Accelerating the transition to clean energy

The role of geospatial technology in the renewable energy sector

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Introduction

The UK's capacity to produce renewable energy is currently in the region of 43.9k megawatts, when both operational facilities and projects under construction are taken into account.[1] Onshore and offshore wind and solar power generation make up over 89% of this clean energy output,[2] but other carbon neutral forms of energy, like hydroelectricity, landfill gas and anaerobic digestion, are making a notable contribution.

Traditional oil and natural gas industries are transforming to decarbonise their production methods. Some are looking to offshore wind to power their North Sea platforms, while others are converting old oil and gas wells into geothermal wells. At the same time, new approaches to carbon capture and storage, new utility-scale battery storage facilities for storing green energy and the rollout of more electricity chargepoints are also helping the UK Government to achieve its net zero target by 2050.

Geospatial technology has been used in the oil and gas industry for decades and is now proving pivotal for the expansion and development of the renewables industry. Geographic information system (GIS) solutions, in particular, provide critical location-based intelligence, allowing organisations to visualise, analyse and share information about the locations of resources, assets, constraints, competitors, markets, supply chains, transport infrastructure and risks.

GIS can be used to overcome many of the challenges faced by the industry, not least the complexity of finding the best locations for new projects. Sites need to be identified where the conditions are right for generating or storing renewable power, but where impacts on the environment and local communities can be mitigated and costs can be minimised.

Many renewable energy companies already use GIS in this way to inform site selection, but GIS can also add value beyond the planning phase. It can be used to enhance efficiency during development and build processes; improve health and safety and reporting at operational facilities; and transform communications with communities, stakeholders and employees.

This publication provides an overview of the many ways in which GIS can be used in the generation, storage and distribution of renewable energy and includes an introduction to some of the companies that are pioneering the use of geospatial technology in this sector.

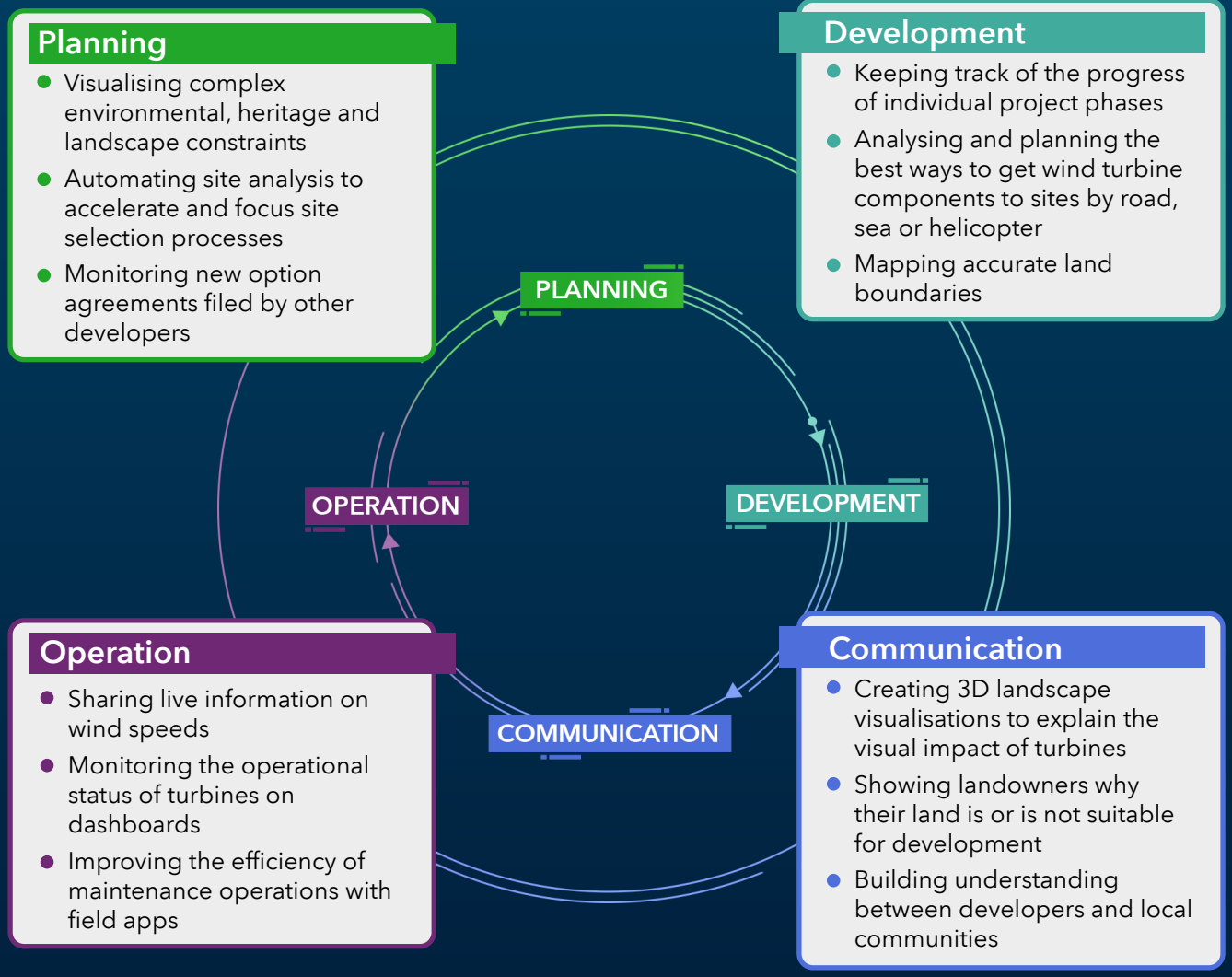
Onshore wind energy

Generating 12% of all energy produced in the UK in 2022,[3] onshore wind is a fast-growing market, but competition for new sites is fierce and development times are long.

While there are plenty of opportunities for onshore wind energy development, it is widely acknowledged that the sites that are easiest to develop are already taken. Consequently, onshore wind developers now need to use more sophisticated techniques to analyse constraints, ranging from environmental and heritage constraints to landscape features, such as the slope of the land. GIS enables organisations to consider a vast array of factors and identify the best locations that are still available, ahead of the competition.

At present, it can take many years to progress a project from site selection to operation. Companies in the onshore wind sector are keen to find new ways to shorten this process and accelerate the time to production. GIS mobile apps can transform the efficiency of project teams working in the field and improve collaboration between teams to deliver projects more quickly. At the same time, 3D GIS models can be used to improve understanding of how proposed turbines will appear in the landscape and inform communications with stakeholders, planners and communities.

Geospatial technology can be used for:



Case Study:

