Global Corporate Venturing

Global Energy Council
Q3 2021

Harnessing the grid's power

Why energy sources are not the only game in town

Chevron

Global Energy Council

The electricity wars are back

Oil and gas quarterly data: deals, exits and funding

Risks and opportunities in nuclear, marine and mobility

Contents

The changes in the energy industry among producers, utilities and end consumers is creating a febrile ecosystem

James Mawson

$3.95bn

Investments by oil and gas majors in H1 2021

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Editorial

Rethinking energy

- **Upheaval unseen since the 19th century electricity wars**
- **The grid is as essential to net zero as energy sources**
- **Oil and gas groups are leading the charge**

By James Mawson
Editor-in-chief

A utility is defined as an organisation supplying the community with electricity, gas, water, or sewerage. While this list could probably now stretch to the internet and telecommunications, safe, efficient and reliable power (the rate at which energy is transferred) underpins society.

But how this energy is produced, transferred and used as electricity is now facing an additional question over its impact on the climate.

The climate change question affects the dynamic of producing more energy from the cheapest source to one of efficiency and carbon emissions. The electric grid is central to this rebalancing as the power can be sourced from renewables, such as solar, marine and wind turbines, and used in the same way as from gas, coal or nuclear plants. But unlike the existing infrastructure, renewables can be more widely distributed and often require storage, making the infrastructure vulnerable to attack.

May's flotation of Smart Wires, a US-based software provider to monetise grid capacity, alongside a raft of venture deals in the past year show the increased attention to the industry and utilities, such as National Grid, moving beyond pilots to deeper collaboration and partnerships.

The commercial relationships are as important as the equity funding and, after a long 10 to 20 years of promise, the signs are now encouraging that the renewable energy sources coming online will be transmitted to the customers who want to use them.

The changes in the energy industry among producers, utilities and end consumers is creating a febrile ecosystem and upheaval unseen since the original electricity wars more than a century ago, with greater venture investing from National Grid Partners among other utility peers, such as Acario Innovation from Tokyo Gas.

Oil and gas corporate venturing groups are some of the most active in rethinking their role and, as GCV Analytics uncovered on p. 13, participated in 77 deals over the first six months of this year, which were worth an estimated $3.95bn.

This rate of investment has picked up and combined with impact or sustainable investments by Amazon, Microsoft and other companies that are heavy energy users means there are promising times for people and the planet.

Feature

Electric grid girds itself for tense decades ahead

- > Generators and grid struggle to keep up with demand
- > Production, transmission and storage changing
- > Corporations increasing work with startups

By James Mawson
Editor-in-chief

The global electricity market is worth around $3 trillion a year and is only likely to get bigger. But if electricity power generation fails to keep up with demand securely and flexibly, what trade-offs need to be made for which devices gets what level of allocation?

These are some of the questions keeping politicians, regulators and the industry awake as people look to electrification to help resolve the global climate challenge.

But, first, the industry has to get through immediate challenges from another hot summer in the northern hemisphere and incipient threats from cyberattacks and solar storms that could put utilities out of business and leave consumers without power.

As the Economist noted, Pacific Gas & Electric (PG&E), whose customers suffered blackouts as wildfires raged in northern California in the past two years, may need to pay fines and legal-settlement fees of nearly $150m for alleged mishandling of those outages. Utilities in New York are threatened with $140m in penalties for alleged failures in responding to storms and demand spikes.

The International Energy Agency (IEA), a France-based oil watchdog, has mapped out a pathway that it

says is “narrow but still achievable” if the world is to cut carbon dioxide emissions to nearly zero and limit global warming to 1.5ºC, according to the Financial Times.

Total energy consumption in 2050 would be less than it is today because of improvements in efficiency, even though the global economy will be 40% larger than it is now.

Most of the energy would come from renewable sources, including nuclear, marine, solar and wind, but electricity use would also grow. Currently, about 20% of total energy consumption is electric, according to the IEA. By 2050, this would rise to 50% to meet the watchdog’s pathway to sustainability. Total capital investment in the energy sector would need to rise to $5 trillion a year, including investment in transmission and distribution grids of $820bn in 2030 from its current $260bn.

Electric utilities are tackling the issues in three ways: bringing on more production across a wider geographical area for transmission, using distributed energy storage and developing demand management software with customers to smooth peak periods.

The UK and US have generally spent less than their peers on research and development in these fields, according to IEA data supplied to the Economist, but relied on market forces and openness to new entrants to meet the changing environment.

First, in adding more power production capacity, utilities are especially targeting renewables, such as solar and wind, in the hope modular nuclear reactors might develop sufficiently to be used based on existing fission technology. Longer-term, even nuclear fusion could output more power than it consumes.

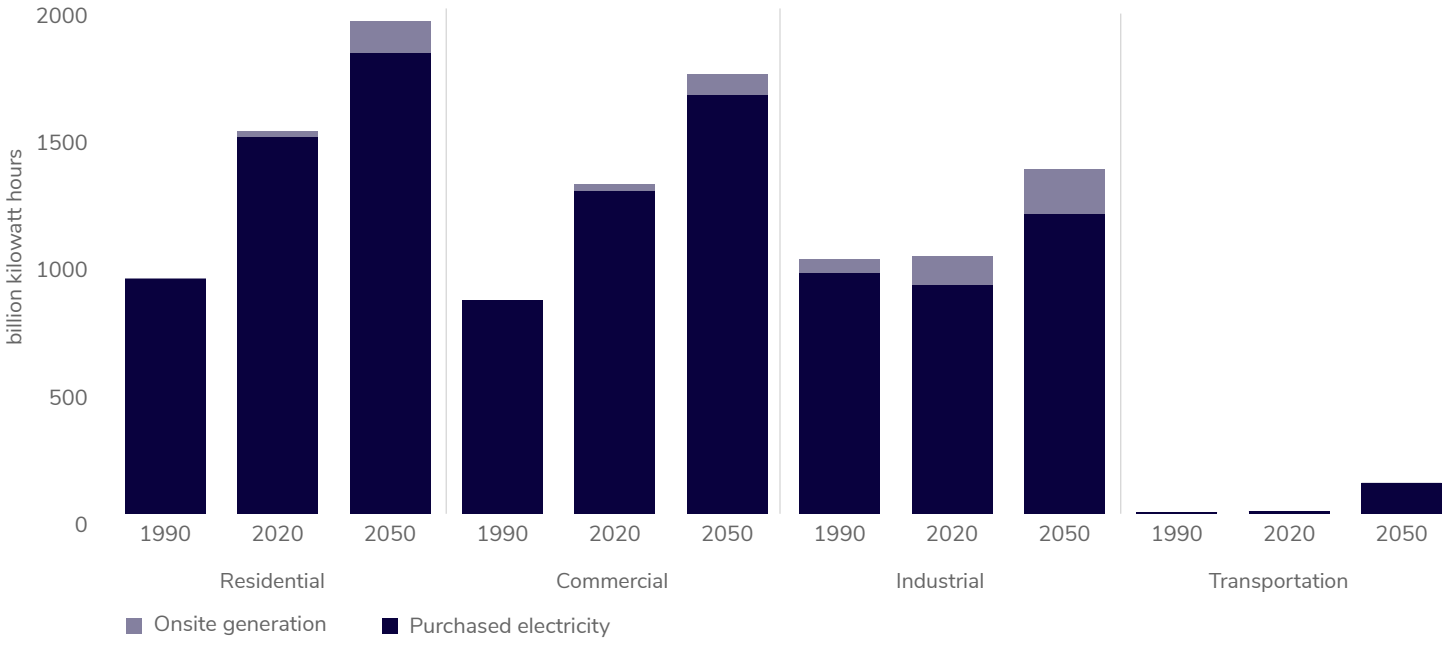
The US’s solar capacity has more than doubled in the past four years to 100 gigawatts (GW). But solar and wind power are intermittent sources that require a mix of long and short-duration energy storage mechanisms as well as “firm energy production”, such as natural gas with carbon capture technologies, to meet demand spikes and therefore reach net zero.

