

**David Reid and
Jenny Darnell,
NOV, USA,**
explain how
the company is
learning from
the past to forge
the way for the
future energy
industry.

While oil and gas will remain critical to powering the global economy, the transition to cleaner, carbon-neutral energy sources is an opportunity to improve the economic competitiveness and affordability of renewable energy. As an industry leader, NOV was inspired to help move toward a more sustainable future. NOV faced that challenge head-on by evolving to include renewable energy initiatives such as wind, solar, geothermal, carbon capture, and more.

NOV's goal is simple: rejuvenate and improve upon what the company already has, repurpose technology and equipment traditionally used in oil and gas operations, and reposition its skills and knowledge in oil and gas into the renewable space – all in the name of a more sustainable future.

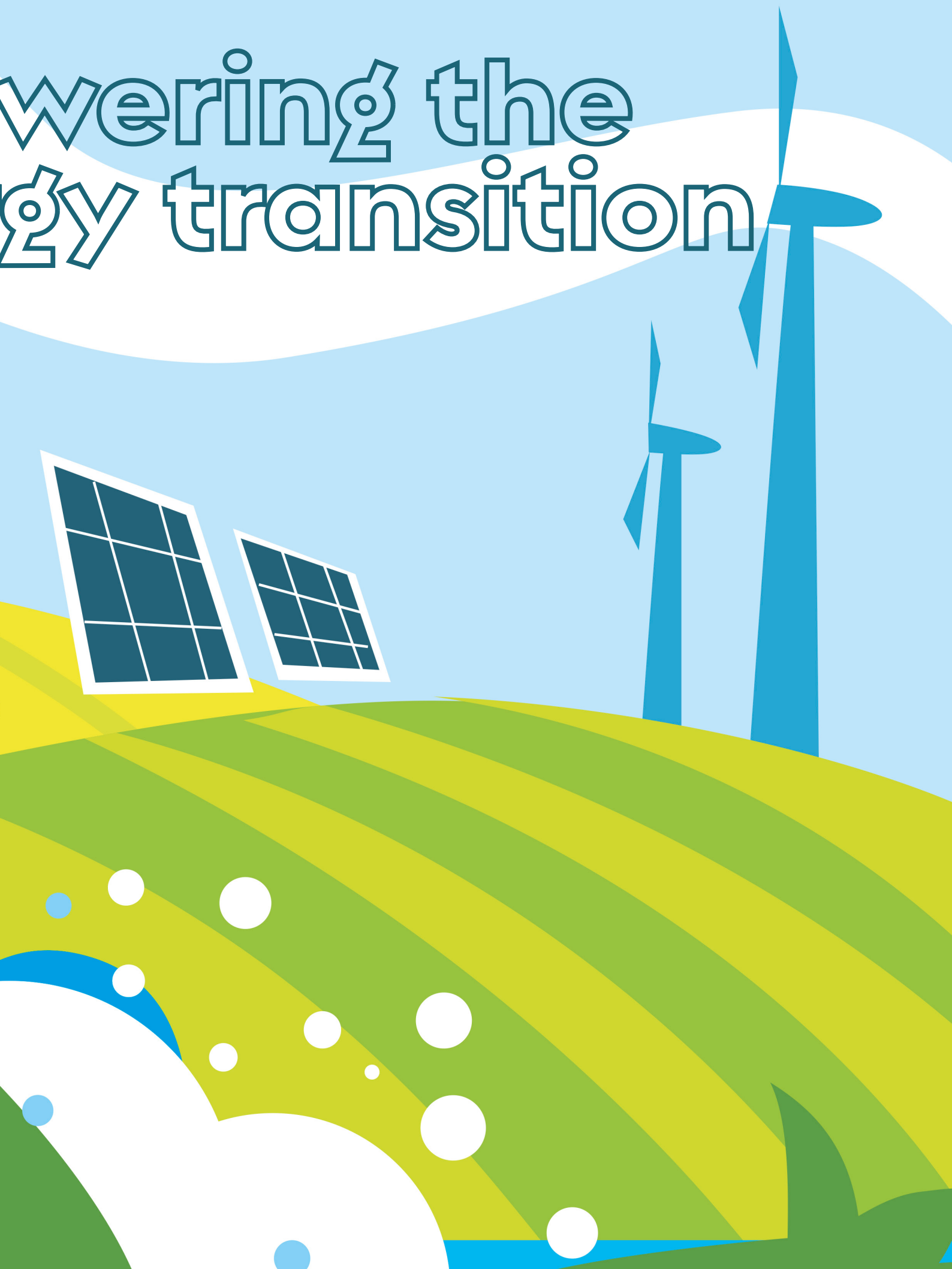
"We enable energy for life," said Clay C. Williams, NOV's Chairman, President, and CEO. "Making energy accessible, affordable, attainable, and sustainable is only one part of our story. We are a diverse company with people who are personally invested in the outcomes of our environment and communities because we live here, too."