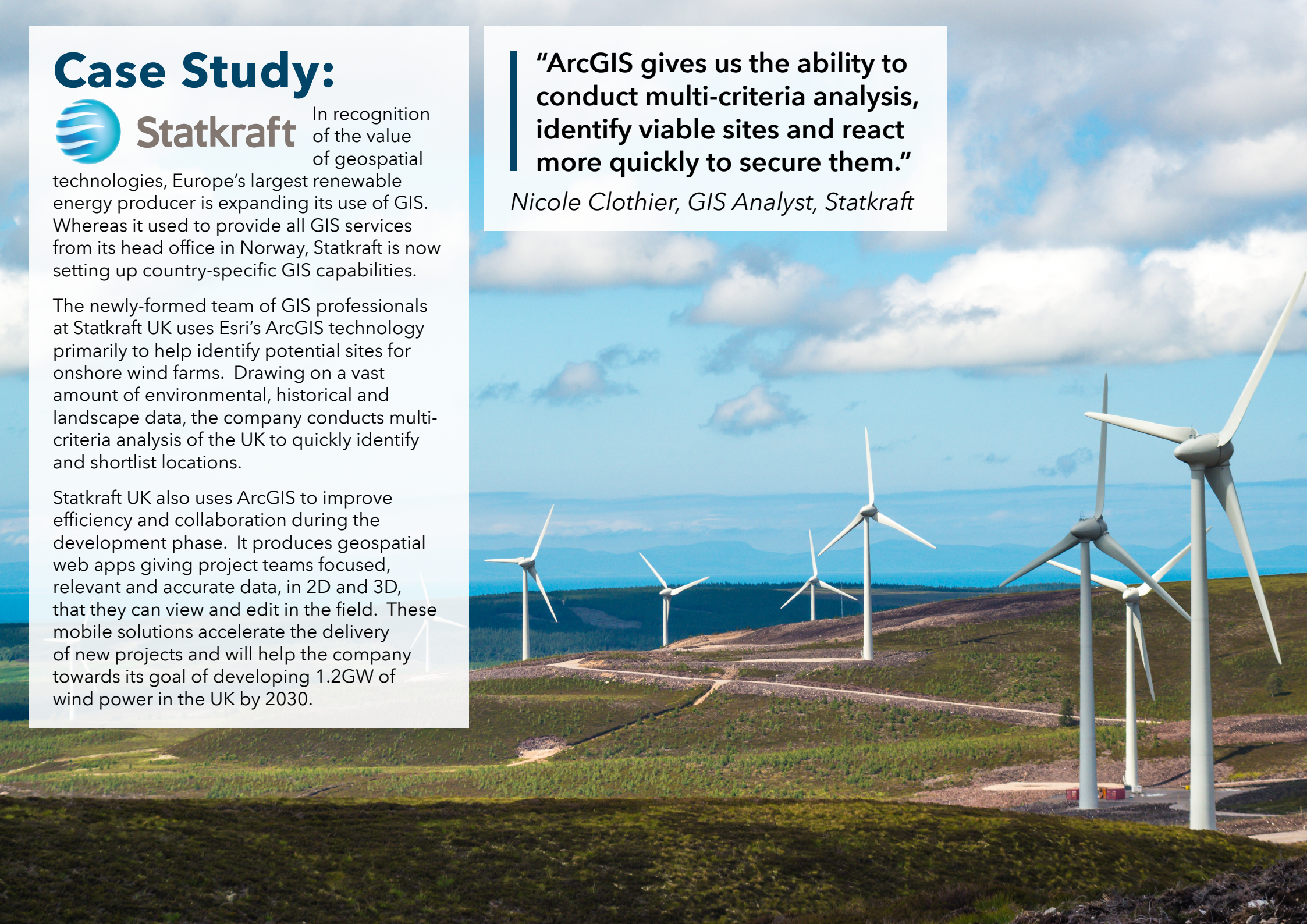
Statkraft

In recognition of the value of geospatial technologies, Europe's largest renewable energy producer is expanding its use of GIS. Whereas it used to provide all GIS services from its head office in Norway, Statkraft is now setting up country-specific GIS capabilities.

The newly-formed team of GIS professionals at Statkraft UK uses Esri's ArcGIS technology primarily to help identify potential sites for onshore wind farms. Drawing on a vast amount of environmental, historical and landscape data, the company conducts multi-criteria analysis of the UK to quickly identify and shortlist locations.

Statkraft UK also uses ArcGIS to improve efficiency and collaboration during the development phase. It produces geospatial web apps giving project teams focused, relevant and accurate data, in 2D and 3D, that they can view and edit in the field. These mobile solutions accelerate the delivery of new projects and will help the company towards its goal of developing 1.2GW of wind power in the UK by 2030.

> **"ArcGIS gives us the ability to conduct multi-criteria analysis, identify viable sites and react more quickly to secure them."**
>
> *Nicole Clothier, GIS Analyst, Statkraft*



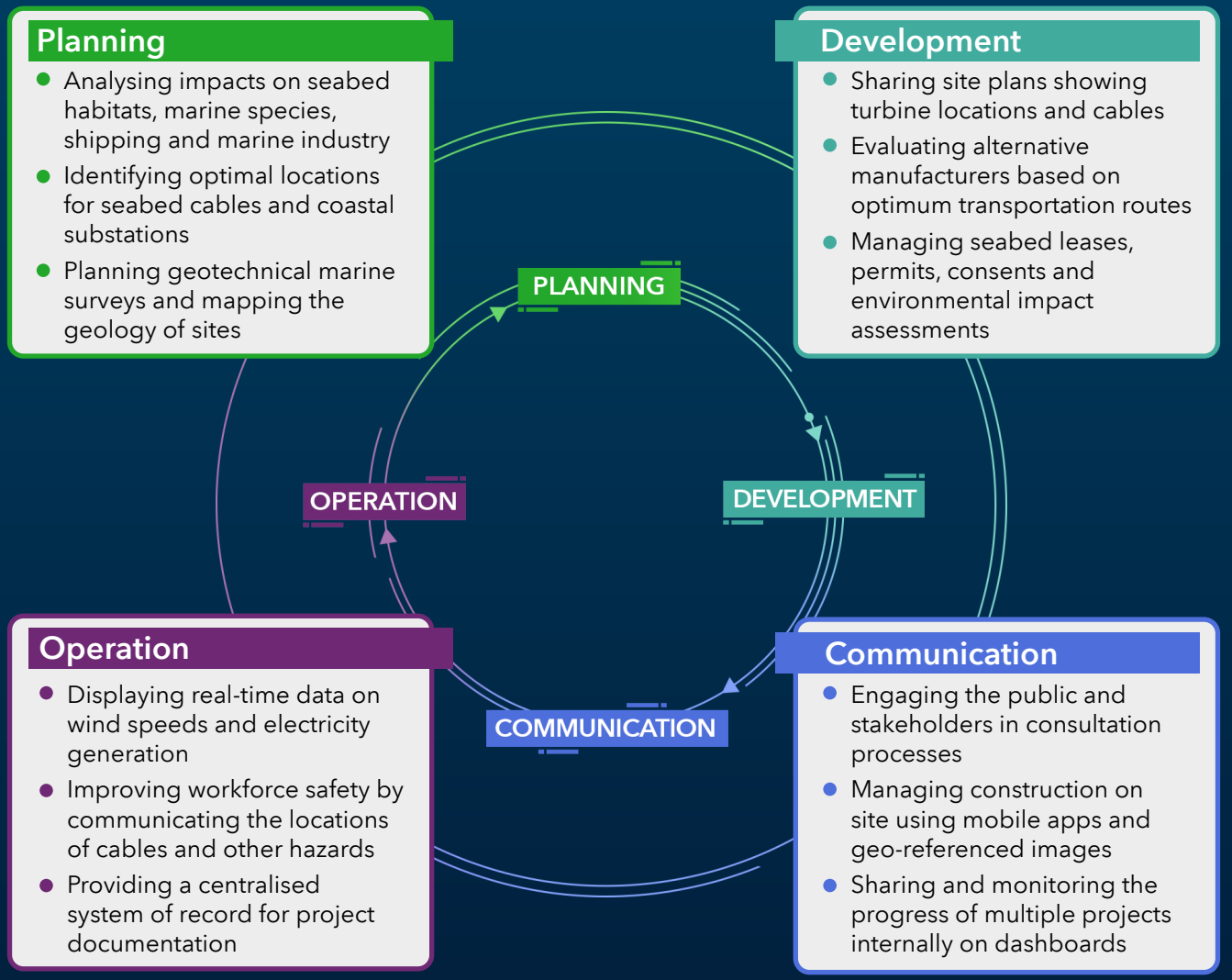
Offshore wind energy

There were over 2,650 wind turbines in operation off the coast of the UK in 2022,[4] and this number needs to grow–to both boost the supply of renewable energy and help decarbonise traditional oil and gas production.

Offshore wind farms have been operating successfully in the waters around the UK for many years. Most working turbines are fixed to the seabed in water depths of up to 60 metres, but now new opportunities exist for floating turbine platforms, which can be positioned further from the shore, in deeper water where higher wind speeds are available. Critically, these floating platforms can supply green energy direct to North Sea oil and gas platforms, reducing the industry's dependency on carbon-intensive gas-fired or diesel power generation.

Planning applications for both fixed and floating wind farms need to take into account the competing interests of marine species and habitats, commercial fishing, shipping and industry. GIS can provide a clear insight into potential impacts and be used creatively to help share information openly with the public. Looking further ahead in the process, GIS solutions can also inform development and logistical decisions and improve the efficiency and safety of ongoing operations.

Geospatial technology can be used for:



> **"Using ArcGIS in our consultation process enables us to provide people with a much more interactive and immersive experience."**
>
> *Stephen King, GIS Lead, Flotation Energy*

Case Study:

GREEN VOLT

FLOTATION ENERGY | vårgrønn

Flotation Energy is using Esri's ArcGIS system to support the development of the Green Volt floating offshore windfarm in the North Sea. With around 35 turbines, Green Volt is one of the most advanced oil and gas platform electrification and decarbonisation projects in Europe, reducing participating platform emissions by 85%. At the same time, it will also supply 1.5 terawatts of renewable power annually to the national grid.

During planning for Green Volt, Flotation Energy analysed a multitude of factors with ArcGIS Pro. These ranged from water depth and offshore wind speeds to the presence of marine mammals and proximity to oil and gas infrastructure. ArcGIS Pro was also used to plan geotechnical surveys and subsequently manage and visualise the data collected, including multibeam data for creating 3D seabed models.

Significantly, Flotation Energy has enhanced its stakeholder engagement and online consultation processes by using ArcGIS Online to share information about Green Volt on interactive maps. The company was able to communicate information with the public, stakeholders and government agencies more clearly, helping everyone to understand the location, scale and impact of this vitally important new offshore wind development.