The Economist noted Southern California Edison, a utility serving the Los Angeles area, added 1.4GW of battery capacity last year. The state as a whole could have more than 2.8GW of storage on its grid before September, nearly five times more than in 2020. Similarly, Texas could have about 1.4GW, an eightfold increase.

But long-duration energy storage is proving complicated to achieve at suitable cost and efficiency, according to a recent paper in Nature by a Massachusetts Institute of Technology team (thanks to David Roberts’s Volts blog for the tip).

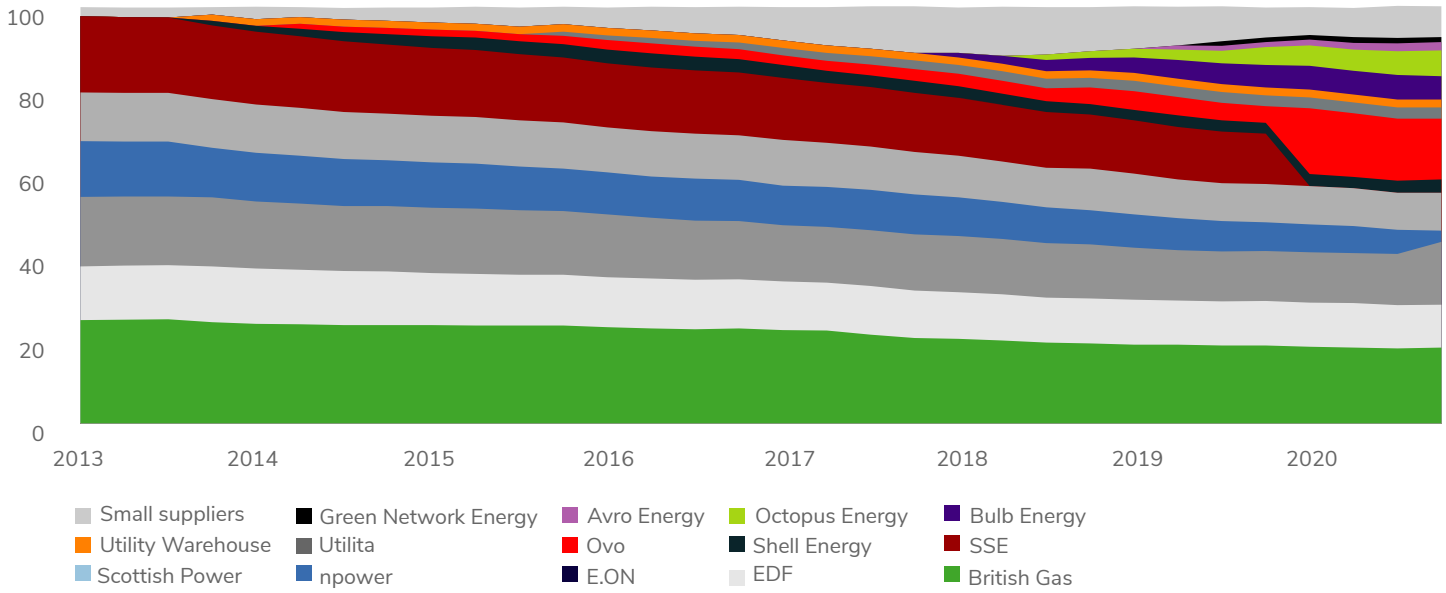
This pushes energy storage for the grid to shorter-term solutions, such as lithium-ion batteries used in electric vehicles. Tesla, an electric-car maker, has been secretly developing a 100-megawatt grid

US electricity use by end-use case



Source: US Energy Information Administration

Share of the British electricity supply market



*SSE sold its British business to OVO in January 2020. Source: Ofgem

battery project outside Houston (code-named Gambit), the Economist added.

Tesla intends to produce three terawatt-hours of battery capacity within a decade, more than 12 times the goal of Germany-based carmaker Volkswagen. Besides bringing the cost of cars down to $25,000, the batteries will also go towards Tesla's home-energy-storage business.

Tesla's home power storage device, along with people using their car batteries to store electricity, means power supply is closer to demand and offers potentially more resiliency to the grid.

The growth in electricity sales from vendors is lessened by significant growth in onsite generation in the residential, commercial, and industrial sectors. Installation of rooftop photovoltaic (PV) systems, primarily on residential and commercial buildings, and combined-heat-and-power systems in industrial and some commercial applications, will account for more than 7% of total electricity generation by 2050, almost doubling the 2020 share of onsite power generators, according to the US Energy Information Administration (EIA).

Managing demand

Using software to control and manage demand brings opportunities for startups. Venture capital firm Westly Group has 15 of the world's larger energy and auto companies as limited partners. Danny Cotter, a partner there, said when his firm backed WeaveGrid, which supplies vehicle power to the grid: "Every automotive manufacturer is moving all-electric. Energy utilities need a way to support this transition without significant impact to their infrastructure."

OhmConnect, a California-based startup backed by Alphabet gives away smart thermostats and aggregates the energy saved by remotely turning down thermostats and otherwise cutting demand when the grid nears overload. OhmConnect can then sell the electricity at peak prices to utilities and share the gains with consumers, while Leap creates a "virtual power plant" by aggregating output from distributed power.

In the UK, electricity tariffs allow customers using "vehicle-to-grid" chargers to top up their batteries when electricity consumption is low and sell it back at a profit when demand is higher. "Best performing customers are making a net benefit of over £500 a year and the extreme examples quite a bit beyond that," Conor Maher-McWilliams, head of flexibility at energy supplier Ovo's technology arm Kaluza, told the Financial Times.

UK-based Ovo and Octopus Energy are the biggest of the new energy suppliers whose "intelligent" software platforms now control more than a fifth of the market, according to the local regulator Ofgem, and are now attracting unicorn valuations.

In December, Japan-listed energy utility Tokyo Gas invested $200m in

Octopus Energy Group at a $2.1bn valuation and said it would license the UK company's technology platform, Kraken. Another utility, Australia-based Origin Energy, agreed in May last year to pay approximately $327m over four years for a 20% stake in Octopus.

In 2019, Japan-listed conglomerate Mitsubishi paid $256m for a 20% stake in Ovo Energy, which planned to use the funding as the basis for an expansion from Germany and its home country of the UK into markets such as France, Australia and Spain. In March, Ovo also announced an agreement with Australia-based AGL to provide access to the UK group's Kaluza technology platform.

A series of market reforms to improve competition in the UK household supply market since 2010 has helped Ovo and Octopus but other startups have been winnowed away.

