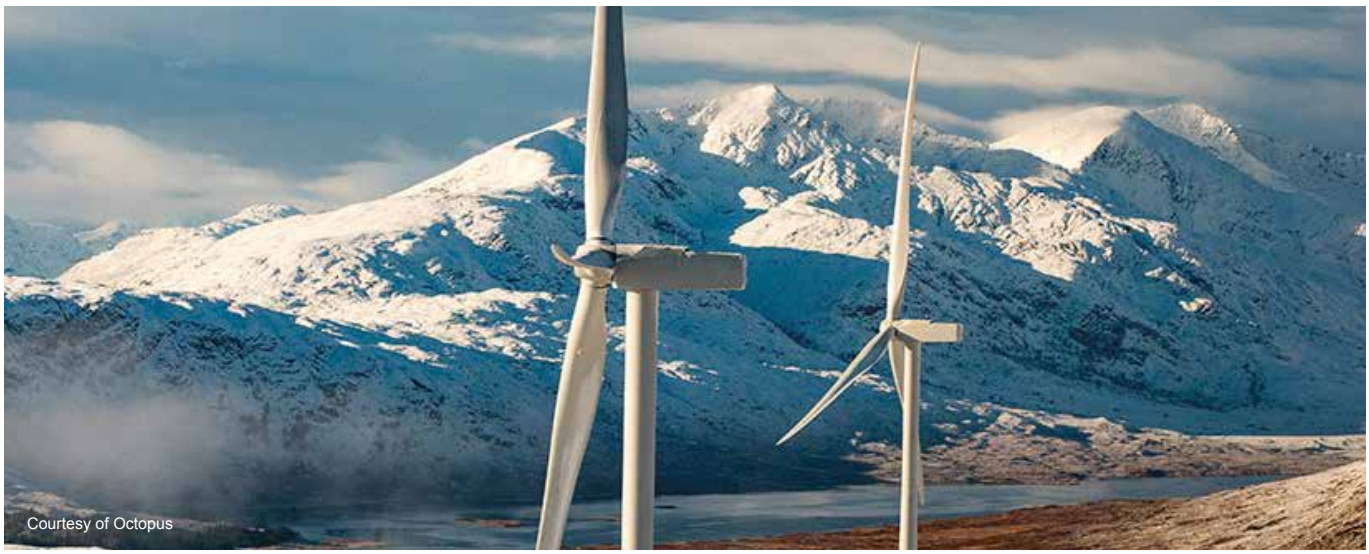
Interview with Matt Setchell, Head of Renewable Energy, Octopus Investments

The energy industry is undergoing a seismic shift whereby developments are being driven by economics and consumers. Innovation has led to very rapid falls in costs for renewables generation and has made these prices competitive with fossil fuels, as well as significantly cheaper than nuclear. Competitive costs mean that renewables investments are no longer as reliant on subsidies to be developed and built. Digitalisation of the sector has also opened up opportunities within areas such as smart technology, demand-side response and energy trading.

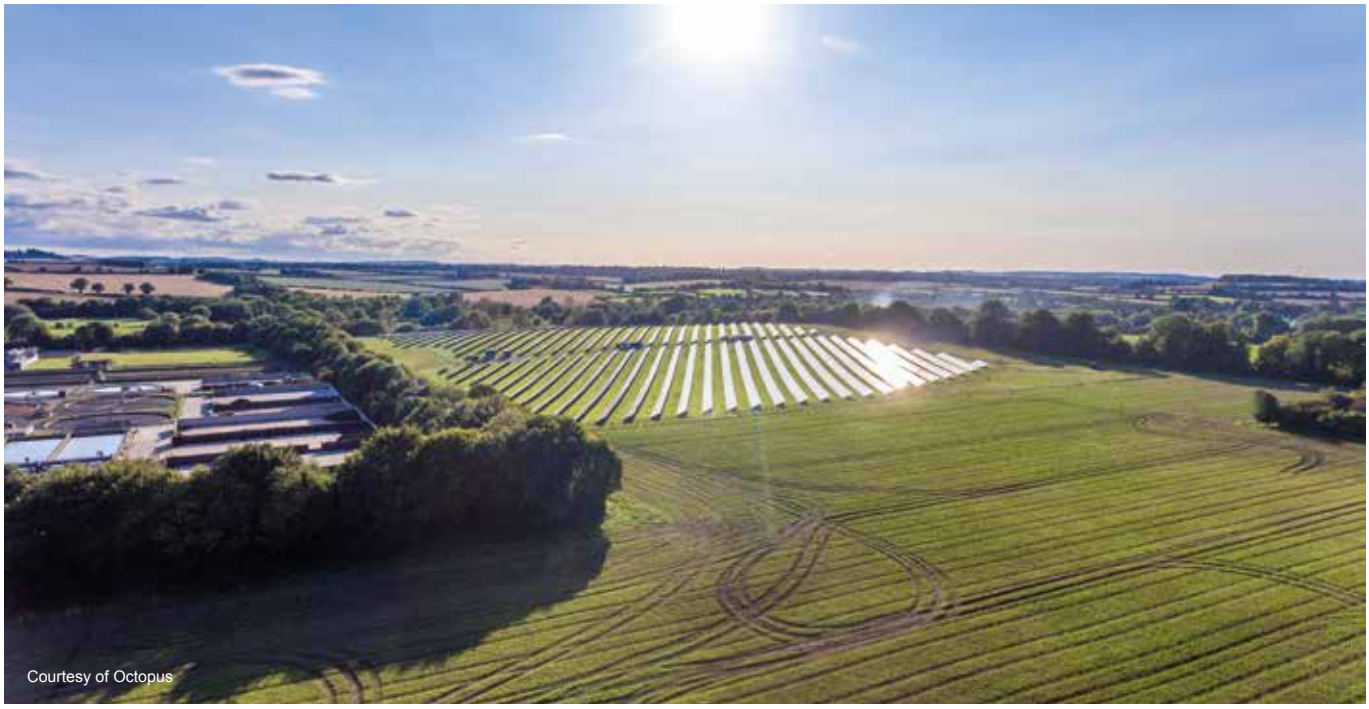
Our approach is to look for industries that have huge macroeconomic tailwinds and where we can improve the experience for customers. The sheer scale of the opportunities offered by the energy transition, however, creates challenges of prioritisation. We are therefore careful to continue focusing on delivery and keeping our customers and investors central to our strategy. Instead of operating as a typical investment company, we establish the businesses, skills, capabilities and technology that are helping us build a next-generation energy company. This delivers better outcomes for investors and enables us to expand the range of emerging opportunities we can take advantage of.

The most obvious of these opportunities is solar generation, in which we are currently the UK's largest investor. We built our first solar plant in 2011 and now have 154 solar farms across the UK, generating 40% of the country's large-scale solar energy – equivalent to powering a quarter of a million homes. There are some challenges in the UK solar market, for sure. High demand and a shortage of supply of solar assets with government subsidies are driving up prices. Although merchant and subsidy-free power is on the horizon, the number of companies involved in the UK's PV sector has decreased dramatically, with widespread consolidation underway. As a result, investors have had to adapt their business models. However, thanks to strong relationships and a track record of delivery, we find it's still possible to secure the right opportunities for the right price.