Whether from traditional oil and gas or renewable sources, NOV facilitates access to reliable, affordable, and clean energy around the world.

Innovating with a purpose

Purposeful innovation shapes the culture at NOV. Every role, project, and product begins and ends with a purpose and an idea. As the energy industry has evolved, NOV has shifted its focus to develop what its customers need to be successful. It has

Powering the Energy transition



never been about the fuel source, but about the process that delivered the products and services the world needed at the time. NOV's goal has always been to help its customers make energy more efficient, affordable, and accessible so that in the end, the people win.

"We have a decades-long history of adapting to a rapidly changing world, but we are very familiar with being the change ourselves," said Rium Johnson, NOV's Chief Health, Safety, Security, and Environmental Officer. "That's why we are not only focusing on designing products that help make a better world, but on the sustainability of how we build them."

From decades of innovation and success in oil and gas operations, to major developments in the offshore wind market, to the development of a fit-for-purpose, post-combustion carbon capture system design, to ground-breaking drill bits and motors shattering geothermal records, NOV is an expert in energy – no matter the source.

Rejuvenating the global energy industry with purpose-built technologies

NOV has always been at the forefront of solving the complex challenges of the energy industry. The industry depends on the company's expertise and technology to continually improve oilfield operations and assist in efforts to advance the energy transition toward a more sustainable future. NOV technologies ushered in the shale revolution much like they are paving the way for the energy transition.

"The truth is that there is a moral case for fossil fuels, and a moral case for alternative energies," said David Reid, NOV's Chief Marketing Officer and Chief Technology Officer. "There is an assumption by some people that those who are pro-energy transition are anti-oil and anti-gas. But the truth is: we are all interested in changing the world and making it a better place."

A good example of purpose-built technology is NOV's Ideal™ eFrac fleet which has augmented the environmental outlook of hydraulic fracturing operations. By shifting from diesel-powered to electric-powered, the Ideal eFrac system is designed to reduce emissions and significantly increase power density. Fewer pumps are needed onsite to reach the same



Figure 1. Ideal™ eFrac.

operational goals, reducing road traffic and contributing to an overall lower carbon emission for the operation.

The company also knows that you do not have to catch what you do not release. NOV's engineering teams study the utility of each of their designs to minimise connections and potential leak points, reducing emissions on equipment in even the most remote locations. In the future, NOV will have the tools to collect data to predict and mitigate these types of emissions even further.

Repurposing core competencies to support the energy transition

As the energy industry evolves, many are ready to shift to strictly clean, carbon-neutral energy – a step the industry is not ready for based on available infrastructure, supply chain challenges, and technological constraints. NOV is here to help move that transition along by repurposing existing technology to support renewable energies, while also maintaining its position as a leading supplier of technical solutions to the oilfield.

"The reality is that the world has low-cost energy that some applications and people must have in the meantime," said Reid. "NOV is helping make that energy and its infrastructure even more affordable and accessible. At the same time, we are reaching for renewable energy – helping to generate it more efficiently, affordably, safely, and sustainably – as soon as possible."

