AtkinsRéalis

OFFSHORE WIND

Engineering Net Zero™

THE CHALLENGE

Offshore wind is a critical element required to deliver the global energy transition towards large-scale, reliable, affordable, low-carbon renewable power.

In order to maintain 1.5°C warming pathway and deliver net zero emissions by the middle of the century, the International Renewable Energy Agency (IRENA) are calling for at least 2,000 GW of offshore wind deployed by 2050.

According to the International Energy Agency (IEA), there is enough offshore wind resource globally to meet the world's entire electricity demand today, 18 times over. Using current technology, the World Bank estimates around 71,000 GW of fixed and floating offshore wind potential worldwide. With only 35 GW installed today, that means we have barely scratched the surface of offshore wind's potential.

Universally, meeting offshore wind targets is an extremely ambitious task for the sector. The challenges are diverse and require an extensive understanding, collaboration and buy-in from the supply chain, regional authorities, and communities. These challenges span the entire project lifecycle of an offshore wind farm, encompassing everything from the environmental impacts, through to the availability of suitable space and infrastructure to support delivery of new developments.

Our approach is to help clients complete projects with minimal impact on the environment, maximum economic and social benefits to the region, while significantly contributing to the delivery of sustainable energy.

SOURCE: Offshore Wind Resource Hub - Global Wind Energy Council (gwec.net)