The long-term outlook for renewables in the UK remains attractive. Britain has a stable legislative system, a



Courtesy of Octopus


Courtesy of Octopus

large base of installed renewable energy capacity and a mature market. So we will continue to seek opportunities in the UK. With the change to incentives for new onshore wind and solar projects, opportunities for new construction are limited. However, unsubsidised renewable energy projects are just around the corner and we're already looking at this market. In addition, as large corporates increasingly seek ways to minimise their effect on the environment, our corporate PPA offering has been gaining traction and adds another string to our bow.

There are opportunities abroad, too. We believe the platform we have built in the UK – based on a leaner business model, less bureaucracy, more transparency and an emphasis on clean energy – can be replicated overseas. We already have portfolios in Italy and France, including 66 solar projects. We have also established a team on the ground in Australia to expand in what we believe will be an interesting market in the coming years.

As we have added more assets to our generation portfolio – not just solar but onshore wind and anaerobic digestion– our focus is turning from new construction to improving returns for investors through asset optimisation. We have added significant technical, commercial and operational expertise to our in-house asset management function. A strategic partnership with a high-tech company called Reactive Technologies, which has developed a communications and control platform to coordinate energy generation, storage and demand, will help us deliver improvements in expected returns and reduce risks.

To complement the skills of our in-house team and partners, we sometimes require the support of external consultants. Octopus has had a long partnership with RINA since the beginning of our investment activity in renewables. RINA supported Octopus as Technical Advisor in the acquisition of the majority of the solar assets from Lightsource Renewable Energy, as well as in some recent asset activity. RINA is also currently supporting us in the acceptance process for some of our solar plants. In addition, it is acting as Technical Advisor in the technical due diligence and construction of unsubsidised assets in Italy.

We've got a leading digital platform and a great team, in an industry that is undergoing a significant transformation. There are countless exciting opportunities to deliver something that is a win for our investors, for consumers and for the planet. It's a thrilling industry to be involved in. Watch this space.

MATT SETCHELL

Matt Setchell is head of Octopus' Renewable Energy Team – one of the UK's largest investors and managers of renewable energy assets. After joining Octopus in 2008, Matt led the highly successful partnership with Lightsource Renewable Energy, overseeing the deployment of £880 million into commercial scale solar assets in the UK. Octopus has since expanded its renewables portfolio into onshore wind, landfill gas, biomass, anaerobic digestion and reserve power plants, as well as internationally in France and Italy. Before joining Octopus, Matt was at Shore Capital and PwC before that. Matt has an MBA from Cambridge and an undergraduate degree in Economics and Accounting from Bristol University.

www.octopusinvestments.com

Scalable local solar: a winning solution

Interview with Evan Riley, Vice-President Development, Cypress Creek Renewables

Sometimes the greatest opportunities come in small sizes. As one of the largest providers of solar energy in the US, we can say that the greatest opportunities for exploiting the potential of solar energy lie in relatively small-scale local solar projects. We call ourselves "leaders in local solar" because our 6+ GW of solar capacity is primarily in operation and planned at a local level.

There are many benefits to local solar projects, particularly in the US. One challenge faced by all renewable energy providers is political uncertainty, which makes it difficult to plan ahead and make large, long-term investments. However, while this uncertainty exists at a federal level, at the state level there is a strong will to invest in renewables. Connecticut has recently passed a renewable portfolio standard, for example, while Oregon is considering community solar programmes. Community initiatives that allow individual households to subscribe to a solar farm and thereby lower their energy bills are increasingly popular. So by keeping our solar projects local, we can avoid many of the risks of federal political uncertainty and rely on the forward-thinking policies of local states.

The biggest benefits of local solar projects are enjoyed by the communities themselves. Where possible, we locate our solar farms near electrical substations, which helps minimise upgrades on the electrical grid. This reduces transmission costs and keeps electricity in the area where it is generated, bringing significant efficiencies and making solar more economically interesting for the consumer. Indeed, our aim is to produce clean solar energy at or below market costs.

Each solar project brings jobs to the local area and we invest heavily in workforce development initiatives to help upgrade the skills of local workers. The skills needed for solar projects are different from those of regular construction workers. That's why we directly fund solar energy training programmes through local community colleges, such as our recent $20,000 grant to Mott Community College in Michigan. Having experienced labour shortages several times in North Carolina in the past, we know that we need to invest early and upfront to get the skilled labour that solar projects need.

Courtesy of Cypress Creek Renewables


Courtesy of Cypress Creek Renewables

Local solar initiatives also benefit from scalability. We are in 15 US states so far and our farms can easily be deployed throughout the country. Of course, we need to adapt our projects to local requirements. Each grid is different and every state has different rules. Projects can have different design requirements. The level of understanding of solar by utility companies varies as well. To deploy new projects in new areas, we really need a thorough understanding of local regulations, expectations and market players. RINA helps us talk to the planners and clarify all these state-specific issues, ensuring a smoother entry.

Our fast growth and the success of new deployments rely on having flexible, expert partners who always deliver what we need, no matter what it takes. RINA is a partner with whom we have a strong relationship of trust. RINA has acted as our technical consultant and engineer for permitting, helping us with civil design and presenting at planning meetings. There are further challenges ahead. In the US at least, large solar farms (over around 80 MW) are subject to more regulations, so larger projects bring compliance issues for which we will need support.

The declining cost of solar technologies has made solar energy increasingly competitive. As load growth increases, so will energy prices. The cost of solar will only continue to fall and create new opportunities. So the future is really bright. I lead the Development Team at Cypress Creek Renewables, which is responsible for moving projects from site control to shovel- and project finance-ready. Like the solar industry itself, my career in solar started small, by installing modules on rooftops for $10 an hour in 2009. So it's immensely satisfying to see our industry, company, colleagues, workers, partners, local investors and competitors provide clean energy on the GW scale to the United States and help bring the cost of clean energy down.

Those of us who work in the solar energy industry share common values and a common vision and this unites us. Our vision is to do well while doing good. In the past, these two concepts often worked against each other. But by helping to bring clean renewable energy to a growing global population, we in the solar industry can do both and know that we are making a difference both for the families that we support, and humanity as a whole.

EVAN RILEY

Evan Riley built and manages the Development shop at Cypress Creek Renewables and is a member of the Executive Team. At Cypress Creek, Mr Riley's team has been responsible for the successful development of over 2 GW of now operating solar photovoltaic assets across 12 states.

Prior to building and managing the Development Team at Cypress Creek, Mr Riley led the PV Performance Services group at Black & Veatch. The company specialised in Independent Engineering for solar assets which supported over $10 billion of successful investments in the form of tax equity, sponsor equity, construction financing and term debt investments in renewable assets.