Toby Ferenczi, director of Ovo's international business, told the FT the UK market had become a test bed for energy technologies because it was one of the first in the world to liberalise. "There has been a few companies like Ovo and Octopus that have had the time to build up the scale and the technology necessary… to enable this [energy] transition to happen."

Smoothing supply

But as well as internal liberalisation, countries and states are working on connecting their grids to smooth supplies.

The world's longest undersea electric cable was switched on this summer for testing. The 720km interconnector that will trade power between the UK and Norway, according to the FT.

The €2bn North Sea Link between the UK's National Grid and Norway's Statnett is due to begin formal operations in October, two years before a similar one between the UK and Denmark becomes operational. Even bigger interconnector projects, such as the Sun Cable between Australia and Singapore and the IceLink between Iceland and the UK, are under development.

Nigel Williams, construction director of the North Sea Link, told the FT the cable would allow the UK to "maximise the use of renewables and the extensive hydro power network in Norway", replacing electricity from fossil fuels.

The cable can carry as much as 1.4GW of power. On windy days when the UK has excess power from offshore wind, the cable will allow it to export power to Norway. Interconnectors supplied about 8% of UK power in 2019, a figure that could more than double to 19% within the next five years and could require 18GW of capacity by 2030.

Beyond the challenges of laying these cables under water, there are other hurdles to jump to deliver green power the cities where two-thirds of people are expected to live over the next few decades.

"There will be no renewables without networks," says Armando Martínez, who leads the grid business of Iberdrola, a big utility, told the Economist. The IEA said annual spending on electricity grids should more than triple by 2030.

One of the hardest challenges is disagreement over the siting of transmission lines from wind farms. In the US, for example, a transmission line must receive approval from each state it crosses and, in some states, approval from each county. This might slow US president Joe Biden's plan for decarbonisation of key sectors, such as power and agriculture.

Biden has been seeking $2.3 trillion from Congress for legislation that would go to electric charging stations, laying out an efficient new national electrical grid and capping abandoned oil and gas rigs and coal mines. This focus on spending and tax could see "$7.5bn on electric-vehicle infrastructure,

Octopus Energy is attracting investment from corporates

$73bn in overhauling the electrical grid, and nearly $50bn in making infrastructure resilient to climate change", according to the Wall Street Journal.

Ultimately, the White House wants 80% of retail power to come from zero-emission sources by 2030 and has promised $8bn to build transmission lines to help effect this.

But this is just a fraction of the expected $100bn in costs and so the government wants to crowd in private capital. In particular, the Clean Energy for America Act could consolidate current energy tax incentives into emissions-based provisions, available to all energy technologies such as transmission rather than just wind or solar.

The promised $8bn will go on high-voltage direct-current systems to connect offshore or midwestern wind plants by using infrastructure located along railroad and highway routes with the lines running underground. To get around planning permissions, Transportation Secretary Pete Buttigieg said the use of public highways and other transportat rights-of-way would speed siting and permitting of transmission lines.

The White House has also announced 22 shovel-ready transmission projects to spur $33bn in investment, create 600,000 jobs and help update much of the country's transmission infrastructure built in the 1950s and 1960s.

As former California governor Arnold Schwarzenegger once said: "You could have all the renewable energy in the world. But if you do not have the transmission lines, you have nothing."

In Vietnam the growth of solar power in recent years has

Solar power has overwhelmed transmission in Vietnam

overwhelmed the country's ability to transmit it to consumers, while in Germany disagreements over the transmission of clean energy between north and south has kept coal-fired plants open longer than expected. The national elections coming up this autumn will turn in part on which party is seen as more capable of carrying out the Energiewende, the policy to decarbonise Germany's energy consumption, according to the FT.

Coal and nuclear turbines provide this stability because they have large rotating masses that, connected to the grid, resist power fluctuations with "inertia", the FT noted. The German Greens' parliamentary energy spokesperson, Ingrid Nestle, acknowledged this problem. "The current government could have been more proactive in providing alternatives for grid security. Security of supply cannot be a question."

This is creating optimism for startups in transmission, such as Veir, which uses high temperature superconductors for electricity transmission and in March raised $10m from VCs Breakthrough Energy Ventures, Congruent Ventures and The Engine; WeaveGrid, a developer of software solutions for the scalable deployment of electric vehicles on the electric grid that in May raised $15m from Coatue, Breakthrough Energy Ventures and others; and Smart Wires, which in late 2019 raised $75m for its modular power flow control solutions to help electric utilities and grid operators.

Most recently, Mainspring Energy, a US-based power generation company, raised $95m in its series D round from corporations including Chevron Technology Ventures, AEP and Equinor.

In April, LineVision, a US-based provider of power line sensor technology, completed a $12.5m series B round that included National Grid Partners (NGP), the corporate venturing arm of electricity provider National Grid, while car parts maker Toyota Tsusho invested in electricity trading platform Digital Grid in 2019 and Schneider Electric's SE Ventures backed distributed grid software provider Autogrid the previous year.

To protect the infrastructure, NGP has also been investing in CNIGuard, an internet-of-things cloud sensor provider for utility-critical infrastructure.

And organisations are working more closely together through the Global Power System Consortium to speed progress toward a carbon-free power system by 2035.

Reliable, abundant energy has powered the world's growth and development. Its successful transition to a lower-carbon footprint will help underpin the next generation's challenges of responsible innovation.

Mobility

Tesla has shaken up carmakers over the past decade by bringing software and electrification into the mass market. Now the industry is looking at how electronics companies, such as US-listed Apple and Foxconn (the Taiwan-based maker of Apple's iPhones), might go even further in disrupting the incumbents.

Foxconn has assembled more than 1,200 member companies in its industry alliance, MIH, from software developers, such as Arm, to auto suppliers, including Germany-based plastics parts maker Konzelmann. It is very active in the space: setting up joint ventures with Chinese and Taiwanese carmakers; working on a partnership with Stellantis, the car group formed by the merger of FCA and PSA; reaching a co-operation agreement with Chinese electric vehicle company Byton; and signing a deal to manufacture for US electric vehicle designer Fisker from late 2023, according to the Financial Times.

Although EVs look similar from the outside and perform a similar function for consumers, they are different on the inside. The electronics companies targeting the automotive supply chain need to pick up new mechanical capabilities and entirely different safety concepts while carmakers (the original equipment manufacturers) and tier one suppliers have to learn software and electrical engineering.

The recalibration of the two industries is set to bring disruption on a grand scale, the FT noted. The electronics industry was valued at an estimated $2.2 trillion last year and employs up to 18 million people, according to the International Labour Organisation. The revenues of the carmakers alone were $2.2 trillion in 2019, according to S&P Global Market Intelligence, and the industry employed close to 14 million people in 2017, according to the UN Industrial Development Organisation.