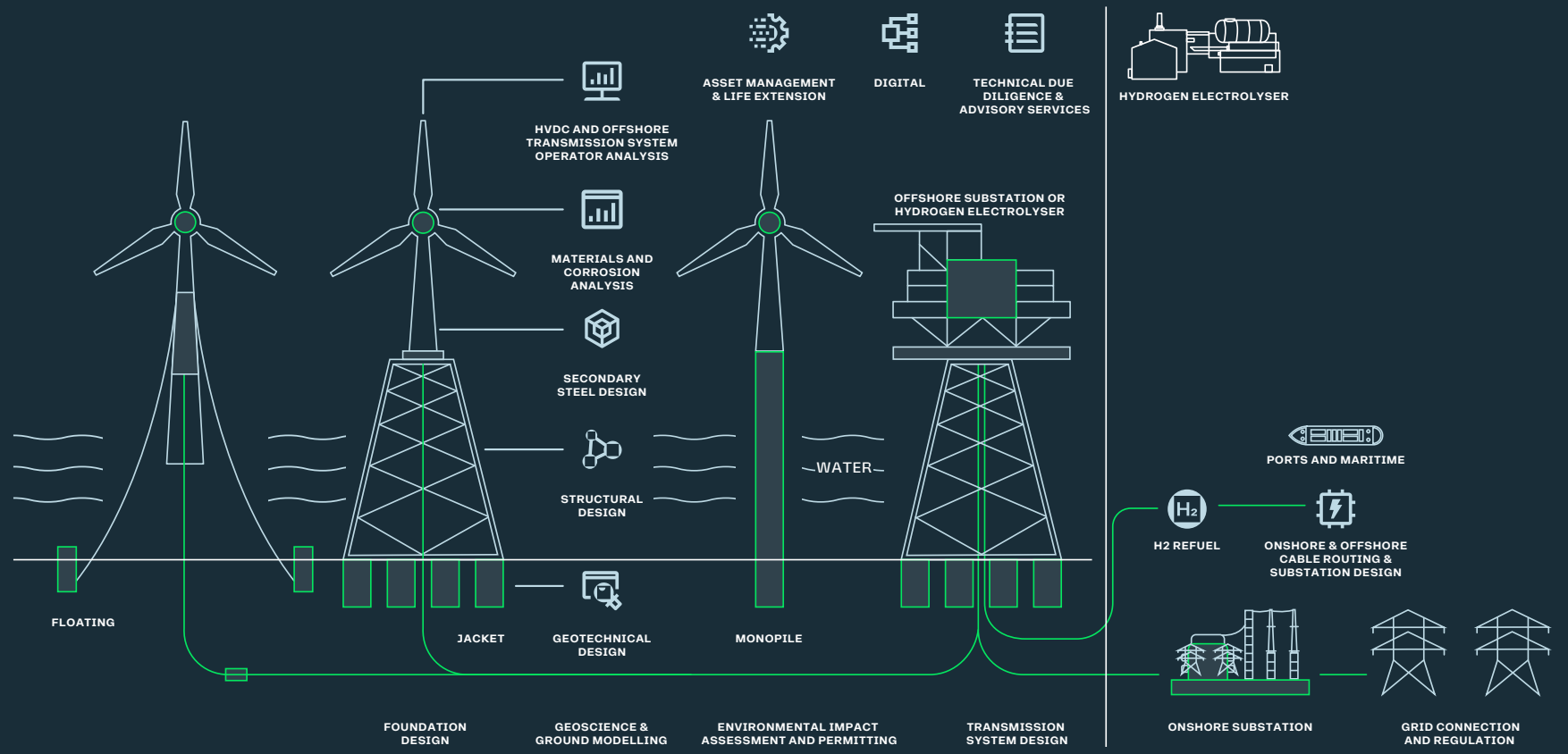
Engineering Net Zero

OUR SERVICES

AtkinsRéalis is a leading engineering, design, project management and environmental consultancy, with extensive experience in providing tailored solutions to the offshore wind industry. Our expertise covers the entire lifecycle of offshore wind projects, and our flexibility ensures we deliver against our client's requirements.

With cross-sector expertise, we bring lessons learned from other sectors to mitigate the risks associated with offshore wind project delivery and ensure the right decisions are made at the right time. Our capabilities focus on:

- Environmental services
- Geoscience and geotechnical engineering
- Ports design
- Offshore substation and wind turbine generator foundations design
- Materials and corrosion
- Electrical design and grid connections (as detailed in our Transmission and Distribution brochure)
- Asset management of operational assets including operational strategy, life extension and repowering
- Project management
- Digital services



OUR SERVICES

ENVIRONMENTAL SERVICES

We believe that offshore wind farms can be delivered without significant damage being caused to the environment if the right approach is taken and the correct assessments are carried out before project planning and delivery begins. We help our clients understand the full range of environmental challenges so they can develop an effective strategy and make informed investment and project decisions to ensure projects are delivered in a sustainable way. By putting the environment at the heart of everything we do, we are working towards a more sustainable energy future, mitigating climate change, protecting habitats and meeting current and future net zero government targets.

Our range of services include:

- Biodiversity Net Gain
- Natural capital audits
- Social value
- Policy and legislation advisory services
- Impact assessments
- Next Generation Environmental Impact Assessment
- Feasibility studies
- Data evaluation
- 3D modelling and data presentation
- Offsetting advisory services

GEOSCIENCE AND GEOTECHNICAL ENGINEERING

We enable our clients to make informed decisions around turbine placement, through a detailed understanding of the geotechnical data of each location. This helps to reduce issues further into project delivery that may result in increased costs being incurred, and therefore damaging the viability of the project overall. Our team of geotechnical experts have worked on some of the largest and most complex projects across the world. Combining this with expertise around gathering, analysing and understanding the geotechnical data, we provide our clients with a detailed understanding of the topography of the seabed, enabling faster decisions to be taken on where to place turbines and how to maximise the space available to deliver the highest KWhr output from the completed windfarm.

Services we provide:

- Desk studies
- Integrated 3D ground modelling utilising geotechnical and geophysical data
- Data integrity interrogation
- On-shore civil and geotechnical design
- Site investigation and management
- Site supervision / client representation
- Onshore and offshore substation design
- Concept optioneering (foundations)
- FEED and detailed design (in collaboration with AtkinsRéalis' structural engineers)
- Pile driving
- Cable burial route assessments
- Trenchability assessments
- Technical specifications

PORTS AND MARITIME

To develop and deliver cost effective, sustainable offshore wind farms, the ports and surrounding infrastructure are critical. This is not only during the construction phase, but throughout its entire lifecycle. AtkinsRéalis believe that in order for the UK to deliver against its offshore wind energy generation targets, the development of supporting infrastructure that enables the building and deployment of turbines requires significant acceleration.