Mr Riley also has participated in authoring and publishing multiple standards and academic papers in the solar photovoltaic space. He holds a Masters of Solar Engineering from the European Solar Engineering School and Bachelors degrees in Physics and Mathematics from Indiana University. When not working to further the cause of clean renewable energy, Mr. Riley enjoys rock climbing, trail running and backpacking.

www.ccrenew.com

Empowering local communities

Interview with Baburam Paudel, Global Technical Manager, Renewable World

In most developed countries, renewable energy sources are replacing fossil fuels with the main aim of reducing greenhouse gas emissions. In many developing countries, in contrast, renewable energy brings power to communities for the first time. The potential of renewable energy to transform people's lives in the long term is huge, with opportunities including new or enhanced income sources, improved health, increase in agricultural production and productivity, access to media and communication, and many more.

Renewable World's work in my home country of Nepal highlights some of the opportunities and challenges of bringing renewable energy to remote communities in developing countries. Those challenges sometimes seem as high as the snowy peaks of the Himalayas themselves, and far less beautiful. Logistics, finance, communications, skills gaps, poor supply chain networks, to name just a few. But thanks to collaboration with partners and the participation of local community members, we are finding creative ways to turn challenges into opportunities.

Affordability is the first hurdle of any renewable energy project. More than half of Nepalese live on less than $2 a day and two thirds of the population have no access to electricity. We have to consider the high upfront costs of the infrastructure and the technology, as well as ongoing maintenance and repair costs.

We try to reduce the cost as much as possible through a competitive bidding process. We also make the best possible use of local resources, for example using wood as a building material in forested areas and sand if the community lives near a river. Despite this, rural communities are still not able to purchase the technology and the private sector is reluctant to invest because of a perceived low return on investment. To get projects off the ground, we mobilise all available resources including project grants, subsidy/block grants from the government, grants from other development agencies and – critically – community contributions both in cash and in kind. This contributes to the sustainability of the project.

We promote different types of renewable energy technologies depending on the situation. Examples

Beneficiaries of a solar-powered water pump - Courtesy of Renewable World

Drip irrigation: beneficiary of water pumping project - Courtesy of Renewable World

include water-powered pumps, solar water pumps and community-owned biogas systems. Water-powered pumps use the energy of falling water to lift a small amount of water up a high hill. Solar water pumps use energy from the sun to achieve the same effect. We promote multiple-use water systems that can be used for domestic purposes or micro-irrigation. Micro-irrigation allows people to produce and sell vegetables to generate income. This enables them to contribute to the project repair-maintenance fund and thereby help to make the project financially sustainable.

Most of our projects are community owned and managed. Community Based Organisations (CBO) are mandated to take key decisions on behalf of community members, creating a sense of ownership and responsibility. However, there are some challenges for communities to manage the project technically due to a lack of skills on the ground. Electricians, plumbers and other skilled workers are all in short supply at the local level – another major issue.

Again, here we can turn a disadvantage into an opportunity. Before we start any new project, we provide basic training in skills such as masonry, plumbing and wiring to selected young people from the community. We then employ these people to help implement the project, during which they develop and practise their new skills. Afterwards, they are equipped not only to maintain and repair the systems, but to generate income by offering their services to others. This capacity building helps to solve the logistical problems caused by the remoteness of the communities. Roads are rough and most vendors are based in the capital Kathmandu, so sending skilled technicians out into the field is expensive and slow. It therefore makes sense to train and license local people to maintain and repair the systems. Again, a win-win solution.

Renewable projects in Nepal and other developing nations are not so much about delivering power to communities as about empowering them. Local conditions dictate what we do: the natural resources available, what community members say they need, how local micro-economies work, what building materials are nearby, which workers we can train and the restrictions of seasonal weather events. We build awareness and involve local communities from day one. And we look at the entire lifecycle of the project, not just at immediate costs and benefits.

The real benefit will come when we can connect all these renewable projects together. The disadvantages of small-scale renewable energy systems – like power fluctuation – can be mitigated with smart grid technologies that allow energy to be bought and sold. This won't happen overnight, but while we are waiting, these small-scale projects will continue to have a huge impact on people's lives.

BABURAM PAUDEL

Baburam Paudel has been Global Technical Manager for Renewable World since 2014. Based in Kathmandu, Nepal, he is responsible for the technical aspects of Renewable World's work in all regions. This includes developing regional partnerships, introducing new technologies, proposing new business models and developing tools for renewable energy surveys.

Mr Paudel has worked in the field of civil engineering and renewable energy technology for more than 15 years. Eight of these were in Afghanistan, where he worked for the Aga Khan Foundation as Regional Renewable Energy Manager and Regional Manager for Engineering.
Along with a degree in Civil Engineering and an MSc in Water Resources Engineering from the Institute of Engineering in Nepal, he has a postgraduate degree in Renewable Energy from the United Nations University in Tokyo.

www.renewable-world.org

Energy storage and the solar-coaster

Interview with Mark Hogan, CEO, WIRSOL Energy

The speed of the solar energy market is incredible. Solar moves unlike any other sector, driven by fast developments in technology, construction, finance and investment. We develop, construct and operate PV systems across the UK and are currently, according to figures from Rystad Energy, the market leader in Australia. So we are continuously adapting to the twists and turns of life on the "solar-coaster".

So what's changing and where is the market going? Firstly, storage and co-location, i.e. energy storage located together with renewable energy generation assets, will play an important part in our near future. A headline example is the Gannawarra Energy Storage System (GESS), a large battery that will be integrated with the Gannawarra Solar Farm in Victoria, Australia. This landmark joint financing, which we achieved in partnership with Edify Energy, will integrate a 25 MW/50 MWh Tesla Powerpack battery with the 50 MW solar farm. The result will be one of the world's largest integrated solar and storage facilities. The main aims are to improve the reliability of the local grid, provide solar energy at night and boost economic growth in the area.

One key question is how storage can positively impact Power Purchase Agreement (PPA) projects. The Gannawarra battery financing is backed by a grant from the Victorian government's Department of Environment, Land, Water and Planning and the Australian Renewable Energy Agency. In two or three years, however, we expect storage to be not just financially viable but an important element of solar farms and PPA projects. In anticipation of this, we are designing all our sites to accommodate storage.

The co-location of energy storage and generation assets on solar sites will open up a world of behind-the-meter possibilities. Businesses with high demands for electricity will not only be able to generate their own power from renewable sources on their own site, but actually become self-sufficient by time-shifting excess energy generated by that system. This gives them the potential to reduce energy costs and have a reliable emergency power source. Data processing – data mining, data encryption, data storage, etc. – will continue to require colossal amounts of energy, so processing data within the solar park may turn out to be an important use of

Gannawarra Solar Farm, connected April 2018 (WIRSOL 94.9% ownership, Edify Energy 5.1% ownership) - Courtesy of WIRSOL

Hamilton Solar Farm, under construction, connection imminent (WIRSOL 94.9% ownership, Edify Energy 5.1% ownership) - Courtesy of WIRSOL

renewable energy. In Australia in particular, co-location will allow more businesses to grow in areas with limited access to the national grid.