Foxconn will manufacture for electric vehicle designer Fisker

Nuclear opportunities

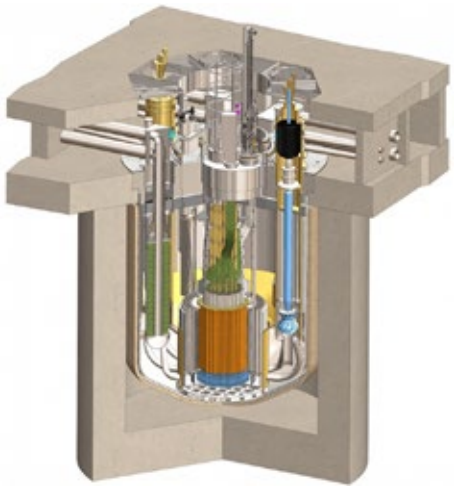
Most nuclear power plants are light-water reactors (LWRs), a technology that was developed in the US in the 1950s. They use ordinary water to cool the reactor core and to increase the intensity of the chain-reaction by moderating the speed of the neutrons that are emitted when uranium atoms split. These neutrons are more likely to go on to split more atoms in turn, the Economist's primer on the topic notes. But these LWRs are housed in big sites by the sea and cost billions to install, run and decommission.

Startups think there are better ways to tackle the challenge of developing effectively limitless, always-available, carbon-free power more. TerraPower, a US-based company founded in 2008 by Bill Gates, co-founder of software provider Microsoft, last month said it would build a demonstration of its Natrium reactor by 2028. The technology replaces the water with hot, liquid sodium to heat a tank of molten salt that acts as a giant battery.

Liquid sodium's high temperature – about 500°C – should make the reactor more efficient while being less corrosive to pipes than hot water and require only a fifth of the concrete required by an LWR of equivalent power. Sodium slightly damps the chain-reaction similar to water but if bubbles of vapour form in the coolant the damping effect would diminish and risk a dangerous feedback loop of rising temperatures and growing power output, the Economist said.

The molten-salt, energy-storage system uses a separate set of pipes to remove heat and produce electricity and so has more flexibility on when power is available, depending on price.

This is helpful to utilities managing power demand. But LWRs' long history means countries and companies are still keen to build them. A consortium led by Rolls-Royce is hoping to build a fleet of mini LWRs across the UK. The consortium, which also includes Jacobs and Laing O'Rourke, hopes to be the first "small modular reactor" (SMR) developer to put its design through the UK's nuclear regulatory assessment to develop a 470MW pilot plant by the early 2030s.



TerraPower's TWR-P reactor

UK prime minister Boris Johnson backed SMRs as part of his 10-point plan for a "green industrial revolution" last year. Proponents say they are a more affordable alternative to large-scale reactors such as the 3.2GW plant under construction at Hinkley Point C in Somerset, UK, which is expected to cost up to £23bn.

Rolls-Royce, which has been working on SMRs since 2015, expects the first five reactors to cost £2.2bn each, falling to £1.8bn for subsequent units. Tom Samson, chief executive of the Rolls-Royce-led consortium, told the FT: "The way we manufacture and assemble our power station brings down its cost to be comparable with offshore wind at around £50/MWh."

Others are looking to fuse atoms together rather than split them in order to release energy.

A fusion reactor uses heat and pressure on hydrogen atoms to break them into plasma before reforming as helium. There are two obvious issues – heating the hydrogen sufficiently takes energy and containing the super-hot plasma is difficult.

Stars, such as the Sun, use gravity to contain the plasma but magnets could theoretically work for a short amount of time while lasers could potentially heat the atoms to form plasma.

Different startups are taking varying approaches. Tokamak Energy, a UK startup, and General Fusion, a Canadian peer, plan to build their pilots at the UK Atomic Energy Authority's campus outside Oxford, also home to the Culham Centre for Fusion Energy, which operates the Joint European Torus – the world's largest working fusion reactor.

US-based Commonwealth Fusion Systems meanwhile will test over the next decade a set of magnets in a ring to form a reactor in Massachusetts.

The biggest project is under way in southern France, where a consortium of countries is building International Thermonuclear Experimental Reactor, a giant reactor that has, so far, cost billions of dollars to build and is running years behind its original schedule.

Sea opportunities

While solar and wind energy technologies have very successfully scaled up and raised billions in recent years to move from pilot to commercial scale, the marine power of the tides and waves to generate electricity has struggled to gain traction.

A high-profile £1.3bn tidal scheme in Swansea Bay, South Wales, which involved constructing a 9.5km breakwater, was rejected for funding by ministers in 2018 because of the cost.

Several corporate-backed startups seeking to harness wave power, such as UK-based Aquamarine Power and Pelamis, have collapsed but local peer Orbital Marine Power, which is based on the Orkney Islands, finally piloted a 2MW tidal energy turbine in April.

Although its capacity is modest compared with the latest offshore wind turbines, which are pushing 14MW, Orbital is one of 45 UK companies that make up the tidal and wave power sector hoping for a change in fortunes.

The UK Marine Energy Council said the sector could be worth £76bn by 2050 as governments turn to a range of clean energy sources. Despite the challenges, 124MW of tidal projects are ready to bid in the UK government's 2021 auction with a minimum 100MW commitment.

Tidal power developers have proposed guaranteed prices in the region of £250 a megawatt hour (MWh) for the auction but the Marine Energy Council said a price below £90/MWh was "eminently achievable" if the sector could deploy 1GW of projects and beyond.

Offshore wind developers have guaranteed prices as low as £39.65/MWh, while the UK government provided a £92.50/MWh guarantee to the Hinckley Point C nuclear power station's developers.

Oribtal Marine Power's O2 turbine being towed into place

Solar storms threaten

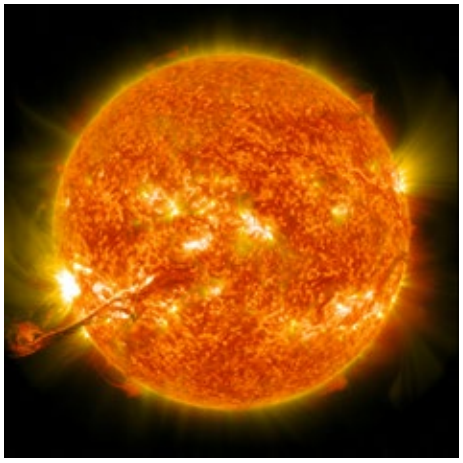
While invisible and harmless to anyone on the Earth's surface, the geomagnetic waves unleashed by solar storms – technically a coronal mass ejection - can cripple power grids.

The sun began a new 11-year cycle last year and is expected to peak in 2025. It could cost the US power industry $27bn to defend against it by integrating non-magnetic steel in transformers and installing more surge protectors in the grid.

A 2017 paper in the journal of the American Geophysical Union predicted blackouts caused by severe space weather could strike as much as 66% of the American population, with economic losses reaching a potential $41.5bn a day.

Within the past 15 years, the US and UK have built space weather forecasting centres that looks at the regular shift in polarity of the Sun's magnetic field and if plasma is being released into outer space and potentially triggering storms on Earth.

In 1859, a solar storm known as 'the Carrington Effect' electrified telegraph lines, setting offices alight in North America and Europe.



A coronal mass ejection, imaged by NASA

Attacking the grid

The Colonial Pipeline, the US's largest conduit for refined products, transporting almost half of the fuel consumed on the east coast, was closed in early May after its operator said it had fallen "victim to a cybersecurity attack".

It said that the attack involved the use of ransomware – hackers seize control of a victim's computer systems or data by installing illicit software, and only release the assets once payment is made.

Darkside, a Russian hacking group, has now attacked US oil and gas infrastructure four times in the past six months, according to cybercriminal investigation firm DarkTracer.

The attack on the pipeline, which spans more than 5,500 miles from Pasadena, Texas, to New Jersey and New York Harbor, comes amid growing concerns about cybersecurity vulnerabilities in North America's critical infrastructure after last year's SolarWinds attack.