The transferability of NOV's technology to support renewable energies is almost unmatched and supports innovation, service, and creativity across the company. NOV jack-up rigs have been used for oil exploration and production for decades, and the company is supporting the offshore wind market with proven and new designs for wind turbine installation vessels. Drill pipe, drilling motors, and drill bits used in oil and gas wells are capable of boring holes for geothermal operations. Pumps and grinders designed for processing hydrocarbons and sewage work just as well for biogas applications.

NOV is seeing, in real-time, how many of its products, services, and technologies can easily be repurposed for use in the renewable space.

Addressing the challenges of an evolving industry

Industry partners and customers actively involved in the energy transition often report hesitations associated with the cost and unpredictable timelines of renewable energy projects. NOV is able to guide its partners through renewable projects with confidence.

The company builds massive structures and drilling rigs that operate with precision in some of the world's most remote and extreme environments. NOV is working better to eliminate the complexity with integrated supply that significantly reduces execution risk.

The company supports its customers' transition to renewable energy in many ways: wind; carbon capture, utilisation, and storage (CCUS); and geothermal, among others.

Offshore wind – fixed and floating

Globally, a considerable portion of the world's installed offshore wind power has been constructed with vessels and equipment designed by BLM and GustoMSC, two groups within the NOV Rig Technologies segment. Since 2002, GustoMSC jack-ups with integrated jacking systems and cranes have installed more than 4000 turbines and foundations, providing the company with the necessary operational intelligence to further optimise its solutions for the wind turbine installation market. NOV's solutions are designed to meet the tailored demands of each unique wind farm, accounting for varying water depths, budgets, and logistics.

NOV is a market leader in providing offshore wind installation technologies, with purchase orders in hand for two GustoMSC NG-20000X self-propelled wind turbine installation jack-up vessels – adaptations of its jack-up vessels used in offshore oil and gas rigs. Each holds five sets of 20+ W turbines and are modifiable for operation with LNG or ammonia fuels.

Carbon capture, utilisation, and storage

NOV has recently announced the availability of a carbon capture system, engineered, designed, and fully executed by NOV. The post-combustion facility design combines the proven amine-based technology with the process expertise gleaned

over three decades from NOV's teams after completing 400 gas processing projects worldwide. The company has also established partnerships with critical technology partners to provide flexibility to match the needs of any emitting facility.

In addition to its carbon capture technology, NOV's fibre glass pipe has been used in CO₂ injection lines, high-pressure and low-pressure pipelines, ductwork, and other challenging carbon capture and transportation applications for more than 70 years. TK Coatings™ have successfully been used in the storage and transportation of corrosive carbon emissions, preventing corrosion and extending tubular life. Beyond its expansive drilling capabilities, NOV offers offshore offloading and injection with CO₂ static and dynamic high-pressure flexible pipe and turret mooring systems.

Geothermal solutions

NOV leverages its experience in the oil and gas industry to offer customers the entire geothermal package. With decades of experience in the geothermal space, the company has helped customers complete geothermal wells efficiently and cost-effectively through its complete portfolio of geothermal offerings, including Phoenix™ series PDC drill bits, drilling motors, TK™ Corrosion Control, liner hanger systems, dozens of land drilling rigs, and more.

In an industry historically dominated by roller cone (RC) drill bits, NOV's ReedHycalog is striving to lead the way in fixed cutter polycrystalline diamond compact (PDC) bits, specifically designed for geothermal applications. Where previous legacy fixed cutter PDC bits could not survive or compete in the harsh environments of geothermal drilling, ReedHycalog's new Phoenix series PDC drill bits are custom designed to enhance drilling efficiency in hard rock formations. To date, ReedHycalog™ drill bits have drilled some of the longest and fastest intervals in geothermal wells around the world, and at the lowest cost per foot drilled.

NOV's Vector™ motors have displayed extreme durability drilling through hard, abrasive, and fractured basalt in Iceland and withstood and succeeded in the hottest wells of Central Europe, outperforming other failed motors on the market.

Since 2003, Tuboscope's proven line of TK Corrosion Control products have been used in a variety of geothermal projects throughout the Netherlands, Germany, and France. In addition to remarkable corrosion protection, Tube-Kote™ coatings prevent deposit mitigation and improve laminar flow efficiency. TK-Liner and TK-Ring II systems have successfully been deployed into geothermal producers in the Netherlands – the world's first application for these types of products in geothermal production wells. NOV's engineered system is proven to prevent corrosion, reduce heat loss, and minimise friction.