Having built a strong base in the UK energy market, Australia is now very much in our focus. We already have a market-leading position with 400 MWp under construction and more than 700 MWp in the pipeline, which we plan to build and connect by the end of 2020. We are also in the middle of undertaking an IPO on the Australian S&P/ASX 300. The company to be listed, Bright Acre Energy, will be the first "pure play" Australian company focusing only on solar energy.

Our move into Australia coincides with a shift in strategy. We previously focused on acquiring "shovel-ready sites", i.e. sites that have undergone all due diligence and are fully certified. Since these sites are ready to go, it is quicker and simpler to develop the financial package and build out the projects. In both the UK and Australia, we have now aligned ourselves with development companies, whereby we fund the development and have a call option once the site is shovel-ready. This is working well for us and allows us to control our pipeline and understand the projects more fully. However, we will continue to acquire shovel-ready sites in the UK, Australia and potentially across EU.

In both the UK and Australia, our primary challenge is to achieve a bankable PPA with a value that matches investor expectations on debt and return on investment. Foreign exchange and module pricing are also issues, as the supply and demand cycle can affect project returns significantly. So financing and the security of revenue streams are clearly crucial for long-term investment and stable returns.

The success of WIRSOL Energy, which is a brand of WIRCON Group, is based on exceptional people and exceptional partnerships. We have a great relationship with RINA both in the UK and Australia, with individual team members as well as at the management level. We value the fact that RINA is respected by the financial community and has a team with whom we can have an open and fair discussion. RINA are probably tougher than others, but as a result I believe our projects will under-promise and over-deliver.

Only time will tell how the solar market will evolve, but one thing is sure – it will happen at breakneck speed. Our projects should be built to the highest levels of quality and designed to stand the test of time. I believe WIRSOL achieves this and our relationship with RINA strengthens the end result.

MARK HOGAN

Mark is the founder of WIRSOL Energy Ltd (UK) & WIRSOL Energy Pty Ltd (Australia). Mark has significant experience in the deployment of solar parks in the UK, Europe and most recently Australia, with power plants ranging from 1 MWp to 110 MWp.

Born in Great Britain in 1966, Mark Hogan studied electronics and electrical engineering at the University of Brighton. In 1993 he played a leading role in the successful management buyout of Delaire Ltd from its parent company Deltron Inc. In 1999, Mark Hogan joined Power-One and rose to the position of Senior Vice President for the Global Sales and Marketing divisions. He then joined WIRSOL Solar AG, where he became a member of the board and Head of International Business Development, in 2014 Mark Hogan became Managing Shareholder of WIRSOL Energy Ltd. in Great Britain. Most recently Mark is responsible for WIRSOL's entry into Australia early 2017, which is now recognised as the leading solar investor in Australia (SERA, a Rystad Energy Company).

www.wirsol.co.uk

Fuelling renewable energy in the USA

Like many things in the US, the renewables market is characterised by its sheer size and diversity. Massive energy demand has driven growth in all forms of energy generation. Excellent resources and favourable policy environments, combined with engineering ingenuity and entrepreneurial spirit, have supported the renewables sector. Renewables now make up just under a fifth of total electricity generation in the US.

Legislation has also played a role. Passed in 1978, the Public Utility Regulatory Policies Act (PURPA) aimed to promote energy conservation, reduce reliance on foreign energy sources and increase the supply of renewable energy. By obliging utilities to purchase power from other providers under 80 MW if the cost was lower than their own "avoided cost" rate, it effectively opened up energy markets to smaller-scale renewable energy providers.

In the early 2000s, individual states began implementing renewable portfolio standards (RPS) requiring utilities to supply a specified percentage of electricity load from renewable sources. To date, 29 out of 50 states have implemented an RPS, with many increasing targets over time. Hawaii's target, for example, is 100% renewable energy by 2045. Tax incentives for both investment and production have also driven large-scale investment of over $10 billion per year in recent times, by providing relative certainty to investors.

Despite its historical support for renewable energy, the current administration has expressed clear preference for other technologies. Policies that roll back on environmental regulation and incentivise coal, oil and nuclear power will obstruct growth in renewables. These policies include tariffs on imported solar panels and steel and reductions in corporate tax rates that reduce the value of tax-based incentives critical to financing.

Thankfully, multiple drivers continue to fuel the renewables market. The falling costs of renewable energy are making them ever more competitive. Innovation in the form of energy storage and photovoltaic technologies, along with larger, more effective and offshore wind turbines, enable projects that address new market needs and find greater penetration.

Individual states and municipalities are committing to the decarbonisation targets set by the Paris Agreement. Demand from corporations is also strong. There were almost 3 GW of PPAs in 2017 and major corporations have announced that they have used renewable energy for 100% of their consumption. This trend is growing, with over 100 other firms committing to achieving the same level. This could contribute to a potential 50 GW of new generation by 2025.

Confidence in renewable deployment is therefore high despite the external challenges facing the industry. The experience of RINA as a development and engineering partner will be invaluable in meeting the constant project-specific challenges of each new renewables project deployed in the US.

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Australia's changing energy mix

There is obvious potential to replace Australia's ageing coal-fired plants with increased renewable generation. Despite some political uncertainty, renewable energy enjoys the support of many local governments. The proposed National Energy Guarantee (NEG) aims to ensure a smooth transition to low-carbon energy production while maintaining reliable supply. As one of the country's leading technical advisors on renewable energy, RINA's Australian office has noticed some interesting trends on the horizon.

The first is solar. Australia has been a leader in the uptake of residential rooftop solar energy. Around 15% of homes have some sort of PV installation, extending to 25% in South Australia. Greater policy certainty in the past 18 months has also supported the construction of utility-scale projects of increasing size. 2017 alone saw 900 MW of new utility-scale PV capacity and around US$9 billion of overall investment in large solar and wind projects, up 150% on the previous year.

This year, construction on the largest PV plant in the country, the 250 MW Sunraysia Solar Farm, will start. At the time of writing there are approximately 2150 MW under construction, mostly using PV technology with trackers to maximise generation. Concentrating Solar Power (CSP), which uses thermal technology and turbines, may also play an important role in the Australian energy mix, especially when combined with thermal energy storage to allow despatchable generation. South Australia has led on this, approving a 150 MW SolarReserve facility this year.

Australia's excellent wind resources currently account for 6% of national generation. The number of new wind projects continues to increase, with approximately 20 GW in the planning or construction stages. However, much of this is remote from existing load centres and existing transmission infrastructure is becoming a restraint. An ambitious 9 GW wind-solar hybrid project in Pilbara aims to circumvent this issue by exporting electricity via undersea cables to neighbouring countries. Australia is also moving towards its first offshore wind farm, the 2 GW Star of the South project.

As lithium-ion battery prices continue to fall, Australia is taking a leading role in the application of energy storage systems, particularly to support stability of the geographically large transmission and distribution network. A 100 MW Tesla installation is now operational in South Australia. RINA continues to support other battery installations under construction in Victoria.

Hydropower has historically provided the largest penetration of renewable energy in Australia (approximately 8%). There is currently government interest in expanding the 4.1 GW Snowy Hydro scheme with an additional 2 GW of pumped storage. A number of innovative private pumped storage projects are under development.