In that incident, Russian hackers gained access to the US commerce and treasury departments, among other government agencies.

The number of ransomware attacks has exploded in recent years as criminals have used cryptocurrencies, such as bitcoin, to receive extortion payouts without being tracked, and have increasingly rented out their expertise to others.

While such attacks have tended to target corporate information technology systems, experts warn that instances targeting operational technology – the computerised systems that are used to control operations – are becoming more prevalent following the Russian attacks on three energy distribution companies in Ukraine in December 2015, the first known successful cyberattack on a power grid.

Hacking can render the grid unstable

Data

Oil and gas venturing in Q2 2021

- > O&G venturing up in both number and dollar terms
- > Long-term focus on cleantech and mobility continues
- > Q2 saw many exit transactions as well

By Kaloyan Andonov
Analyst

There has been quite a turnaround in the oil and gas industry. The year 2020 will go down in history as a very eventful one for black gold. West Texas Intermediate (WTI) oil prices stood at above $70 per barrel in the middle of the year but pressures on demand and supply made the price lower than $20 when pandemic reached the Western world and stay-at-home orders were imposed en masse. WTI futures contracts even entered negative territory in April which made for memorable headlines, though it was because of a technicality related to their physical delivery settlement. Since then, however, oil prices have moved considerably up and there is some uncertainty as to whether OPEC countries will agree to raise production, while oil inventories in the US are falling.

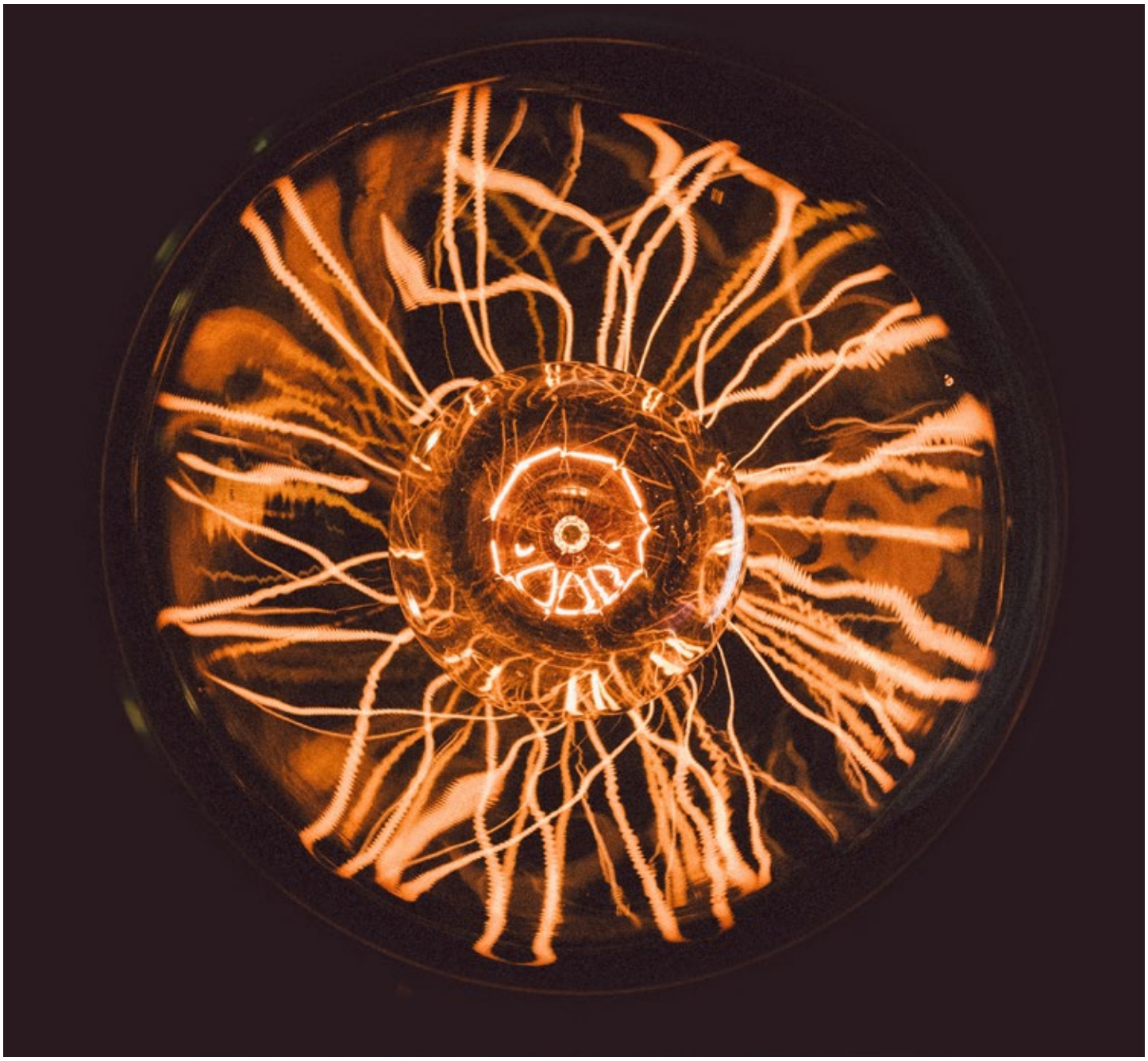
In these interesting times, oil and gas majors and their peers have remained active in corporate venturing, irrespective of headwinds or tailwinds. Over the latter half of the past decade, we have been observing a shift of focus among oil and gas corporates, still very evident today and likely to continue the post-pandemic world. Many of the disclosed deals tend to go into emerging businesses from non-core areas, primarily in IT

and cleantech, as well as transport and mobility.

It is precisely these non-core areas which are deemed to have the most disruptive potential to the core business of oil and gas, as low-carbon energy technologies may replace or eat up the position of fossil fuels. The increasing adoption of electric vehicles may affect a considerable part of oil and gas companies' customer base. There has also been an increasing digitisation of industrial activities, which has a tangible impact on production and efficiency.

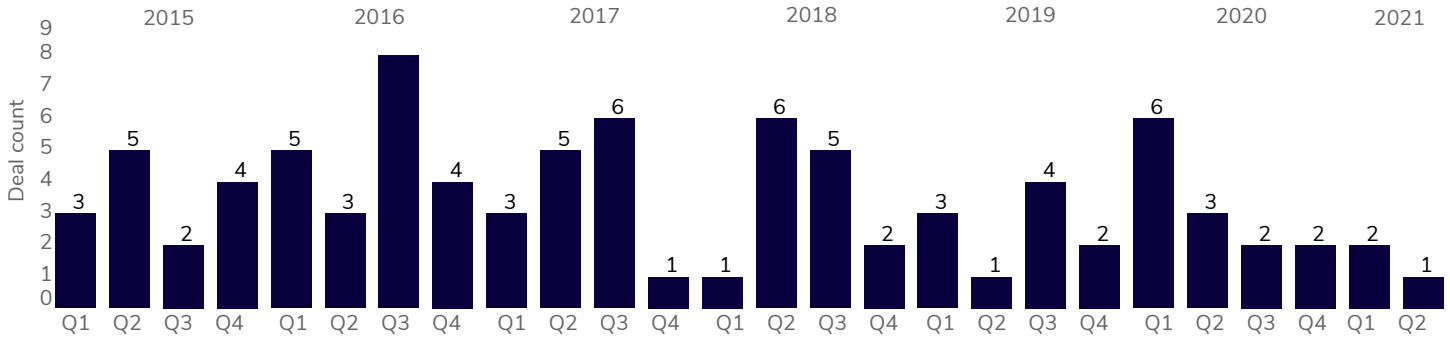
However, it is reasonable to expect more investments in core oil and gas technologies, particularly in companies whose solutions provide significant cost savings or that make operations less polluting. These investments will continue to form part of the portfolios of the sector's corporate venturers due to its capital-intensive nature, contingent on the swings of commodity prices. Any innovation that improves processes and reduces fixed costs is likely to be embraced.