Drawing on our world-leading ports and infrastructure engineering knowledge, we bring together a team based around each specific client project to ensure they are getting the right people at the right time to provide timely, high added-value advisory design and engineering services. By working closely with our clients, we look to understand their drivers and objectives before taking a holistic view of the area and developing a series of options for the client to make informed investment decisions.

OUR SERVICES

STRUCTURAL DESIGN

AtkinsRéalis has designed in excess of 370 foundations for the offshore wind industry ranging from jackets in water depths up to 55 meters, XL monopiles in excess of 7 meters diameter and jacket design with drilled and grouted piles. We have worked for a range of clients including developers, fabricators and installers which has helped build an understanding of the drivers and constraints in the market and a robust knowledge base that is fully utilised in the holistic assessment of offshore wind farms.

AtkinsRéalis has worked on various design projects, including concept, Front End Engineering Design (FEED), and detailed design for offshore substations on jacket and monopile substructures. AtkinsRéalis' breadth of expertise covers all aspects of Offshore Sub Station (OSS) design, and we are a leader in the engineering design of offshore substations for both traditional offshore substations and Offshore Transmission Modules (OTM). Our long-standing relationship with major offshore wind power developers demonstrates our commitment to drive down offshore wind costs while maintaining the highest design standards.

Services we provide:

- Full structural design of monopile or jacket foundations for wind turbine generators (WTGs)
- Structural ultimate and fatigue analyses (including the full in-place, load-out, transportation and lift analyses for all structures)
- Global and advanced local Finite Element Analysis (FEA) modelling.
- Pile grouted connection design and substantiation
- Secondary Steel design and substantiation
- Ship impact, on-bottom stability and redundancy
- Substantiation to DNV codes
- Full design of OSS foundations and top-side including:
  - Structural and architectural design
  - Mechanical piping and layout
  - HAZID and safety engineering
  - Utilities, electrical and instrumentation design

MATERIALS AND CORROSION

AtkinsRéalis has extensive experience in providing solutions to corrosion related issues affecting offshore assets. We have a proven track record of designing and implementing reliable and commercially attractive corrosion protection solutions for new assets and performing analyses and assessments to help address emergent issues.

Our clients are external companies and asset owners, as well as other businesses and project teams within the broader AtkinsRéalis Group. We offer knowledge and experience in delivering code-compliant designs to manage the corrosion of the offshore asset throughout its entire life.

We also provide advice and solutions for a wide range of corrosion-related problems that potentially threaten the integrity of offshore assets. We ultimately provide solutions that contribute to maximising the safe and economical energy generation of new and existing offshore assets.

Services we provide:

- Concept, FEED and detailed design of systems for corrosion protection
- Design to DNV GL, ISO and NORSOK codes
- Design and assessment of Cathodic Protection (CP) systems
- Material selection
- Fabrication and protective coatings specifications
- Corrosion assessment based on corrosion coupon testing and visual inspection
- Assessments of risks to structural integrity and safety of personnel from corrosion and/or corrosion protection measures
- Management of Biofouling; assessment and prevention of risks from Microbiologically-Influenced Corrosion (MIC)

OUR SERVICES

ASSET MANAGEMENT AND LIFE EXTENSION

AtkinsRéalis has extensive experience in supporting clients to tackle offshore asset integrity issues from evaluation, to option derivation, design and support through to implementation. Our services cover a wide range of unique challenges for which we have successfully built a strong reputation over the last decade. Our work has allowed clients to continue asset operation and maximise value from their investments.