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Statistics in this article are taken from SERA Analytics, Bloomberg New Energy Finance, RenewEconomy and the Sydney Morning Herald.

Subsidy-free renewables in Italy

Thanks to government incentive schemes, the Italian renewable energy market grew significantly over the past decade, particularly in the wind and solar photovoltaic sectors. However, the incentive system was gradually phased out from 2013 and there are currently no direct incentive systems available for large-scale solar and wind plants.

Released in November 2017, Italy's National Energy Strategy aims to achieve the following objectives by 2030: a reduction in primary energy consumption by 20 Mtep; renewables to represent 55% of electricity demand and 28% of overall energy demand; 184 TWh electricity generation from renewables; and an average national wholesale price of €72/MWh. Italy has already reached the 17% renewable energy target set for 2020, so this has been increased to 27% renewables by 2030. The strategy suggests a positive outlook for the Italian renewables market, which is currently experiencing a new wave. The main keywords are solar market parity projects, a vibrant secondary market, repowering and corporate PPAs.

The Italian PV market saw a slight recovery in 2017, suggesting the start of a "market parity" round of installations. Our work as an independent engineer on Europe's first project to connect a large-scale solar merchant power plant to the grid, led by Octopus Investments, has given us deep insights into subsidy-free projects. Although conditions for projects under market parity remain challenging, there is a strong belief that market conditions will improve over the next 12 to 18 months with decreasing costs and easier access to finance. In this evolving scenario, with the dynamics of the electricity market at the centre of the picture, utility company Engie managed to secure Italy's first private PPA for "grid-parity" solar. Under the five-year PPA, it will sell electricity generated by solar PV plants to four facilities of a manufacturer in Italy.

Mergers and acquisitions activity has also increased, with several large portfolios changing ownership. This has given large Italian operators, including ERG, A2A and Eni, the opportunity to make their first move into solar or increase ongoing aggregation trends. Going forward, competitive auctions will be launched from 2020 for long-term PPAs of 10–15 years to reduce market risks and facilitate investment in large-scale renewable energy projects. Developers and investors are focused on new installations but also on revamping and repowering existing ones, thanks to favourable new rules approved by the Italian government.

Overall renewables capacity is currently around 53 GW. In light of these new opportunities, Milan-based Energy & Strategy Group anticipates growth in 2018–2020 of +4.5–5 GW of solar, +1.8 GW of wind and +400 MW of other renewables. Busy times for RINA, who has become a key player in the Italian renewables market and is ready to ride this new wave.

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Spanish solar industry on the rise

Spain's so-called "photovoltaic boom" took place in 2008, when around 4 GW of solar capacity were installed. Ten years later, the figure currently stands at only around 5 GW, far behind Germany, Italy, the UK and France.

What happened? In 2012, the Royal Decree 1/2012 abolished public financial support for new renewable energy installations, as well as plants producing electricity from waste or CHP. The resulting lack of support and trust in future energy policies brought Spain's solar industry to a standstill. Spanish developers and renewable energy advocates watched in dismay as other countries accelerated ahead.

But Spain is back in business. The rebirth of Spain's solar industry was sparked last year, when the government's renewable energy auctions awarded 4 GW of solar PV capacity to be installed by the end of 2019. The need to reach EU targets of 20% renewable energy by 2020 is a driving factor behind this renewed commitment to solar and other sustainable energy sources.

The outcome of the auctions was that PV projects will get the main benefit from the sale of energy to the market. Looking at this scenario, many developers are planning to construct their PV projects without any government subsidies and sell their energy directly to the market. This is now possible given that PV technology is becoming increasingly competitive. According to the International Renewable Energy Agency, the cost of PV generation decreased by 73% between 2010 and 2017. It anticipates that this cost will fall by up to 50% more in the next two years.

So the Spanish solar future looks promising. The Spanish solar association UNEF estimates that 135 MW of new capacity were installed in Spain last year, 145% higher than the 55 MW installed in 2016. This new capacity mostly comprises self-consumption facilities, grid-connected projects and standalone projects for agricultural use.

Thanks to the sector's recent take-off and the success of the last auctions, UNEF predicts an exponential rise in solar PV capacity over the next seven years. This will generate tens of thousands of jobs and many interesting opportunities for partnerships and investment, both locally and from outside Spain. Initial indications are that applications for 29 GW of PV capacity have already been submitted to the authorities.

The lack of a strong legal framework or public support during the past few years led Spain to lose its leadership position in the renewable energy sector. However, the PV installation capacity estimated by UNEF indicates a bright future for the market. From RINA's recently opened Madrid office, we are watching the rebirth of our solar industry with interest and helping a number of clients to evaluate investment options in new renewable energy projects across Spain.

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Supporting renewables in Latin America

What does "renewable energy in Latin America" bring to your mind? Perhaps abundant natural resources... low renewable energy prices... fierce competition between developers... government stability vs. instability... energy auctions vs. lack of regulation... limited infrastructure... environmental impact... social opposition... oil & gas contribution to the energy matrix... currency exchange rate risks... local taxation... How can we combine all of these aspects to make clever investment decisions around renewable projects? It's a tough question, but a question worth tackling. Because the opportunities are huge.

Leaving aside hydropower plants, there have been many developments since renewable energy was introduced on a large scale in Latin America. These include ongoing supporting programmes, tenders and auctions in Brazil, Mexico, Uruguay and Chile starting in 2009, and the launch of Argentina's RenovAr renewable energy programme in 2016. All of this progress has taken place against a challenging economic and social background: changes in governments, economic crises, resistance towards renewable energy from old-school electricity suppliers, as well as limited and obsolete energy infrastructure. No wonder there is still some fear around investing in renewable energy in Latin America.

However, the current picture looks promising. Renewable energy is already well established in many countries. Their targets lead us to believe that the Latin American renewables market is still in its early stages and has the potential to grow fast.

We have seen wind turbine manufacturers installing blade, nacelle and tower facilities in Brazil. New manufacturing facilities are due to be built in Argentina. Governments of the largest states, including Mexico, Argentina and Brazil, have drawn up new energy laws and are putting in place the corresponding regulations, while at the same time investing in electrical infrastructure. Government support is crucial in Latin America, and governments clearly now wish to promote the growth and integration of renewable energy in their countries.

Some examples of this promising market are the 7,500+ MW of new renewable energy generation awarded in Mexico between 2015 and 2017, including 17 wind projects and 38 solar PV projects, and the 3,500+ MW awarded in Argentina between 2016 and 2017. Deals move fast in this market, too. The 30 wind projects and 36 solar PV projects in Argentina are scheduled to be operational by 2019–2020.

Within this positive framework, RINA professionals have recently developed engineering designs and assessed more than 3 GW of wind and solar projects in Latin America for investors and lenders. We expect current growth to continue, as the region combines excellent wind and solar resources with high levels of quality in terms of technology and performance. So here's a warning. Do not invest in renewable energy in Latin America if... you want to miss out on a good opportunity.