Over the long haul, corporate venturing arms of oil and gas incumbents will continue to be more strategic rather than purely financial. In addition to investing in technologies that may profoundly disrupt the sector, strategic benefits may come in the form of building an ecosystem, finding suppliers or helping business units with specific technical challenges.

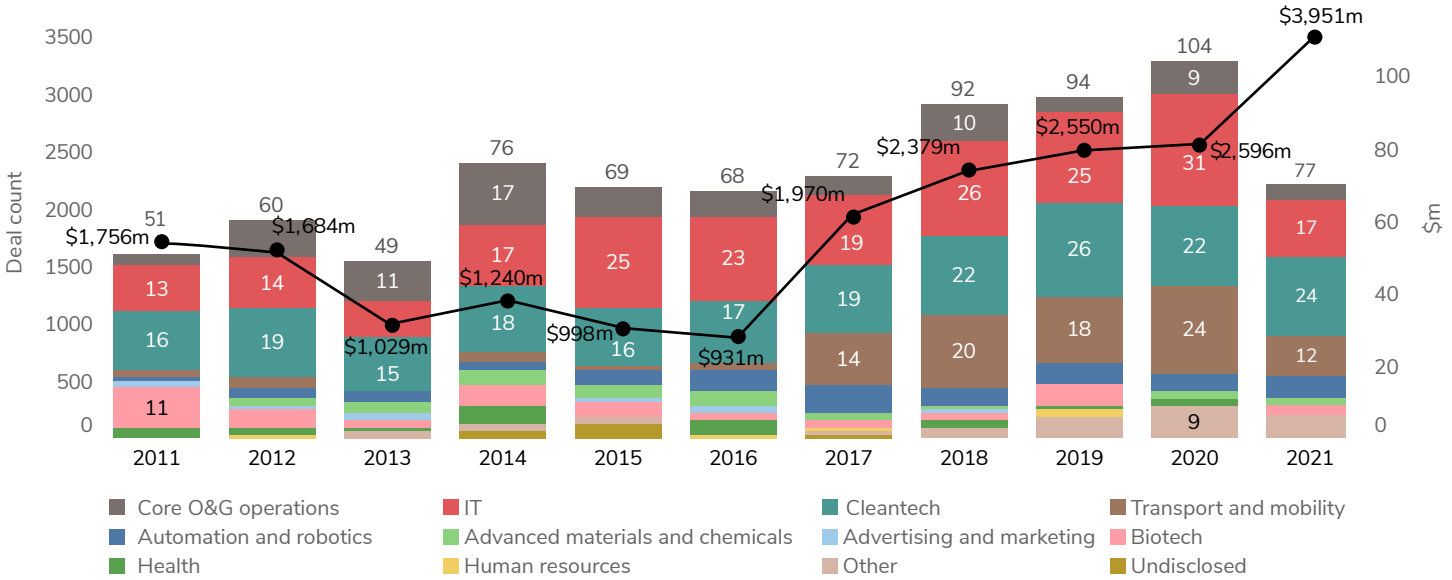


The sector in charts

Deals in oil and gas with corporate investors



Investments of the oil and gas peer group

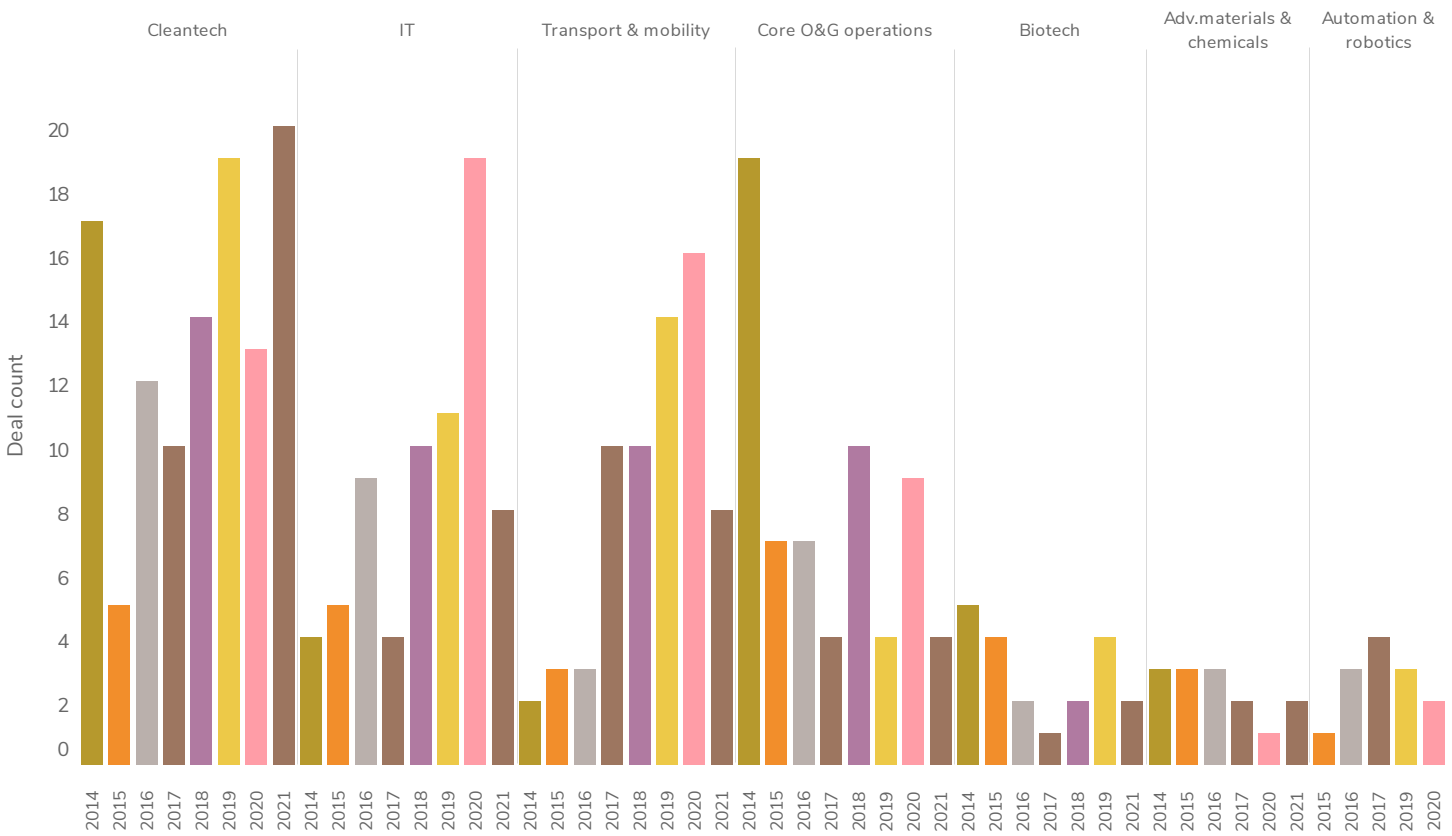


*The O&G corporate peer group includes: Shell, Chevron, Statoil/Equinor, BP, Saudi Aramco, Exxon Mobil, Total, Eni, Schlumberger, Subsea 7, E.On, Engie, Siemens/Next47, Eneco, Sumitomo, Petrobras, Repsol, Air Liquide, Occidental Petroleum, Petroleum Fuels, Petronas and Hindustan Petroleum Corporation