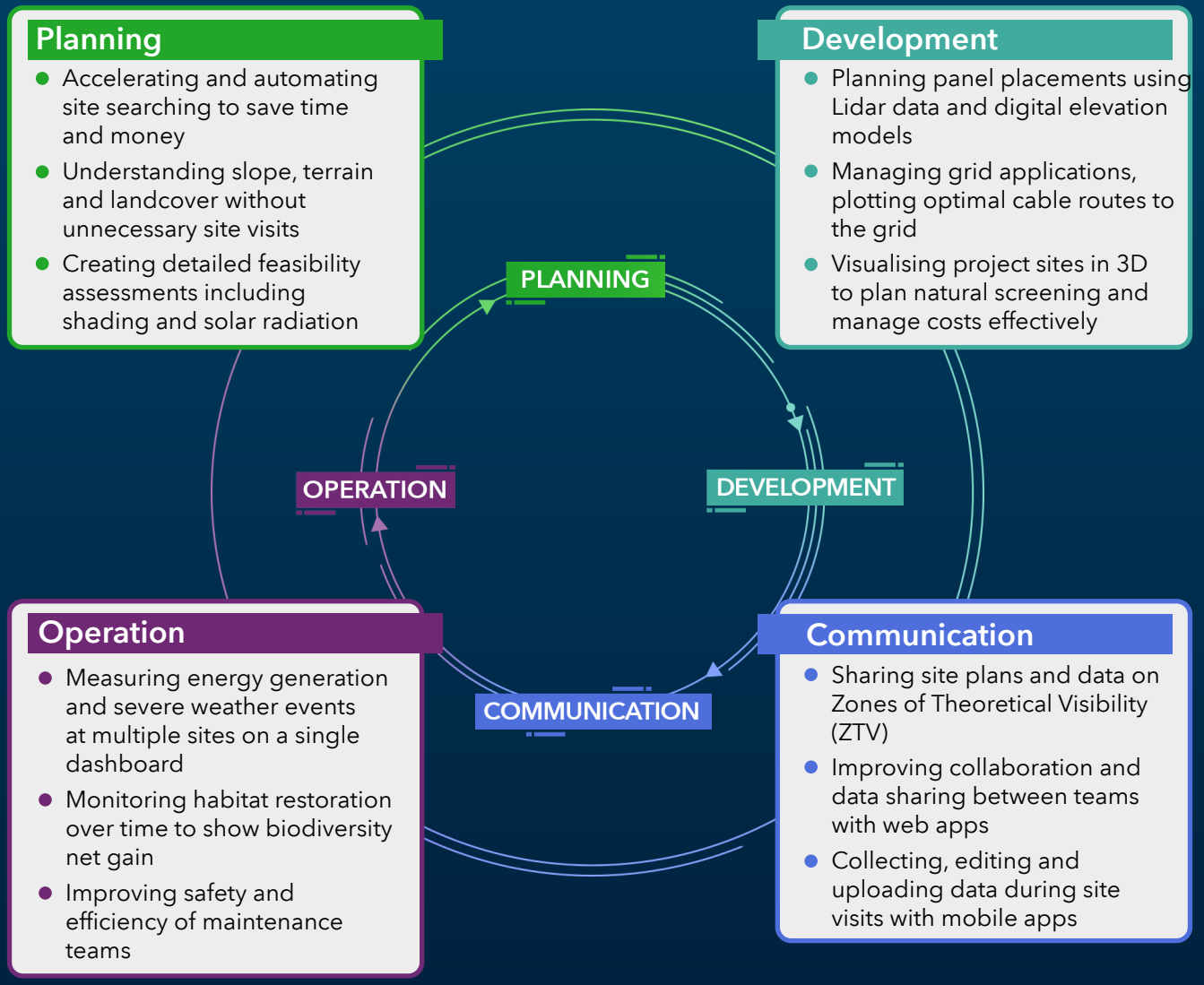
Solar energy

If the UK is to achieve its target of a net zero economy, the amount of solar capacity in this country will need to triple between 2021 and 2030.[5]

An entirely new approach to site selection and development is required to enable the solar energy industry to scale up this rapidly. Historically, solar developers have had to use mass communication approaches to reach landowners and refer to multiple planning constraint websites to assess the suitability of each potential location. This time-consuming and resource-intensive approach can, however, now be fully automated with GIS technology.

GIS allows an unlimited number of potential constraints to be taken into account in minutes and visual impacts to be more accurately assessed in a fast and efficient process. Project sites can be analysed and visualised in 3D, and these interactive, data-rich maps can be shared both internally and externally to improve collaboration, public engagement and financial control.

Geospatial technology can be used for:



Case Study:

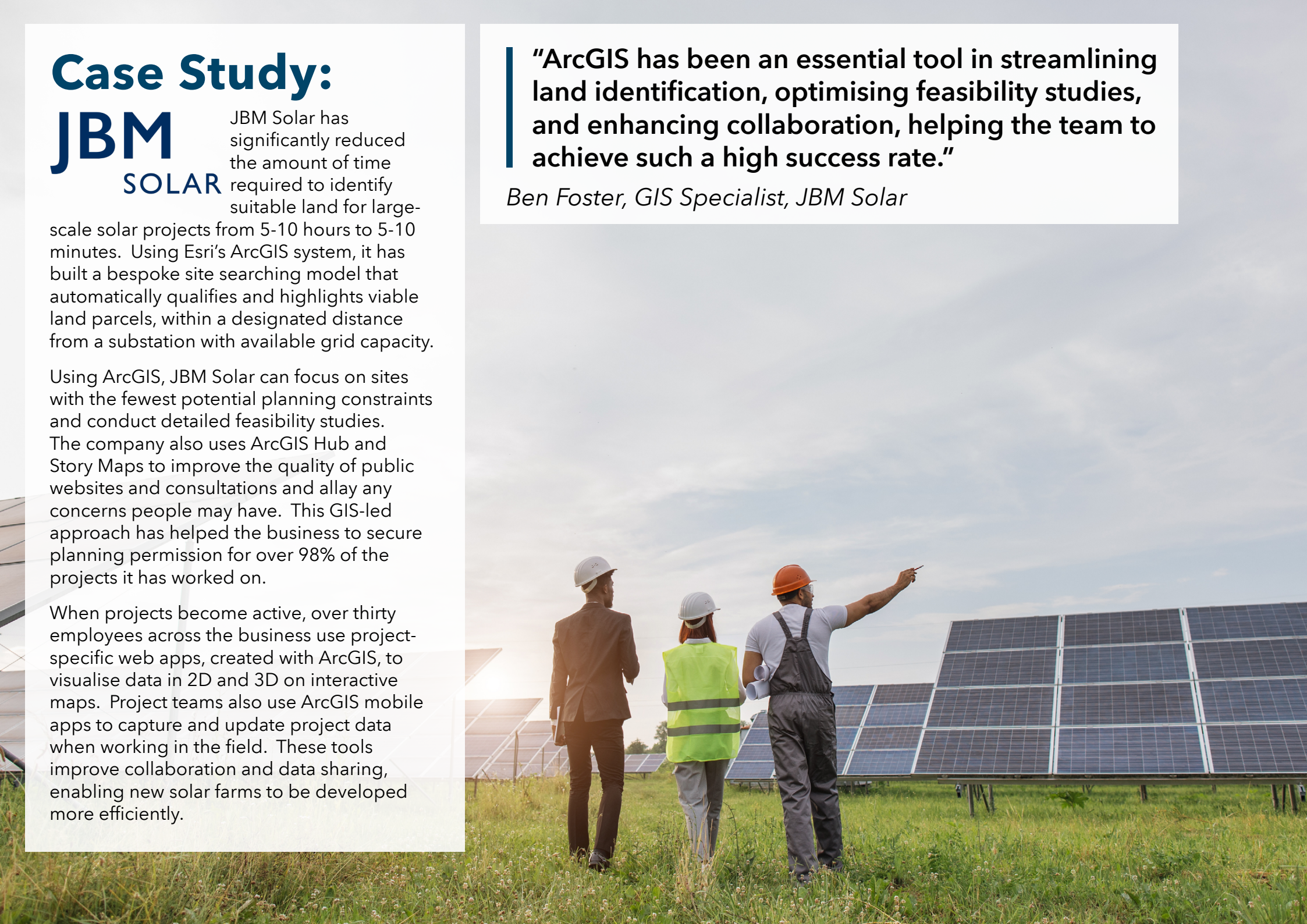
JBM SOLAR

JBM Solar has significantly reduced the amount of time required to identify suitable land for large-scale solar projects from 5-10 hours to 5-10 minutes. Using Esri's ArcGIS system, it has built a bespoke site searching model that automatically qualifies and highlights viable land parcels, within a designated distance from a substation with available grid capacity.

Using ArcGIS, JBM Solar can focus on sites with the fewest potential planning constraints and conduct detailed feasibility studies. The company also uses ArcGIS Hub and Story Maps to improve the quality of public websites and consultations and allay any concerns people may have. This GIS-led approach has helped the business to secure planning permission for over 98% of the projects it has worked on.