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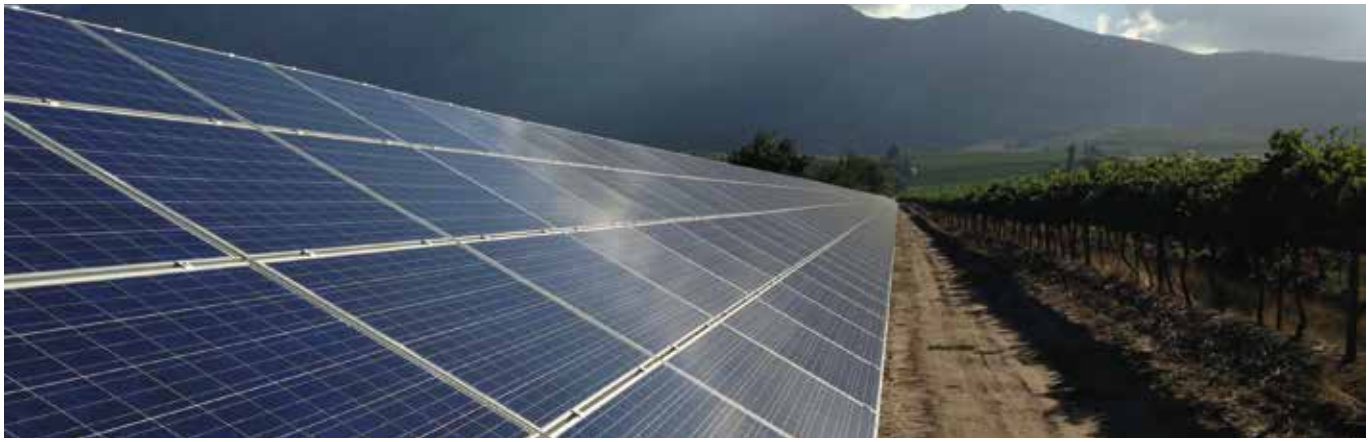

Solar energy in Sub-Saharan Africa

Sub-Saharan Africa: an endless summer. Access to electricity in Sub-Saharan Africa: available to a privileged few. Chronic power shortages and limited extension of national grids affect a number of countries. There is simply not enough electricity or connectivity to meet demand. Most countries in Sub-Saharan Africa rely on conventional power sources, with renewables only making up a fraction of the electricity supply.

The potential for solar power to fill the gap in electricity supply is clear and enormous. But large-scale solar projects have impacts on people located on or around project sites, and these have to be considered. Renewables are often perceived to have significant positive environmental impacts as they reduce greenhouse gas emissions, leading many to believe that there is no requirement to manage any associated environmental and social risks. What are these risks and what can developers do to mitigate and manage them?

Firstly, land use. Large-scale solar projects require a lot of land and therefore tend to be located in rural areas. Many communities rely on land for farming and grazing, so this loss of land can have a negative effect on their incomes and ability to support their families. Women earning a living from food processing can become vulnerable. Alternative farming and grazing land might not be available, depending on the geography and land tenure regimes.

Secondly, communities will naturally believe that a new large-scale solar project will improve their access to, and the affordability of, electricity. However, many such projects connect directly to the national grid, to which rural communities may not have access themselves. Communities may also have high expectations in terms of employment.

A third major aspect is financial. Communities not only need access to electricity, either through the national grid or minigrids, they also need to be able to pay for it. With the potential loss of income from land take, this may not always be the case. Income may not be guaranteed and financial resources may be scattered within communities.

Developers need to manage these social risks, firstly by engaging and consulting with local communities to understand the potential implications of their project and manage expectations. Secondly, land owners and land users need to be fairly compensated. This compensation shouldn't just be a one-off cash payment – developers need to identify sustainable ways to restore the livelihoods of people affected by their projects. Lastly, developers should invest in community development initiatives such as off-grid power supply, education and skills training.

Solar projects need to include meaningful ways to engage with communities and manage environmental and social impacts. Only then will they fulfil their great potential to transform the electricity market in Sub-Saharan Africa and benefit the lives of many people.

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Support for the Solar Incubator

Despite having roots dating back to 1861, RINA remains dynamic and in touch with developing trends in all sectors. Always supportive of innovative renewable energy initiatives, RINA is involved in the Solar Incubator scheme led by Dubai-based solar energy provider Phanes Group. The incubator is open to any PV projects in sub-Saharan Africa, at any stage of development, with a strong element of corporate and social responsibility.

Despite the benefits of clean energy, utility-scale renewable energy projects (the most popular investment vehicle) seldom bring any direct long-term benefits to local communities. The CSR-focused approach of the Solar Incubator addresses this gap. The projects must have a capacity between 10 MW and 100 MW. The candidate's experience in PV solar development, as well as technical and commercial aspects of the projects, also played a role in the decision of which projects to support.

At the 2017 Unlocking Solar Capital Africa conference in Abidjan, Côte d'Ivoire, RINA participated in an evaluation panel along with representatives from Phanes, Hogan Lovells, Proparco, Solarplaza, the African Development Bank and responsAbility. The winner – out of nearly 1 GW of potential projects – was Marlon Santos with his plan for a utility-scale ground-mounted PV system in northern Mozambique. The CSR component of Marlon's project was a solar-powered water pumping scheme. The two runners-up were a utility-scale solar plant developed on an old unrehabilitated waste site just outside Abidjan in the Côte d'Ivoire and a number of small-scale ground or rooftop PV installations to supply currently unelectrified university campuses in Ethiopia

As well as participating in the panel, RINA helped sponsor the three finalists' conference travel expenses and participated in a four-day mentoring workshop in Phanes' Dubai office for the winner. We look forward to seeing how both Marlon's project and the Solar Incubator initiative develop in future years.

For more information, see phanesgroup.com/incubator.

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Offshore wind sector: spinning fast

The world's first offshore wind project was decommissioned last year, after producing 243 GWh of electricity over 25 years. Commissioned in 1991 in Denmark, the Vindeby installation consisted of 11 x 450 kW wind turbine generators manufactured by Bonus Energy, now Siemens. Sceptics thought it was a crazy idea and only two other offshore wind projects were installed in the 1990s: Tunø Knob in Denmark and Bockstigen in Sweden.

From these humble beginnings, the offshore wind sector has now started to spin. According to WindEurope, in 2017 Europe alone had more than 4,000 wind turbine generators representing almost 16 GW of capacity. The technology has three key benefits over onshore wind: reduced permitting challenges, the ability to deploy at scale, and higher and more consistent wind.

Large wind projects often suffer permitting challenges due to their visual impact, whereas large offshore wind projects may even be invisible from the shore. Moreover, the low-friction surface of the sea increases wind speeds, leading to enhanced generation. These advantages make offshore wind interesting to governments looking to make carbon reductions while avoiding controversy. The largest project currently under construction is Hornsea Project One, in the North Sea off the east coast of Britain. The 1.2 GW development will be equivalent to a large thermal power station, with the ability to generate electricity for more than a million homes.