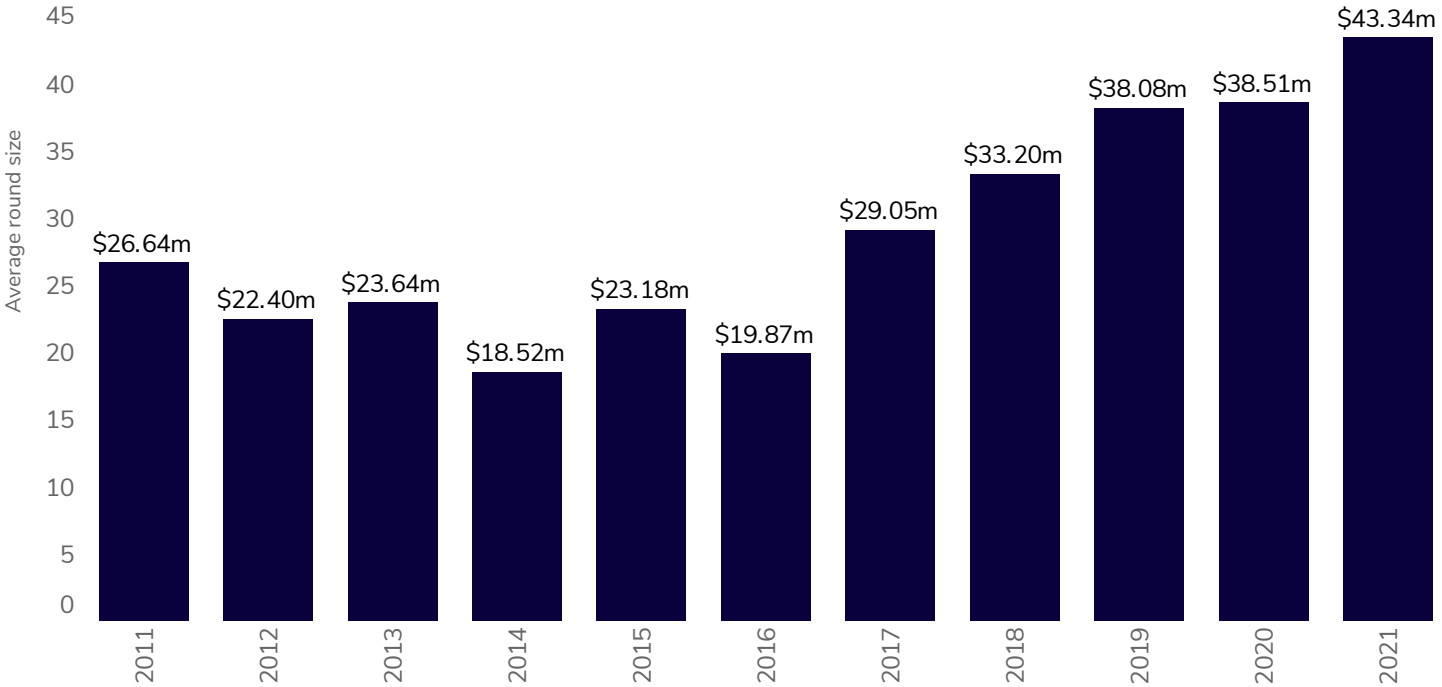
Source: GCV Analytics

During the second quarter of 2021, cleantech, transport and IT startups received more attention than other areas. The average size of deals in which oil and gas corporate venturing peers participated stood at $43.34m, an upwards move. In total, we tracked 77 deals by the peer group conducted over the first six months of this year, which were worth an estimated $3.95bn – a figure that clearly surpasses the midpoint from any previous year. This suggests that investment activity has increased and so have valuations.