When projects become active, over thirty employees across the business use project-specific web apps, created with ArcGIS, to visualise data in 2D and 3D on interactive maps. Project teams also use ArcGIS mobile apps to capture and update project data when working in the field. These tools improve collaboration and data sharing, enabling new solar farms to be developed more efficiently.

> **"ArcGIS has been an essential tool in streamlining land identification, optimising feasibility studies, and enhancing collaboration, helping the team to achieve such a high success rate."**
>
> *Ben Foster, GIS Specialist, JBM Solar*



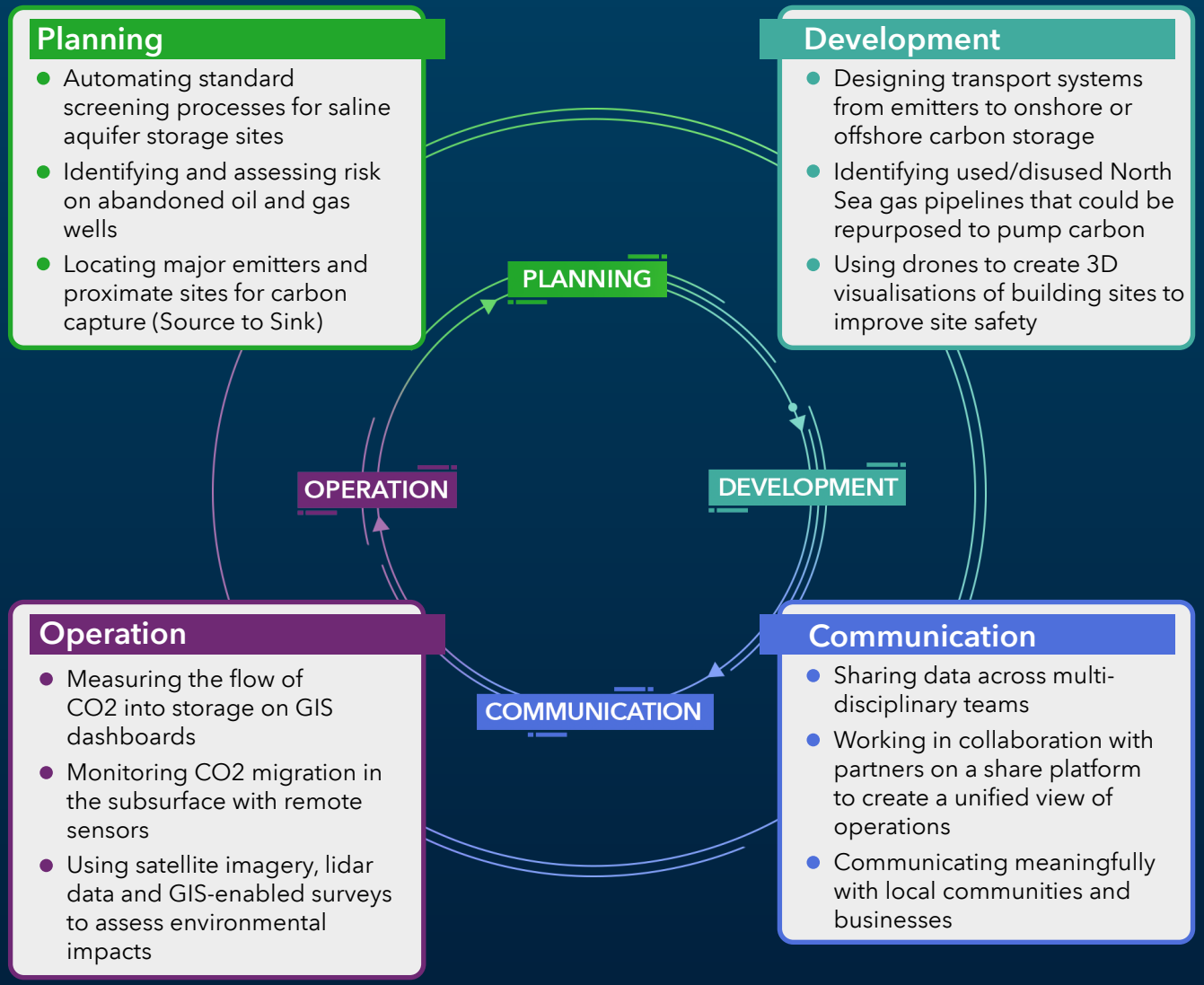
Carbon capture and storage

The UK Government has released an investment roadmap for carbon capture, usage and storage, updated in April 2023.[6] Now the industry needs to respond.

According to this government report, the UK is a 'first mover' in the carbon capture and storage sector, with the potential to be one of the greatest CO2 storage bases in Europe. Companies operating in and entering this field need to be able to understand where CO2 can be captured directly from energy intensive industrial sites before it enters the atmosphere; where state-of-the-art facilities can be cost-effectively located to extract CO2 direct from the air; and where the captured carbon can be stored in saline aquifers and former gas fields.

Data is undeniably the challenge in this new sector. Some data doesn't exist, some is hard to access and some exists but is of poor quality. GIS can be used to build, standardise, collate, share and visualise existing and new data sets, shedding light on how to develop carbon capture and storage facilities that are financially viable, highly productive and urgently needed.

Geospatial technology can be used for:



Case Study: STOREGGA

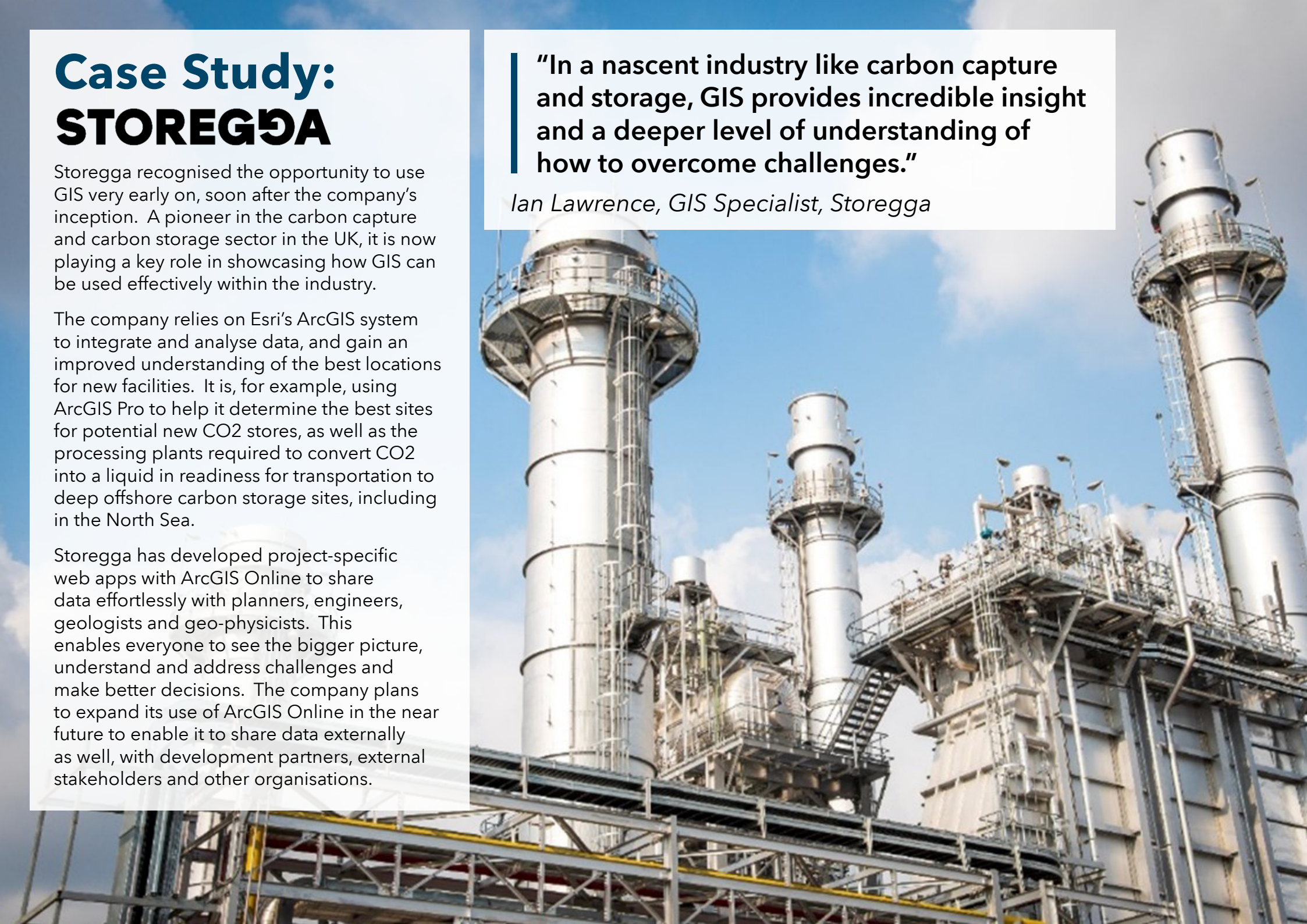
Storegga recognised the opportunity to use GIS very early on, soon after the company's inception. A pioneer in the carbon capture and carbon storage sector in the UK, it is now playing a key role in showcasing how GIS can be used effectively within the industry.