Asset management is a key area for AtkinsRéalis and our mission is to support owners in optimising their assets using data driven decisions. Our key goals are to:

- Reduce operational risk
- Reduce OPEX
- Extend the life of assets
- Increase revenue generation

Services we provide to support with that mission are:

- Corrosion Management
- Foundation Load Monitoring
- Structural Integrity Management Strategy
- Remedial Solutions and Failure Investigation
- Safety Case, Risk Assessment and Environmental Issues
- Reliability, Availability, Maintenance and Safety
- Data Management and Predictive Modelling

ELECTRICAL ENGINEERING AND GRID CONNECTIONS

AtkinsRéalis have a wealth of power systems analysis and design experience that we have applied to our work in the offshore wind arena. We have supported clients in the FFED development of wind farm cable arrays, offshore substations (HV primary plant, LV operational design, and P&C aspects), rating requirements for export cable systems, and onshore OFTO substations.

AtkinsRéalis have used our extensive experience in environmental and planning requirements to also supported the development of these offshore connections through assessment of cable landing points and routing.

In addition, AtkinsRéalis have extensive experience in UK, and other European countries, grid code compliance and technical performance requirements. We have previously supported clients in ensuring their developments are able to pass the stringent compliance assessments required to allow commercial operations to commence and worked with them to assess and resolve any ongoing performance and compliance issues. In addition we have significant experience supporting onshore transmission network operators with their assets and have successfully applied this knowledge to help our offshore clients any additional onshore substation requirements (e.g. harmonic filter etc). Further information in the Transmission and Distribution brochure.

PROJECT MANAGEMENT AND DELIVERY

Strong project management is essential for any successful project. AtkinsRéalis's project management methodology uses a variety of dashboards, reporting and digital tools to deliver projects safely and efficiently. We pride ourselves on agile execution with integrated cross-functional teams delivering customized solutions that focus on maximising CAPEX/OPEX, solving pain points and delivering long-lasting sustainable projects.

DIGITAL

With an array of digital tools and approaches available across the vast breadth of AtkinsRéalis, our approach enables us to take complex data and translate it into easy-to-understand information for all involved, that results in faster, more accurate and 'right first time' project delivery outcomes. These tools enable clients to reduce the time between initial investment and subsequent return on investment by streamlining the early stages of a project enabling construction and operations to commence sooner and with reduced risk. These digital approaches will often lead to faster planning and consent processes by demonstrating the benefits of the project to the region in easy-to-understand information that reduces public objections and secures consent faster and easier.

OUR EXPERIENCE AND CAPABILITIES

Delivered by our dedicated, in-house, low carbon technology specialists, our project and technical staff support our clients throughout the project lifecycle in the development, engineering, design, construction, operation and decommissioning of wind turbines.

LES EOLIENNES SUR MER WIND FARMS

AtkinsRéalis developed the concept designs for 4-legged jackets for Le Treport Wind Farm and 3-legged jackets for Noirmoutier Wind Farm considering three clusters each.

We have served as the subsurface technical authority since 2013 and owner's engineer since 2017.

- This work was undertaken to support Van Oord with an EPCI bid which included provision of Design Basis Part C, design briefs, drawings, substantiation reports, design reports as well as the O&M and decommissioning strategies. Services included:
- Concept design development for the foundations and all secondary steel work
- Cathodic protection design and coating specification
- Geotechnical engineering

Key success factors and success factors

AtkinsRéalis have successfully delivered six concept designs and all associated reports within a two-month period which relied significantly on AtkinsRéalis' experience and judgements which was positively received by Van Oord.

AtkinsRéalis have also delivered substantiation for ULS and FLS conditions with recommendations for the FEED stage on further analysis options to utilise in the substantiation of the design. This work also delivered added value considering:

- Specific recommended design optimisation options ranging from structural improvements (to reduce steel weight/fabrication costs) to corrosion management as well as use of digital services to aid with fabrication verification against design
- Alternative options which included a 30-year life (instead of 25), reduced interface level (tower-TP), moving switchgear equipment as well as a pile diameter beyond 2.2m limit
- O&M and Decommissioning Philosophy as well as risk assessments

DUDGEON OFFSHORE WIND FARM

AtkinsRéalis carried out a concept design study for the foundations of 67 6MW wind turbines.