Repositioning today's technology for tomorrow's growth

While innovation is central to NOV and occurs at each of the company's locations, its dedicated research and



Figure 2. Phoenix™ series drill bits for geothermal applications.



Figure 3. Vector™ series drilling motors for geothermal applications.

development facilities are meant to inspire collaboration and ideation.

Just outside of Houston, in Navasota, Texas, US, is the Springett Technology Centre, where a dedicated renewables team works to assist pockets of teams across NOV with rapid prototyping and creative problem solving. Using 3D printers and leveraging a wide range of tools in their maker space, the renewables team supports democratising technology development across NOV.

Similarly, at the Flotta Environmental and Low Carbon Laboratory, located on Orkney Island in Scotland, NOV's teams prioritise research and development toward its carbon capture initiatives and other technologies to support the energy transition.

While NOV's areas of research and development are vast, a few include:

Biogas

NOV's range of solids handling, pumping, and mixing solutions, along with its composite piping, is already in use in biogas projects covering all kinds of waste including wastewater, landfill, and animal waste.

The company's current product development efforts and strategic partnerships in this space aim to solve recurring plant efficiency issues, high operational costs, and fragmented supply chains. Furthermore, NOV helps food and manufacturing companies leverage its expertise to proactively solve their waste compliance issues with growing regulations around disposals, circularity, and overall carbon footprint.

Hydrogen/ammonia

Designed for oil or condensates, NOV's subsea storage units (SSUs) are simple, flexible-bag structures that rest on the seafloor, each with a protective dome.

This eliminates problems with the emulsion layer and bacteria growth — yet saves on capital and operating costs. These are being repurposed for safe, easy subsea storage of hydrogen as ammonia.

NOV also offers its fibre glass system (FGS) competitive, lightweight, corrosion-resistant vessels as an alternative to austenitic stainless steel pressure vessels often used in traditional seawater applications. They are rated up to 290 psi (20 bar) and certified for transportation of ammonia.

Offshore floating wind

NOV partnered with the University of Maine to design and build the first US offshore floating wind composites prototypes. This market is currently in the precommercial development phase, but there is growth opportunity over the next decade, with rapid growth likely through 2030.

The company is also developing an efficient, highly automated fabrication process that employs the existing shipbuilding and offshore supply chain. This will lower costs and increase the scalability of commercial-size floating wind farms.



Figure 4. Tri-floater is a triangular, semi-submersible floating wind turbine foundation.

Improved crane technology on installation vessels will increase lifting capacity to 1764 t at a 131 ft (40 m) radius, with a 522 ft (159 m) main hook height above the main deck, allowing for the installation of the larger, new-generation wind turbines scheduled to be delivered in 2024 and beyond.

Floating wind turbines are key to unlocking the massive energy potential in global offshore deep water, where there are strong winds, and bottom-founded structures are not economically feasible. Other industry players are partnering with NOV to develop technologies to mitigate project execution risk for these structures.

For example, a tri-floater semi-submersible floating wind foundation is designed to require less steel and lower total project CAPEX but retains full quayside construction. Going deeper and larger than ever before, NOV's tri-floater design is ready for full scale offshore application and commercialisation where it can unlock massive energy potential. The tri-floater design provides the wind turbine foundation and is based on a proven semi-submersible technology developed for the offshore oil and gas industry.

Onshore wind

NOV is developing fit-for-purpose onshore wind tower erection equipment with a unique mobility system to provide superior lifting at taller heights and significantly improve the safety, reliability, and efficiency of tall wind tower installation.

Summary

When it comes to the energy transition, NOV is working closely with its customers to rejuvenate the resources the company already has, repurpose traditional oil and gas technologies, and reposition its skills and expertise to better serve today's industry and make renewable sources of energy more accessible and affordable for everyone.

As NOV learns from the past to shape the way forward, the company continues to power the industry that powers the world. 🌍