The company relies on Esri's ArcGIS system to integrate and analyse data, and gain an improved understanding of the best locations for new facilities. It is, for example, using ArcGIS Pro to help it determine the best sites for potential new CO2 stores, as well as the processing plants required to convert CO2 into a liquid in readiness for transportation to deep offshore carbon storage sites, including in the North Sea.

Storegga has developed project-specific web apps with ArcGIS Online to share data effortlessly with planners, engineers, geologists and geo-physicists. This enables everyone to see the bigger picture, understand and address challenges and make better decisions. The company plans to expand its use of ArcGIS Online in the near future to enable it to share data externally as well, with development partners, external stakeholders and other organisations.

> **"In a nascent industry like carbon capture and storage, GIS provides incredible insight and a deeper level of understanding of how to overcome challenges."**

Ian Lawrence, GIS Specialist, Storegga



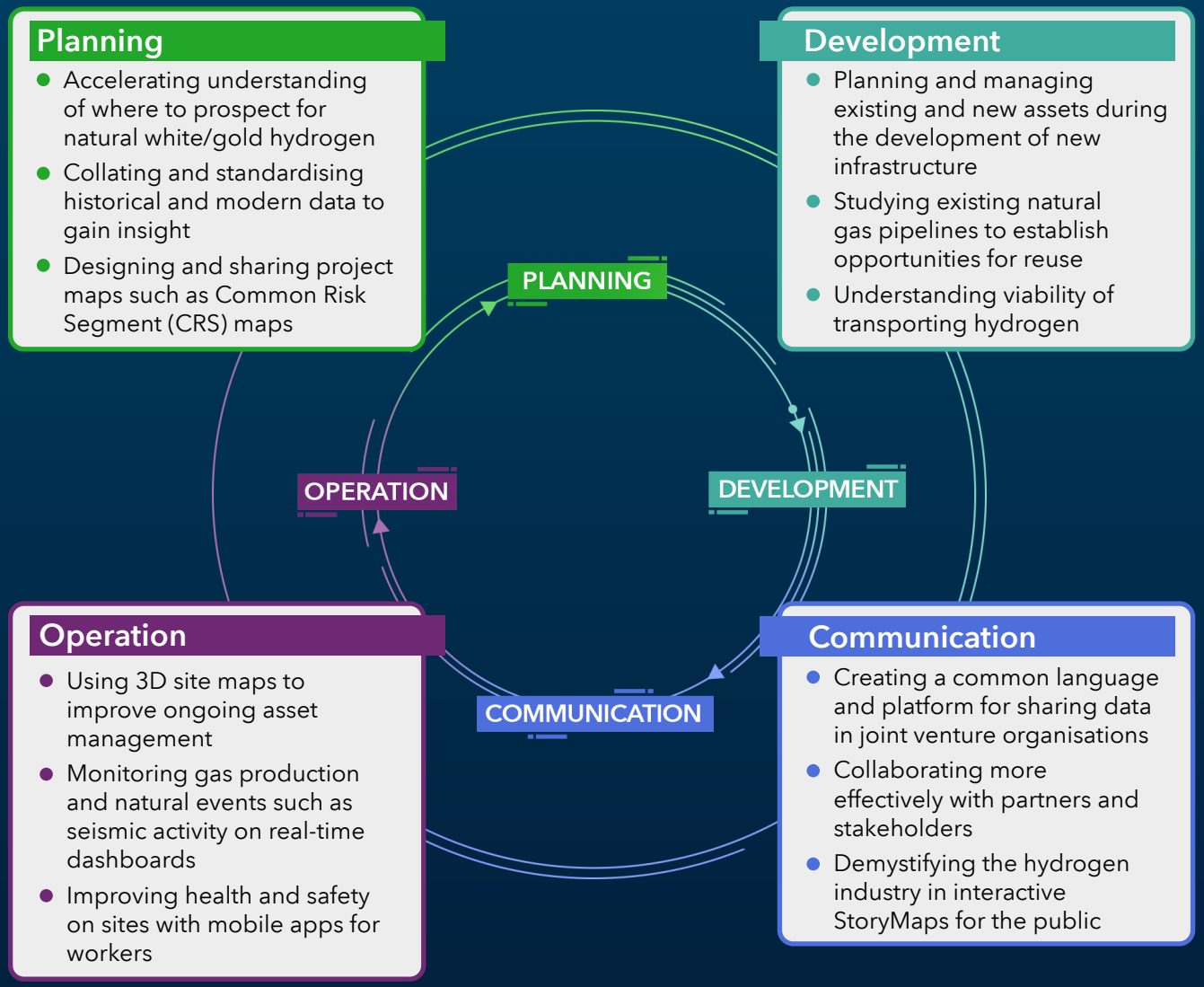
Hydrogen production & exploration

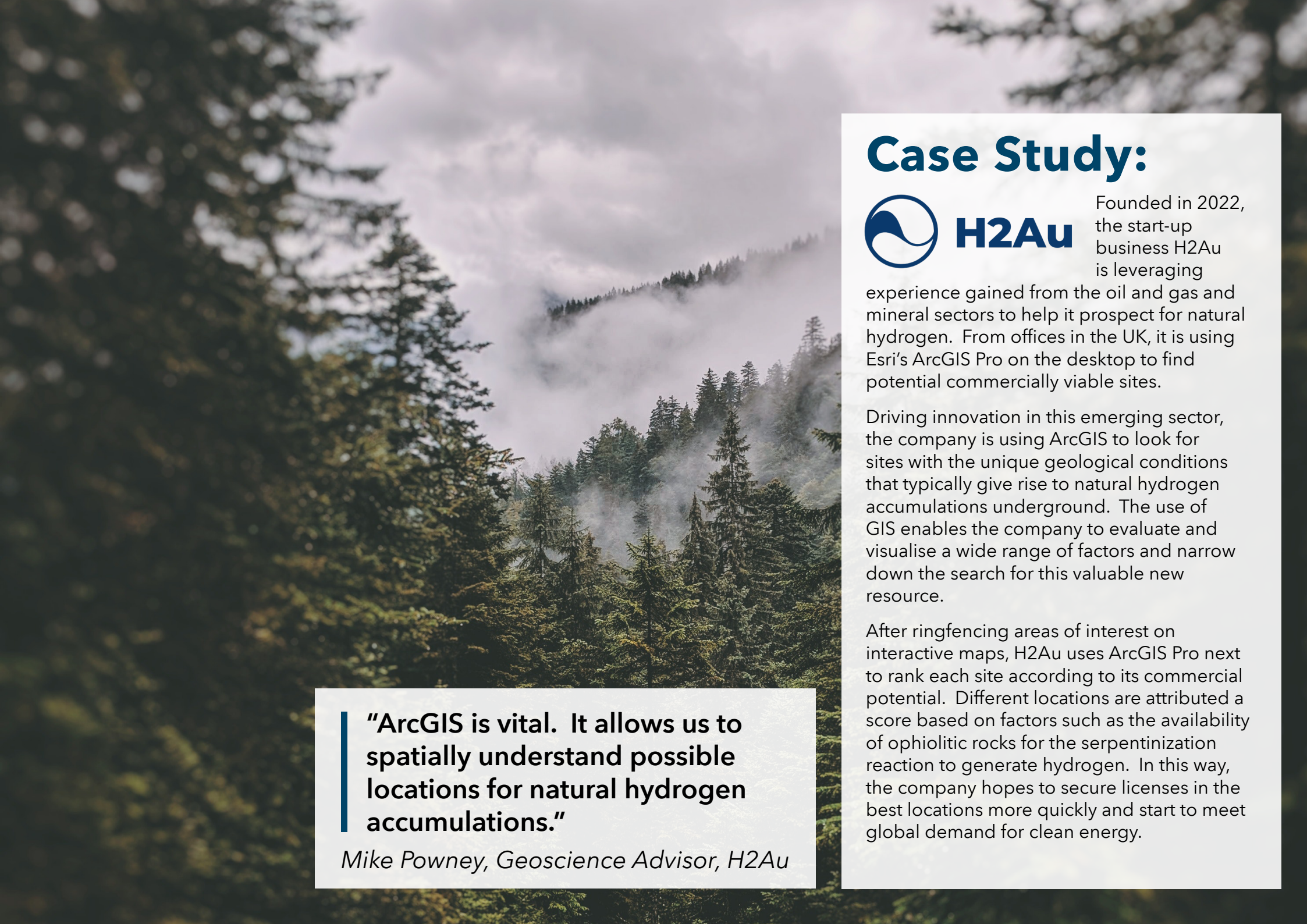
96% of global hydrogen output today is produced using fossil fuels.[7] Greener (and gold) methods of capturing hydrogen are needed.