Until 2015-16, offshore wind costs were typically around €/£140 for each MWh of energy produced. That's more than three times the cost of thermal power in the UK. Costs have now fallen dramatically, with some projects even proposing to deliver energy without needing subsidies. Technological advances have helped to reduce costs, for example turbine rotor diameters have increased from 100–120 m to 150–160 m, and generator capacities have more than doubled in recent years. Supply chain pressure and reduced financing costs have also helped. Of course, nothing is certain – most low-cost projects have yet to be built. However, given the benefits of offshore wind, lower costs could lead to a dramatic expansion in the sector.

Offshore wind has traditionally been a European business, but new markets have emerged in recent years. The USA finished construction of its first offshore wind project, Block Island Wind Farm off the coast of Rhode Island, in 2016. Growing offshore wind markets in Asia include Japan, Taiwan and India.

Realising the potential benefits of offshore wind generation requires smart solutions that consider a project's entire lifecycle and are based on multidisciplinary expertise. RINA experts have worked on major offshore wind projects across Europe, providing geotechnical and electrical design work, inspections, technical advisory services, due diligence, energy yield and marine warranty surveyor work.

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Forecasting PV asset performance

The global PV market continued to expand in 2017, with new capacity totalling >96 GW commissioned throughout the year. This represents growth of 29% relative to 2016 and brings the total installed capacity to over 400 GW, according to the International Energy Agency.

Until now, subsidies have helped drive this rapid expansion of the PV market. Many countries provide policy mechanisms to promote the growth of the industry and increase PV installations. These include feed-in tariffs, favourable pricing of power purchase agreements (PPAs), green certificates and direct or tax-based financial subsidies. Such subsidies have not always been reliable in the long term. The industry's main challenge is therefore to continue reducing costs to the point where solar energy can compete with traditional energy generation on a subsidy-free basis.

Developing a PV project is a capital-intensive process, with high costs during the development and construction phases in particular. In contrast, these projects have relatively low operational and maintenance requirements, and no ongoing fuel costs. The long-term performance and operating lifetime are critical factors determining the financial viability of PV projects. Their assessment will play a key role in leading the drive towards cost-competitive PV installations.

Until recently, operating lifetimes of 20-25 years were considered feasible. Now, driven by longer subsidy programs and component warranties, project developers are assessing the viability of maintaining operational PV assets for 35 years or more.

From a technical perspective, the key challenge when developing a project is to understand the impacts on capital and ongoing operational costs. This includes implementing "best practice" design and component selection principles that will maximise the operating lifetime of the plant equipment. Developers also need to define best practice operational and maintenance procedures, as well as ongoing component replacement strategies, to maximise availability and energy output throughout the asset's lifetime.

The limited availability of field data makes it more difficult to validate long-term PV plant performance assumptions. Uncertainties exist when forecasting the performance and output of the PV system for its entire operational lifetime. It is essential to understand the mechanisms governing long-term degradation of the PV plant components. We need to quantify these in order to define the ongoing impact on the plant's energy output and revenues. This information helps us to determine the financial viability of extending the plant's operational lifetime.

As part of RINA's solar PV due diligence services, we work closely with project developers and equipment manufacturers to address some of the above issues and more. Our work includes extensive modelling of the long-term energy output of solar PV assets and the operating expenditure required to operate them for 35 years and beyond.

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Integration is not just "plug and play"

The rise in use of renewable energy technologies is already transforming the energy market. For an effective and lasting transformation, however, we must meet the operational and technical challenges of integrating renewable energy into our legacy energy networks.

Legacy networks rely on information about seasonal and even daily/hourly energy usage to balance supply and demand. Traditionally, a small number of large, strategically located generating plants provide a consistent and reliable supply of energy. Today many large-scale generators are being decommissioned and replaced by a large number of distributed renewable energy sources.

This new landscape brings fresh challenges to transmission system operators. In traditional networks, variability is largely a demand-side issue. With renewable sources, this variability is also a supply-side factor – you can't flick a switch to make the sun shine or the wind blow. The use of energy storage and balancing plants are key developments here, helping to smooth out or boost supply to meet demand.

Increased use of electric vehicles going forward will bring new challenges, particularly in terms of network loading and operation. It will also bring opportunities for demand-side supply of energy back to the network when those vehicles are not in use. A truly smart grid like this, which can support short-term demand for energy by "borrowing" it from our cars or from other distributed storage systems, will require a rethink in terms of capacity, communication and control.

The choice of location for a renewable energy plant will depend upon a number of factors, not least appropriate climatic conditions. Our existing transmission network has certain capacity and operational constraints that will dictate whether a planned plant can find an economic route to market for its energy.

If the only way to take that energy to customers is to construct new or additional transmission or distribution infrastructure, this could well make certain developments less viable. Micro-grid or private-wire networks are potential solutions, in addition to offering increased energy security.

Connecting an energy source to a network means meeting basic requirements for voltage, frequency and harmonics. This can be a challenge for some renewable operations, as the power electronics can make it difficult to control these parameters under all operating conditions. Connection at the distribution level also requires modification to the network to support bi-directional energy flow.

RINA's Power & Grid team supports investors, developers, integrators, operators and TSO/DSOs in the planning, design, integration and commissioning of renewable energy operations worldwide. These are exciting times for renewable energy, and by working together to achieve smarter and more efficient integration into our energy networks, renewable energy may soon be viewed as our "conventional" source of electrical power.

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Hydrogen in our future energy mix

Demand for energy is still increasing worldwide, but the energy mix is changing. It is clear that natural gas and renewable energy sources will play a major role in meeting our future energy demands. Many countries have set challenging targets, such as Germany's target of 80% renewable energy by 2030. Reducing the financial cost of energy, as well as its environmental cost, is also a goal.

In this scenario, interest in hydrogen is quickly growing. Hydrogen is an infinitely available energy source with high energy efficiency and low environmental impact. In some countries, for example Australia, hydrogen has been identified to soak up excess renewable energy production. This will increase the availability of hydrogen for massive storage and electricity conversion, opening up new possibilities in energy management and green vehicle transportation systems. Japan is also investing significantly in hydrogen mobility.

Electric mobility – covering ships, trains, trucks, buses and in particular cars – is the driving force behind developments in battery and hydrogen fuel cell technologies. Thanks to their soft social impact, battery-powered electric vehicles are close to achieving widespread use. Developments in battery technologies have been huge, with significant improvements in capacity (to improve distance ranges), weight and recharge times. New concept cars are now hybrid or fully electric using battery stacks, with major car brands moving toward 100% electric vehicle production. Cost, range, recharge times and pollution are still issues with battery-powered vehicles, however.

Hydrogen-based systems, on the other hand, produce little or no local emissions, have longer ranges and take just a few minutes to refuel. Hydrogen has the potential to drive a new generation of green mobility. To achieve this, we need to improve devices and systems and integrate hydrogen into transportation infrastructure. With high pressures up to 700 bar, safe hydrogen storage is a crucial issue for ships, trains, trucks, buses and cars. Developing reliable and safe hydrogen vessels that can be produced on a large scale is a major challenge we face.