Concept designs were developed for monopile foundations as well as 3-leg and 4-leg jacket designs with suction buckets due to uncertainty in achievable pile capacity at this site. The conceptual design entailed Ultimate Limit State (ULS) and Fatigue Limit State (FLS) checks for preliminary sizing and costing to evaluate feasibility considering installation costs. The study confirmed that the monopile is the most feasible option noting they were larger than any designed before (>7m diameter) and installed at water depths up to ~36m (deepest at the time). AtkinsRéalis progressed the design through FEED and detail design of the monopiles and transition pieces as well as post fabrication, transport and installation management support.

In addition to the structural design, AtkinsRéalis provided geotechnical analysis, electrical design, cathodic protection design and interface management with the fabricators and installation contractors.

Key success factors and success factors

- AtkinsRéalis completed extensive geotechnical sizing of monopiles and assessment of drivability to consider installation feasibility, informing on the risk of pile free fall and enabling structural design of the monopile considering buckling and fatigue damage.
- Collaborative working between Geotechnical and Primary Steel teams to reduce pile lengths whilst maintaining structures' natural frequencies within target range.
- Early engagement with fabricator, and collaborative working to optimise design for fabrication.

BEATRICE OFFSHORE WIND FARM

Beatrice Offshore Wind Farm is in the Outer Moray Firth, Scotland and comprises 84 wind turbines and was designed to generate up to 588MW.

For our client SSE Renewables, and latterly Seaway Heavy Lifting, AtkinsRéalis undertook the following work scope:

- Phased ground modelling and offshore site investigation surveys from concept through to FEED and detailed design
- Integration and interpretation of geophysical, geotechnical and geological data, leading to the development of a 3D ground model for the site and production of engineering terrain unit mapping.
- Soil parameter interpretation and geotechnical foundation design (Concept, FEED and Detailed Design)
- Jacket pile design (geotechnical and structural)
- Secondary and tertiary steel design
- Materials and corrosion design

AtkinsRéalis successfully delivered this project on all fronts, on time and under budget. The glacial ground conditions vary between 38m and 55m water depth, making this the world's deepest fixed bottom foundation wind farm.

TRITON KNOLL OFFSHORE WIND FARM

Triton Knoll is within the Greater Wash strategic area, located off the east coast of England, approximately 20 miles from Lincolnshire.

It is one of three 'Round Two' strategic areas around the coast of Great Britain, which were released for offshore wind development by The Crown Estate and the Government in 2003. This included 90 turbines and two offshore substations.

AtkinsRéalis provided:

- Site investigation and ground modelling
- Site clustering and geotechnical analysis
- Scour protection design
- Cathodic protection design and coating specification
- Geotechnical detailed design and soil structure interaction

Key benefits and success factors:

- The Wind Turbine Generator Foundation structure was ~ 20% lighter than industry standard.
- The geotechnical design was realised using data from the PISA Joint Industry Project (JIP);
- AtkinsRéalis developed calibrated numerical models using FLAC 3-D and modifications to standard p-y curves for practical design. These enabled a better representation of soil response and more reliable and efficient monopile designs.

SAINT BRIEUC WIND FARM

Due to become operational in 2023, the Saint-Brieuc Wind Farm will have a total installed capacity of 496MW. Located 16km off the coast of Brittany, France, the site will cover a surface area of 75km².

For client Ailes Marines AtkinsRéalis role was to provide:

- 3D ground modelling work for foundations, cables and installation, including installation planning phase ground modelling, and land and expand ground modelling.
- Onshore pile load test scoping and interpretation to support the design of drilled and grouted piles in rock.
- FEED and detailed geotechnical design, including turbine jacket substructures FEED and detailed design. This site required drilled and grouted piles in rock

Key benefits and success factors:

- AtkinsRéalis work on the St Brieuc offshore wind farm project was essential in understanding the complex ground conditions across the site with rock at shallow depths and mitigating the ground risks for our client.
- Due to the shallow bedrock, drilled and grouted piles are used for the jacket substructures foundations. Drilled and grouted piles in rock only have a very limited track records in an offshore wind context and assessing their performance under the onerous loading from WTG substructures was a significant challenge for the project. AtkinsRéalis designed, supervised and interpreted an onshore pile load test campaign aimed at assessing the axial capacity of drilled and grouted piles in rock under static and cyclic loading to enable a reliable and efficient design for the WTG and OSP foundations. The geotechnical aspects of the detailed design for jackets on piles to support 62 no 8MW WTGs were delivered on time and achieved certification.