Hydrogen has the potential to substantially reduce carbon emissions from transportation, homes and industry, but more sustainable means of manufacturing or capturing this gas are needed. Renewable or green hydrogen can now be produced successfully using electrolysis and solar or wind power to split water into hydrogen gas and oxygen. GIS can inform the development of large-scale, renewable hydrogen plants, paving the way for more hydrogen to be produced without creating carbon emissions.

GIS can also be used to enable faster, more accurate prospecting for naturally-occurring hydrogen (known as white or gold hydrogen). This is a nascent industry, but the first hydrogen wells have already been drilled in the USA, and companies around the world are using GIS to proactively seek out areas where lucrative new sources of natural hydrogen may reside.

Geospatial technology can be used for:





Case Study:

H2Au

Founded in 2022, the start-up business H2Au is leveraging experience gained from the oil and gas and mineral sectors to help it prospect for natural hydrogen. From offices in the UK, it is using Esri's ArcGIS Pro on the desktop to find potential commercially viable sites.

Driving innovation in this emerging sector, the company is using ArcGIS to look for sites with the unique geological conditions that typically give rise to natural hydrogen accumulations underground. The use of GIS enables the company to evaluate and visualise a wide range of factors and narrow down the search for this valuable new resource.

After ringfencing areas of interest on interactive maps, H2Au uses ArcGIS Pro next to rank each site according to its commercial potential. Different locations are attributed a score based on factors such as the availability of ophiolitic rocks for the serpentinization reaction to generate hydrogen. In this way, the company hopes to secure licenses in the best locations more quickly and start to meet global demand for clean energy.

> **"ArcGIS is vital. It allows us to spatially understand possible locations for natural hydrogen accumulations."**

Mike Powney, Geoscience Advisor, H2Au

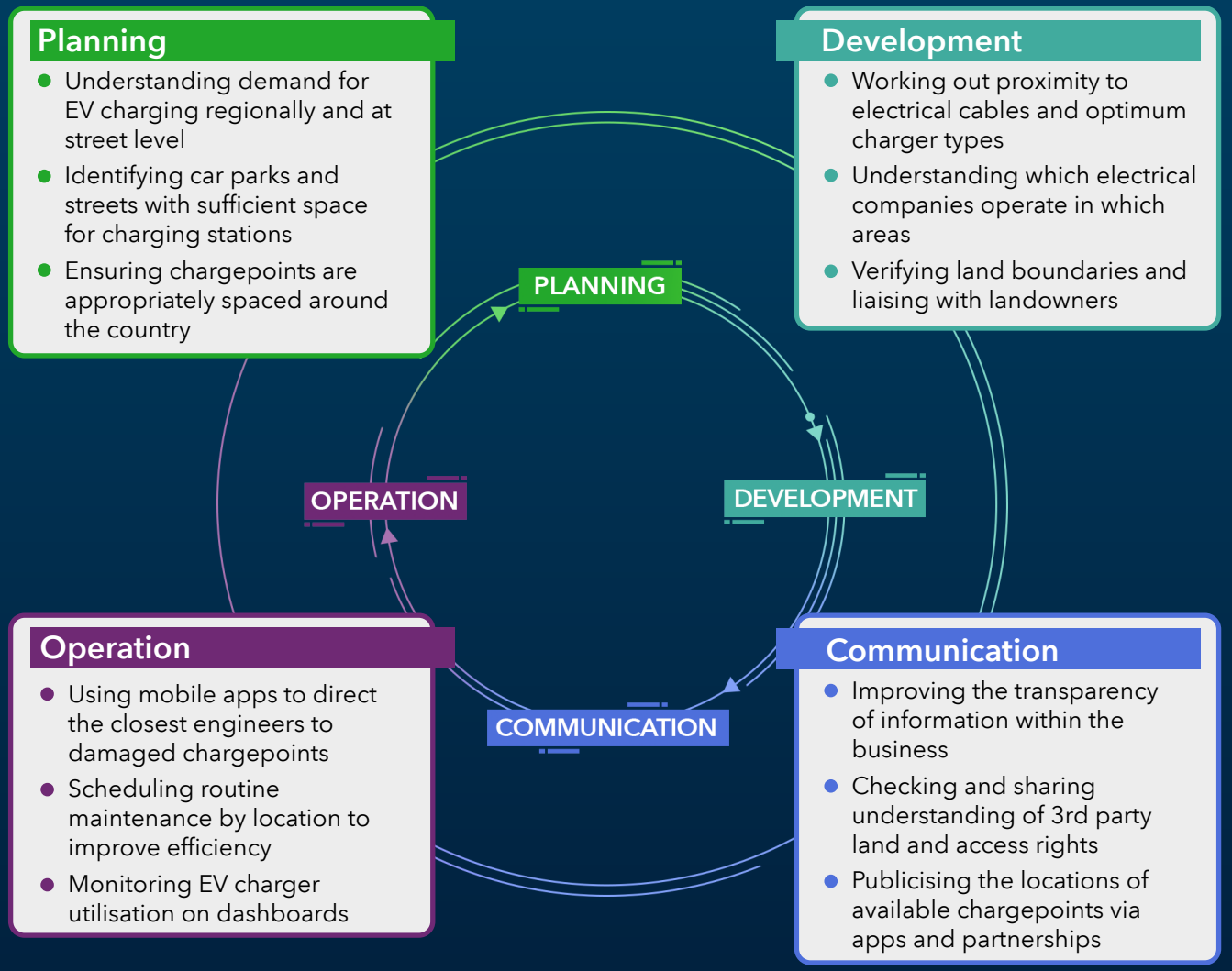
Electric vehicle charging

A tenfold increase in electric vehicle chargepoints is needed by 2030[8] but can the industry respond quickly enough to meet this goal?

The Government's target of 300,000 electric vehicle (EV) chargepoints in the UK by 2030 is hugely ambitious. Many thousands of chargepoints are already in development, but more–many more–must be developed quickly to encourage and facilitate the widespread adoption of electric cars and commercial vehicles. Chargepoint operators need to accelerate their rollout plans, and many are using GIS to help them do this.

Critically, EV chargepoints need to be sited in the right locations to meet the needs of motorists, landowners, electricity providers and commercial fleet operators. GIS has been used for years to help EV operators and local councils understand where EV owners live, which demographics are likely to invest in electric cars next, whether they have off street parking, if on-street charging is required and where they travel. As the adoption of electric cars increases, these complex questions will need to be answered at even greater pace.

Geospatial technology can be used for:



Case Study:

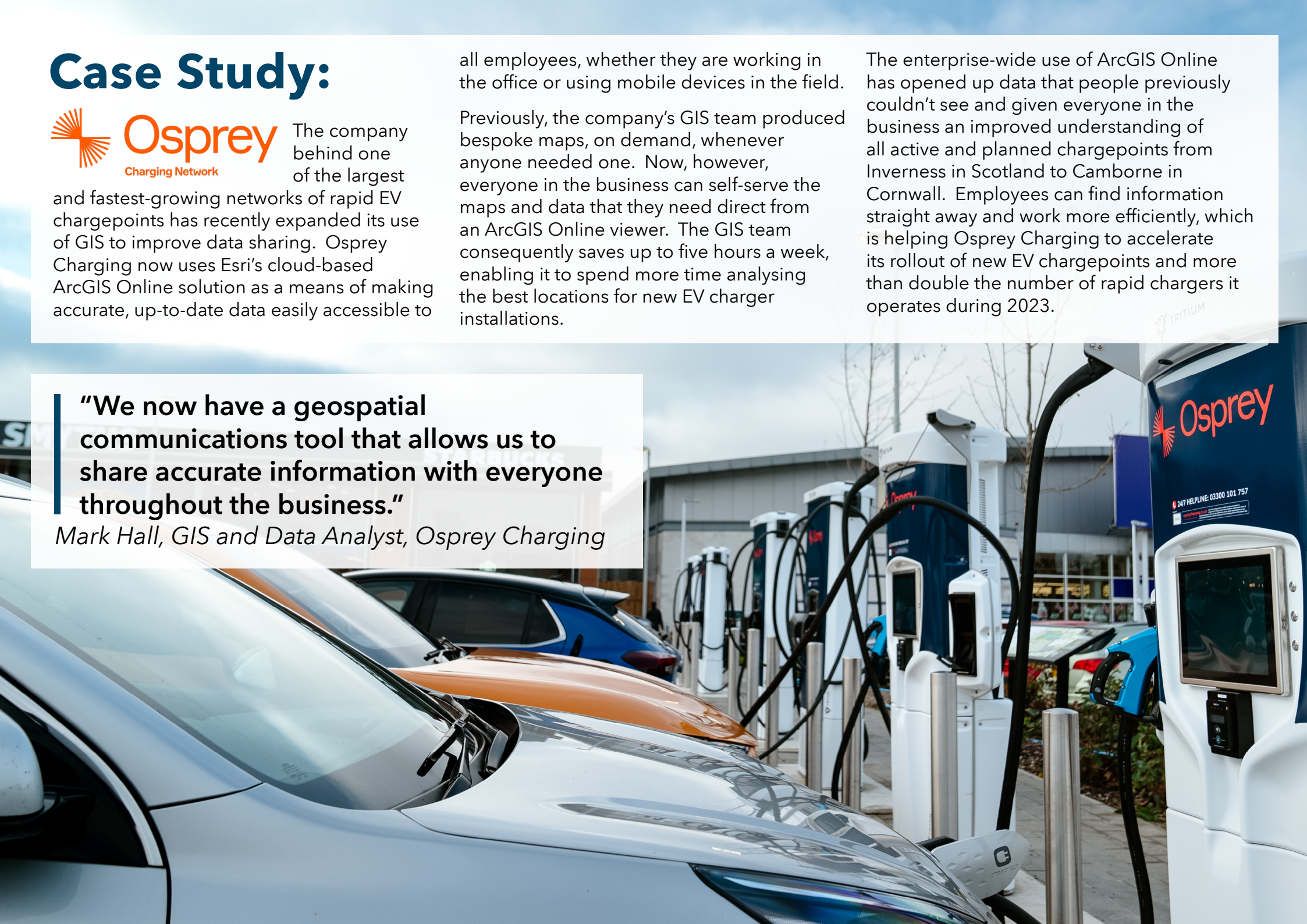
Osprey Charging Network

The company behind one of the largest and fastest-growing networks of rapid EV chargepoints has recently expanded its use of GIS to improve data sharing. Osprey Charging now uses Esri's cloud-based ArcGIS Online solution as a means of making accurate, up-to-date data easily accessible to all employees, whether they are working in the office or using mobile devices in the field.

Previously, the company's GIS team produced bespoke maps, on demand, whenever anyone needed one. Now, however, everyone in the business can self-serve the maps and data that they need direct from an ArcGIS Online viewer. The GIS team consequently saves up to five hours a week, enabling it to spend more time analysing the best locations for new EV charger installations.

The enterprise-wide use of ArcGIS Online has opened up data that people previously couldn't see and given everyone in the business an improved understanding of all active and planned chargepoints from Inverness in Scotland to Camborne in Cornwall. Employees can find information straight away and work more efficiently, which is helping Osprey Charging to accelerate its rollout of new EV chargepoints and more than double the number of rapid chargers it operates during 2023.

> **"We now have a geospatial communications tool that allows us to share accurate information with everyone throughout the business."**
>
> *Mark Hall, GIS and Data Analyst, Osprey Charging*



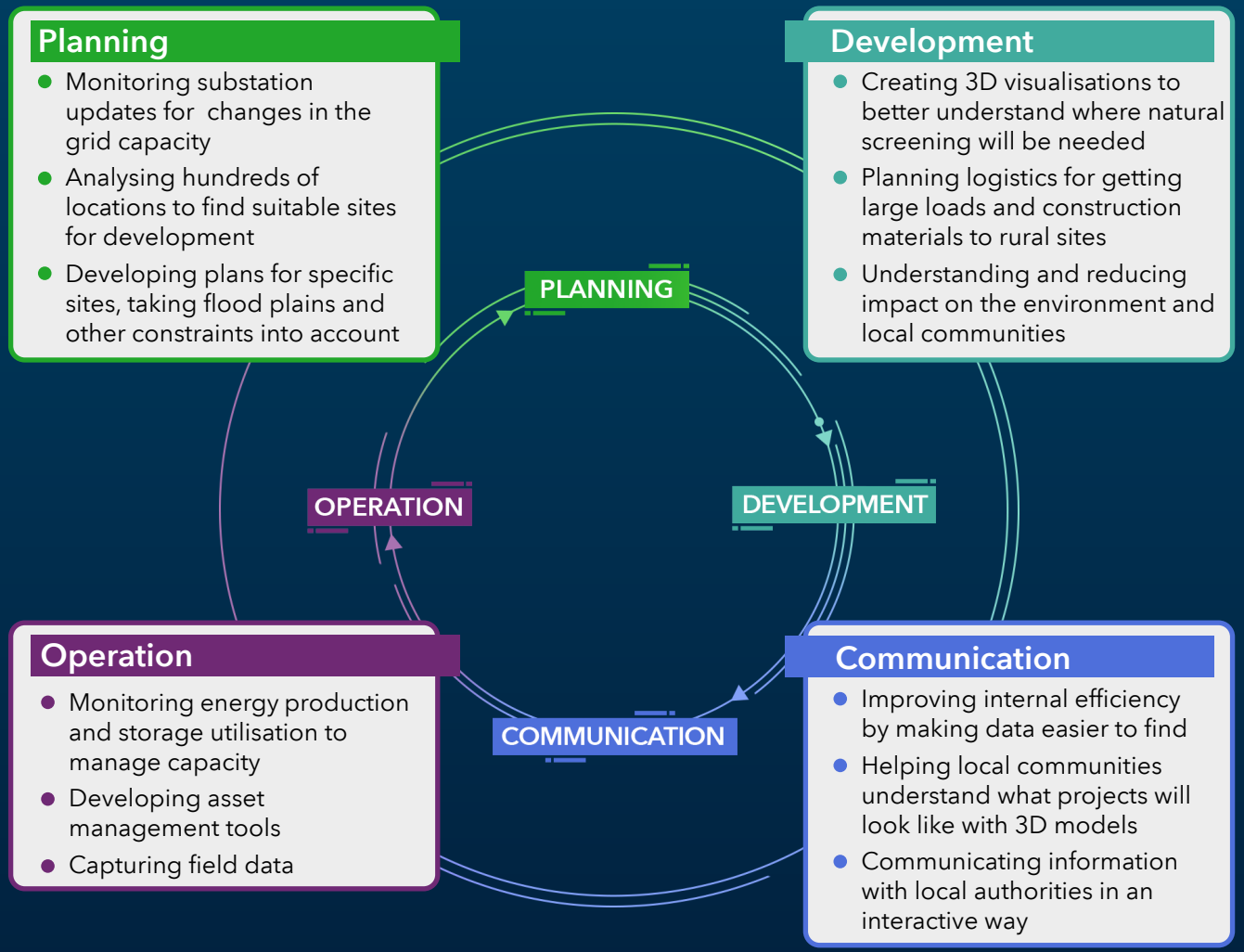
Battery storage

Despite the challenges posed by a heavily constrained national grid, utility-scale battery storage capacity increased by a record 800 megawatt-hours in the UK in 2022.[9]

One of the biggest constraints limiting the development of large-scale, battery storage is the availability of capacity on the grid. Organisations need to understand, not just whether there is capacity now, but also when there might be future capacity, in order to enable planning for new facilities that could be years in development. GIS has become an almost indispensable tool for analysing available capacity, monitoring changes and reacting quickly and strategically to secure the most viable sites.

Like all providers of renewable energy, battery storage developers need to be good neighbours. They can use GIS to help them to understand environmental, historic and natural constraints and to plan interventions to improve screening, address flood risks, protect species and increase biodiversity net gain. Many are using GIS to share plans visually with local communities and help allay any concerns residents may have about the appearance of schemes, impact on traffic congestion and noise.

Geospatial technology can be used for:



Case Study:

exagen

Exagen develops large-scale, grid-linked battery storage systems in conjunction with solar farms in the UK. Recognising the need to be able to operate nimbly in this emerging market, the company is using Esri's ArcGIS Online solution to make accurate, dependable data readily accessible by Exagen teams.

The company has integrated ArcGIS Online with multiple third-party systems including its custom-built Exagen Information Management System (EIMS), computer-aided design (CAD) systems, Microsoft SharePoint and Power BI. Exagen teams use ArcGIS web applications to find the projects they are working on and access further information needed for better decision making. In this way, ArcGIS provides an intuitive gateway to all the information teams may need about planned and potential projects, from site plans to budgets.