When technical challenges stand in the way of real needs and solid demand, innovation is the answer. We need to develop new materials and new concept vehicles that are light, safe and high-performance. Standards and testing procedures to validate materials and technologies must be defined before we can bring hydrogen mobility or storage systems to market. With this new energy scenario in mind, RINA has built a new high-tech lab focused on the characterisation of material properties in the hydrogen environment.

While RINA experts test and assess products and prototypes in real-life scenarios using state-of-the-art equipment, RINA representatives are involved in European-wide renewable energy management and hydrogen-related projects. Through innovation and expertise, we look forward to helping shape our future, greener, energy mix.

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How DLT can benefit energy markets

The energy industry is beginning to see the potential of Distributed Ledger Technology (DLT), the technology underlying blockchains and crypto assets such as Bitcoin. Recent public debate over Bitcoin has raised awareness of DLT's capabilities. But what is the benefit of DLT over previous ways of recording and sharing information?

DLT's game-changing feature is trust. Advanced digital cryptographic technology has proven its capability to administer and protect sensitive information in a ledger encoded by DLT. A group of parties with no previous relationship can now share copies of the same ledger and can trust that this shared ledger is accurate and true. Participants can control access to their records. Decentralising trust within a group, making custodians and intermediaries redundant, fundamentally changes how business relationships operate.

DLT offers numerous benefits. These include lower costs of record-keeping and reconciliation, reduced data error and greater visibility and traceability of transactions. With a shared, accurate ledger, it is easier to see where commodities have come from and the chain of transactions that they have undergone. DLT offers increased market accessibility for previously excluded parties, for example small-scale generation or storage assets, as well as reduced counterparty credit risk through near real-time settlement.

Many sectors are using DLT to improve their systems, including mining, commodities, infrastructure, healthcare, government, property and real estate, shipping and transport, consumer markets and, not least, power and energy.

The speed of decentralisation in electricity markets is increasingly apparent. The UK has moved from a centralised network of around 100 major power generators to around a million electricity exporters today, distributed throughout every level of electricity networks. We are seeing similar trends in other countries.

Electricity networks and markets will need strong innovation to cope with the millions more electric vehicles predicted to be in use within a few years. Innovations around DLT can create opportunities for power utilities, including new channels for raising project capital, obtaining renewable energy certification, automating demand management and optimising load balancing. Peer-to-peer energy trading can help to reduce energy loss across networks, while consumers will benefit from greater transparency and cost optimisation at the device/vehicle level.

Nevertheless, new enabling technology raises fresh technical integration and management challenges. These include interfacing DLT networks with generation asset control systems, managing permissioning, and contractual mechanisms for asset utilisation. RINA continues to stay at the forefront of opportunities emerging from DLT, enabling clients to understand and benefit from the energy sector's transition to decentralisation and digitalisation.

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The power of earth observation data

How can detailed observations of the earth help renewable energy industries to become more efficient and effective? This is one question on the minds of public stakeholders as they turn their attention to the green energy transformation. As well as committing to funding initiatives and creating the conditions for a fully sustainable energy market, governments and other authorities must build a strong foundation for technological development.

One of the European Commission's many initiatives in this area lies within the framework of the Copernicus Programme. Copernicus is the world's largest earth observation programme, coordinated by the EC in partnership with the European Space Agency. The complex system gathers data from multiple sources, including different satellite constellations and air/ground stations, in order to provide detailed earth observation data for several areas: land, marine, atmosphere, climate change, emergency management and security. With Copernicus now fully operational, the EC and ESA are pursuing a number of joint initiatives to promote and increase the use of Copernicus data in these sectors.

Earth observation (EO) data and services are expected to play a key role in renewable energy generation and exploitation. They have the strong potential to help increase energy efficiency and security, as well as facilitate the integration of renewable energy sources into existing networks and systems. The main applications are related to energy resource assessments, plant siting, operations (including safety) and decision-making support.

Renewable energy sectors are still facing challenges in integrating and exploiting the full potential of EO data. Major issues include harmonisation with existing datasets, as well as the deployment of new infrastructure essential to validate EO products for specific applications. Furthermore, from the EC perspective, the lack of a clear understanding of the costs and benefits of using EO data and derived insights in the field of renewable energy still represents a challenge.

Within this context, RINA has been awarded a contract for a study on "Research needs on the use of earth observation data for the benefit of renewable energy exploitation and deployment" issued by the EC's Directorate-General for Research and Innovation. The key objective is to provide the EC with an in-depth analysis of how EO data are currently used in six renewable energy sectors: on- and offshore wind energy, solar energy, ocean (wave and tide) energy, hydropower, bioenergy and geothermal energy.

Starting from the current status, the project involves identifying possible research and development paths for EO data and analysing the potential benefits that could be achieved by implementing the results of this research in the different sectors. The main outcomes of the project will be used as baseline documents for research policy development and applications of EO in the field of renewable energy.

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Technologies that drive transformation

The renewable energy industry is constantly transforming in line with new technological developments. Inspection services and site supervision activities are a typical example. For the first generation of renewable energy projects, market demand was centred on quality assurance and vendor inspection services, as investments focused on the development of new plants. Nowadays, in parallel to greenfield developments, a number of large players own, manage and operate a significant portfolio of renewable energy plants spread across several locations or even countries.

Activities around mature assets, aimed at extending a plant's life, improving performance and managing operations more efficiently, are thus becoming a fundamental aspect in the renewables business. This is particularly visible in wind farms, where there has been a trend towards higher towers in recent years. Such massive structures are not easy to inspect, since industrial climbers are expensive and there are risks associated with climbing at great heights.

In this fast-evolving scenario, new technologies are being considered, developed and implemented to properly respond to the changing market demand. For example, developments in new materials have helped to drive tremendous evolution in drone manufacturing over the last few years. Latest-generation drones are now able to carry more high-performance equipment, capable of capturing several kinds of information with higher accuracy and resolution.

RINA has developed its own digital platform in order to be able to exploit both unmanned applications and remotely operated services. RINA is now recognised by the aviation authorities as a qualified drone operator for critical campaigns, marking another step along the continuous path of development of this new service line.

Automated data collection mitigates safety issues and provides a large amount of data for easy processing and elaboration. Analysis is becoming more cost-effective, providing plant operators with real-time information on structural behaviours. In a demand-driven market, plant operators should be capable of predicting the future production capability of a renewable energy plant. Reliable weather forecasts allow a more precise prediction of the energy produced by a plant. Weather forecast data are associated with live data from the plants, metadata from individual turbines or solar systems and historical data to get the best possible prediction of production in the short term. This will all, in turn, have an immediate impact on energy price forecasts.

At RINA, we embrace the role of new technologies in the renewables sector and have identified digitalisation as a key pillar of our strategic plan. The development of our cloud-based platform, RINACube, is a fundamental step in enlarging and improving our offering in the renewables industry, opening the door to improved predictive asset management and new ways to exploit technologies such as big data and artificial intelligence.

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