THANET OFFSHORE WINDFARM – OFFSHORE TRANSMISSION ASSETS

AtkinsRéalis provided technical advice to Vattenfall helping them resolve issues associated with the Offshore Transmission assets (the connection between the wind farm and the onshore network) sold to Balfour Beatty.

AtkinsRéalis provided technical expertise in the following areas:

- Carried out a full audit of all technical documentation associated with the assets being transferred (offshore substation platform, subsea and onshore cables and onshore substation).
- Carried out technical audits on the SCADA system, fire suppression system and metering.
- Provided technical analysis and advice regarding key technical performance and compliance issues associated with the assets being transferred. This included: the onshore export cables and the dynamic reactive compensation assets (Static VAR Compensator) operating regime, including the review of failure reports produced by the OEM contractors.
- A review of the Grid Code compliance test results and reports for the SVC and wind farm.
- A technical review of the Grid Code compliance pack before submission to NGET.
- Review of technical documentation associated with the implementation of a Distributed Temperature Sensors (DTS) system for the export cables and for a Dynamic System Monitoring system (DSM).
- Review of risk assessment and method statements for work undertaken on site.

As with all tasks undertaken on this site, AtkinsRéalis were responsible for ensuring all the necessary documentation is provided by the various contractors. This was to check for its suitability before the asset/repair was handed over to the OFTO operator.

MORAY OFFSHORE WINDFARM

The Moray Firth wind farm project in the North of Scotland consisted of several arrays of wind turbines connected to an Offshore substation platform via 33kV undersea cable.

An Onshore platform then exported power to an Onshore substation and grid interface point through 220kV undersea and underground cable. The proposed substations were 500MVA at 275(400)/220kV onshore and 220/33kV offshore. AtkinsRéalis provided electrical system design and management consultancy support in the specification, contracting and design management of the export connection part of the project.

AtkinsRéalis provided support across 3 key areas: Offshore Transmission System Operator (OFTO) works - 275/220kV Onshore Substation (With potential for upgrade to 400/220kV with minimal works); 220/33kV Offshore Substation Platform; 220kV Offshore export cables including onshore/ offshore cable junction point.

AtkinsRéalis developed a comprehensive FEED design package including Basis of Design, primary and secondary drawings, data sheets and comprehensive specifications for all major equipment to be installed.

These deliverables included:

- Geo-Environmental Desk-top Study
- (400kV)275/220kV Onshore GIS Substation FEED design
- 220/33kV Offshore GIS Substation Auxiliary supply design
- Substation plant specifications (400)275kV, 33kV
- Protection & Control design for both Substations.
- LV systems design and specification
- Subsea 220kV HVAC Export Cable Ratings
- Onshore Export Cable calculations & specification
- 33kV Array Cable design & specification.
- WTG 33kV Switchgear specification.
- 3D Model - Onshore Substation

A complete design package to the required UK and Transmission Network Operator standards was handed over to the Client.

OUR LOW CARBON TRACK RECORD

Over 100 years ago we made our mark while the energy sector was undergoing major transformation.

Today, as a new energy paradigm emerges, our clients recognise us for our sustainable project execution and tangible contributions to improving people's lives around the world.

Our teams are based in the UK, Europe, Middle East, Canada and the United States.

Across the globe AtkinsRéalis has 36,000 engineering and project management staff with over 3,000 working on low carbon energy projects. Our experts deliver offshore wind, hydroelectric, carbon capture, hydrogen and power distribution projects.