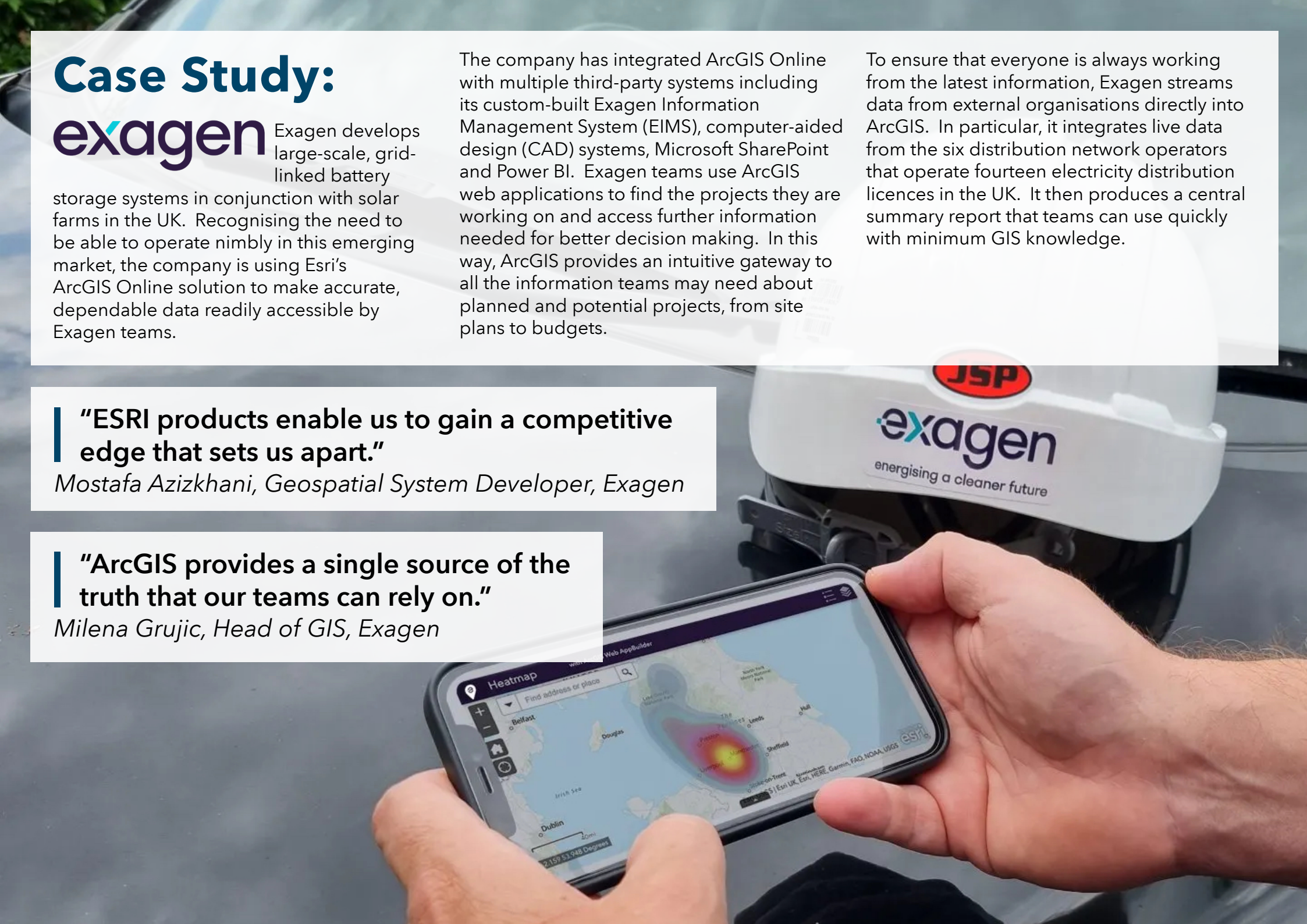
To ensure that everyone is always working from the latest information, Exagen streams data from external organisations directly into ArcGIS. In particular, it integrates live data from the six distribution network operators that operate fourteen electricity distribution licences in the UK. It then produces a central summary report that teams can use quickly with minimum GIS knowledge.

"ESRI products enable us to gain a competitive edge that sets us apart."

Mostafa Azizkhani, Geospatial System Developer, Exagen

"ArcGIS provides a single source of the truth that our teams can rely on."

Milena Grujic, Head of GIS, Exagen



GIS technology

GIS is well-established…

Developed in the 1960s, geographic information system (GIS) technology has evolved through the decades to become a critical tool for managing, integrating, analysing, visualising and sharing geospatial data. Esri's ArcGIS system is the world's leading GIS software, used for everything from protecting the natural world to designing state-of-the-art engineering projects. Long before the renewable energy industry emerged, ArcGIS was being used in traditional oil and gas businesses to manage assets and improve the efficiency of upstream, downstream and midstream operations.

…and constantly evolving.

Today's GIS solutions bring together the latest mobile, web, cloud, real-time and 3D technologies, enabling people to create interactive digital twins of ecosystems, built infrastructure, population demographics, transportation movements and utility networks. ArcGIS has evolved from a system of data capture and visualisation into a suite of advanced tools for undertaking advanced location analytics, creating 3D scenes from drone-captured data, integrating and understanding real-time data from sensors and using machine learning in semi-autonomous, automated functions.

ArcGIS enables organisations in the renewable energy sector to:

Understand context and constraints

Visualise features, such as flood zones, terrain and elevation, in 2D and 3D with ArcGIS Scene Viewer to better understand the wider environment around renewable energy sites.

Create a single version of the truth

Combine geospatial, CAD, BIM and drone data in ArcGIS Online and use ArcGIS Hub to create a single, immersive visual environment for accessing all project data.

Empower field workers

Build bespoke mobile apps with ArcGIS Field Maps and Survey123 to equip teams with the tools to view and edit maps and capture data more efficiently in the field.

Monitor progress and status

Keep everyone in the loop with ArcGIS Dashboards that show progress towards key targets, as well as real-time energy production and storage capacity metrics.

Analyse change in real time

Ingest and analyse vast amounts of data collected by Internet of Things (IoT) sensors to detect changes in natural resources (like wind) quickly and monitor energy generation using ArcGIS Velocity.

Engage successfully with stakeholders

Make complex situations understandable for everyone by using ArcGIS web apps and ArcGIS StoryMaps to share information about proposed new projects and support public consultations.

Automate routine tasks

Use artificial intelligence models in ArcGIS Pro on the desktop to quickly analyse and identify deficiencies in assets and automate tasks to improve operational efficiency

Look beyond the horizon

Use Esri UK's Premium Data Services and the Esri Living Atlas of the World to discover new data, easily access third party data and stream live feeds for weather and traffic.

Gain fresh insight into opportunities

Model wind and solar levels or predict demand for electric vehicles at specific locations using ArcGIS Insight.

References:

[1] Esri. UK Renewable Energy Capacity Dashboard (Statistics from 6 June 2023).
Available on ArcGIS Online at: **https://www.arcgis.com/apps/dashboards/79321ddd146e49809aabb2482d49f1a8**

[2] Esri. UK Renewable Energy Capacity Dashboard (Statistics from 6 June 2023).
Available on ArcGIS Online at: **https://www.arcgis.com/apps/dashboards/79321ddd146e49809aabb2482d49f1a8**

[3] UK Government, Department for Energy Security and Net Zero. Energy Trends UK, October to December 2022 and 2022 (Statistical Release 30 March 2023).
Available at: **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1147249/Energy_Trends_March_2023.pdf**

[4] The Crown Estate. Offshore Wind Report 2022.
Available at: **https://www.thecrownestate.co.uk/media/4382/11720_owoperationalreport_2022_tp_020523plusaccessibility.pdf**

[5] Solar Energy UK. Lighting the way: Making net zero a reality with solar energy. 2021.
Available at: **https://solarenergyuk.org/wp-content/uploads/2021/06/Lighting-the-way-report.pdf**

[6] UK Government. CCUS Net Zero Investment Roadmap: Capturing carbon and a global opportunity. April 2023.
Available at: **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1148954/ccus-net-zero-investment-roadmap.pdf**

[7] International Renewable Energy Agency. Hydrogen Overview. (Webpage, accessed 26 May 2023).
Available at: **https://www.irena.org/Energy-Transition/Technology/Hydrogen#:~:text=As%20at%20the%20end%20of,around%204%25%20comes%20from%20electrolysis.**

[8] UK Government. Tenfold expansion in chargepoints by 2030 as government drives EV revolution. (News Story 25 March 2022).
Available at: **https://www.gov.uk/government/news/tenfold-expansion-in-chargepoints-by-2030-as-government-drives-ev-revolution**

[9] Solar Power Portal. Record 800MWh of utility-scale storage added in 2022. (Article 2 February 2023.)
Available at: **https://www.solarpowerportal.co.uk/blogs/record_800mwh_of_utility_scale_storage_added_in_2022_according_to_solar_med**

About Esri

Esri is the global market leader in geographic information systems (GIS), offering powerful mapping and spatial analytics technology that is used across all industry sectors, including renewable energy. In the UK renewable energy sector, Esri UK harnesses maps, data and analytics to enable organisations to plan, develop and operate renewable energy infrastructure, as well as communicate effectively with stakeholders, partners and the public. Esri UK's renewable energy customers include: Statkraft, Flotation Energy, JBM Solar, Storegga, H2Au, Osprey Charging and Exagen.

For more information about the use of GIS in the renewable energy sector, please contact Esri UK on:

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