LEADING INDUSTRY BY EXAMPLE

TRANSMISSION & DISTRIBUTION

We work with National Grid, Office of Gas and Electricity Markets (OfGEM), and Energy System Operators (ESOs) to support the transformation of the grid to support increased decentralisation of supply from renewables. We provide services in network planning and development, power system modelling, High Voltage and Low Voltage substation Front End Engineering Design and detailed design and support to utility regulation.

mayure.daby@atkinsrealis.com

CARBON CAPTURE

We delivered SaskPower's groundbreaking Integrated Carbon Capture and Utilisation initiative in Saskatchewan, Canada. We have completed feasibility, concept and FEED studies for carbon capture projects for Drax, Energy Technologies Institute, SSE, National Grid, the Department for Business Energy and Industrial Strategy (BEIS) and the International Energy Agency. AtkinsRéalis is the owner's engineer for the pioneering Whitetail Clean Energy project on Teesside in the UK.

adekola.lawal@atkinsrealis.com

ENERGY STORAGE

Our energy storage team specializes in the subsurface storage of hydrocarbons and clean energy products such as hydrogen and compressed air. As owner's engineer for Nord West Kavernengesellschaft (NWKG), we provided technical and project management services across NWKG's operational assets. We are a long-term delivery partner to SSE Gas Storage and have advised the Energy Technologies Institute on salt cavern behavior when operated in a hydrogen storage system.

christopher.mcmichael@atkinsrealis.com

INDUSTRIAL DECARBONISATION

We support energy intensive industries to develop their roadmaps to Net Zero through specialist engineering advice. We assist our clients in understanding their current energy demands and greenhouse gas emissions and utilise our in-house tools, methodologies and expertise to identify viable technology interventions to achieve targeted levels of emissions reductions.

tom.jumar@atkinsrealis.com

NUCLEAR

We work alongside our clients to provide unparalleled support throughout the entirety of the nuclear lifecycle. We are working on projects to realise the benefits of nuclear generation in a low carbon energy system, including for hydrogen generation and direct air carbon capture. We are also heavily involved in the future of nuclear power developing small modular reactors (SMRs) and fusion projects.

james.goodenough@atkinsrealis.com

WIND & RENEWABLES

We work closely with our clients to support them through all stages of their projects. We have provided concept design and optioneering for TAQA, EDF and the Energy Technology Institute as well as being appointed owner's engineer for SSE. Our services cover hydrogen production from electricity, heat or reforming fossil fuels with carbon capture and storage as well as hydrogen storage and distribution networks.

tom.jumar@atkinsrealis.com

Engineering Net Zero

WORKING TOGETHER TO PROTECT TOMORROW

DIFFERENTIATORS BRINGING VALUE TO OUR CLIENTS

SUSTAINABLE DEVELOPMENT GOALS

WE ARE A MEMBER OF THE UN GLOBAL COMPACT, SIGNIFYING OUR COMMITMENT TO ADOPTING UNIVERSAL SUSTAINABILITY PRINCIPLES FOR THE GOOD OF ALL.

FULLY INTEGRATED GLOBAL TECHNOLOGY CENTRE

Our advanced global technology centre located in India is fully integrated with our day-to-day client delivery and held to the same highquality standards and systems across our organisation. Our focus on investing in the best tools and data processing capabilities and a team that has delivered hundreds of projects all over the world provides our clients the opportunity to achieve lower costs, and longer working hours – seamlessly.

LOCAL COMMUNITIES AND SUSTAINABLE DEVELOPMENT

We are committed to leaving behind a positive and sustainable legacy for the communities in which we work. We have a demonstrated track record of our commitment to community engagement, particularly in industrial work locations, delivering:

- Skills training and mentoring programs
- Involvement in our local community's organizations
- Traditional knowledge and community studies
- Assistance in education and health services
- Permitting and approvals.

NET ZERO CARBON. NET ZERO EXCUSES.

Engineering Net Zero™

engineeringnetzero.com

atkinsrealis.com

Rupert Green
Offshore & Renewables Market Lead, EMEA

Rupert.Green@atkinsrealis.com

+44(0)7900 675 106

AtkinsRéalis