Type of oil and gas corporate investments by year

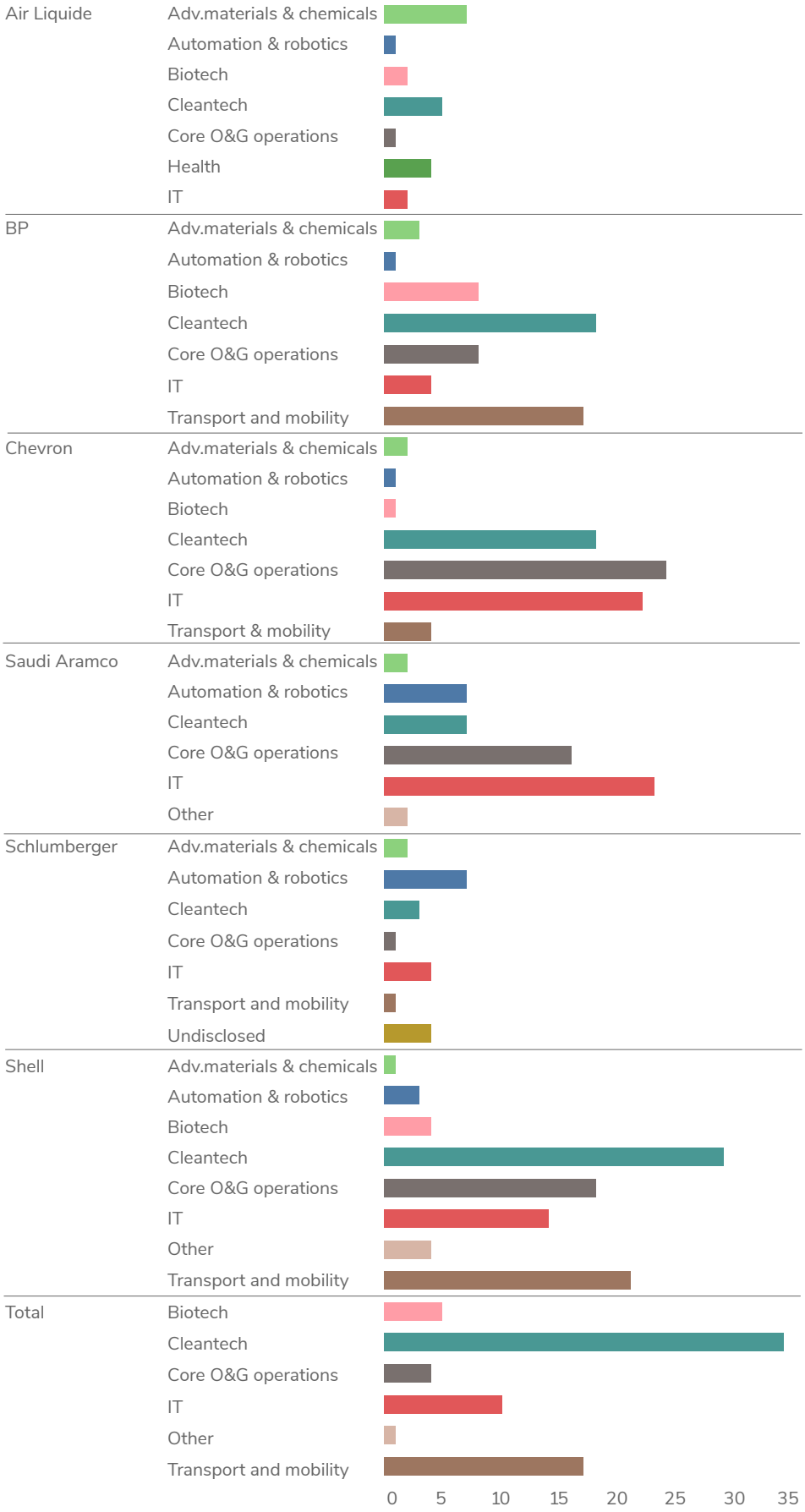


Average size of deals backed by oil and gas CVCs



Source: GCV Analytics

Type of investments by company



UK-based BP has disclosed a significant number of rounds in cleantech and transport companies since 2014, along with investments in core operation technologies and biotech.

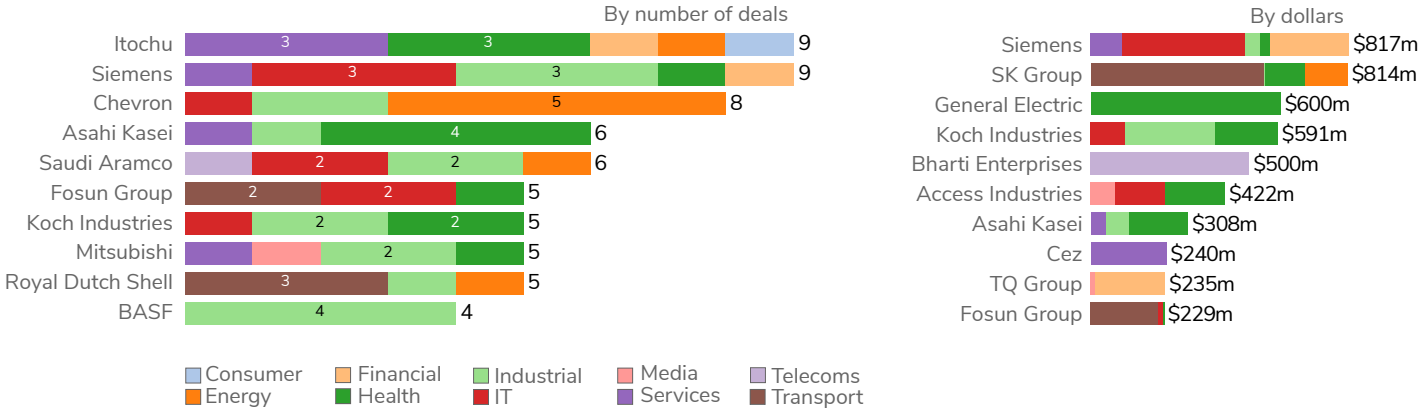
France-based Total has placed heavy bets on cleantech and transport, while Anglo-Dutch company Shell has been focused on both cleantech and core oil and gas technologies as well as IT.

US-based Chevron's publicly disclosed commitments revolve around core energy operations, the digital dimension of its operation and recently cleantech.

Saudi Arabia-based Saudi Aramco has historically focused its minority stake investments on IT, core technologies but increasingly cleantech as well. In brief, nearly all oil and gas majors are involved in some way with the low carbon and advanced mobility opportunities on the venturing scene.

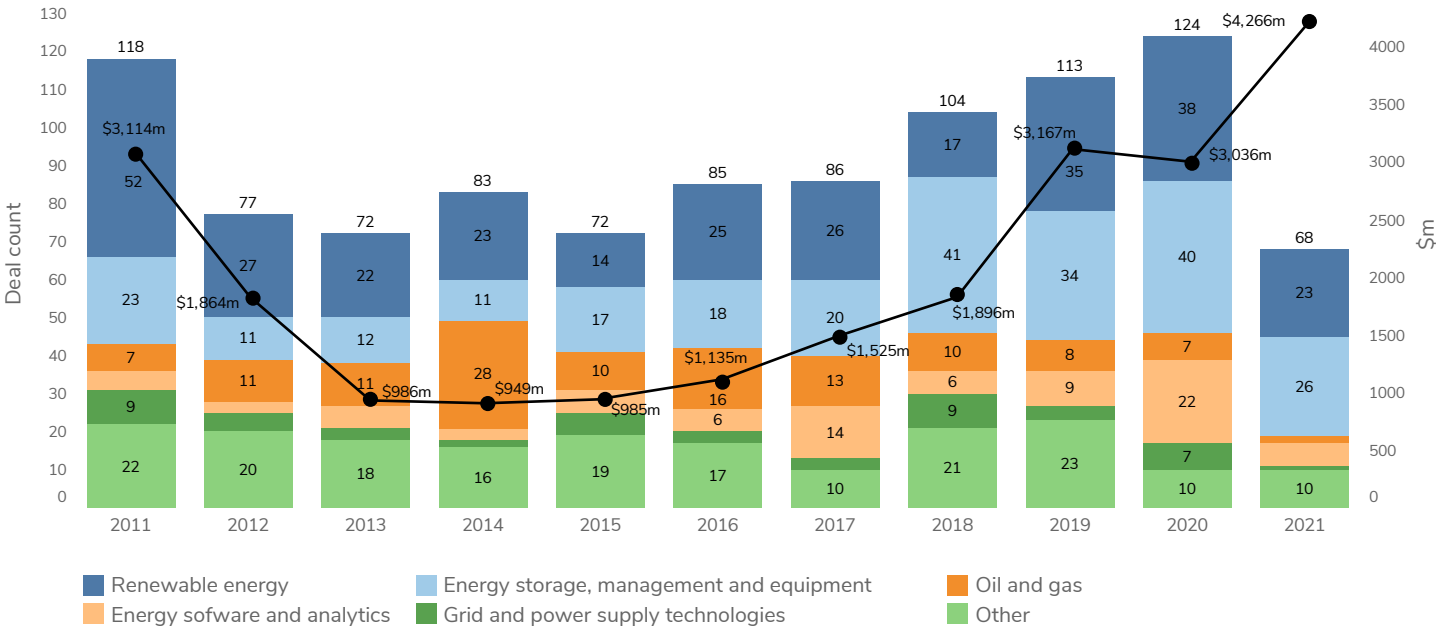
Source: GCV Analytics

Top investors



The oil and gas companies found among top corporate venture investors from the industrial and energy sectors were oil and gas companies Chevron, Saudi Aramco and Shell.

Corporate-backed rounds in emerging energy enterprises



Source: GCV Analytics

Deals

Top 10 deals by oil and gas corporate investors

Portfolio Company Name	Round	Sector	Size ($m)	Investors
Claroty	D	IT	$140m	Bessemer Venture Partners | I Squared Capital | LG Electronics | Rockwell Automation | Schneider Electric | Siemens | Standard Industries | Team8 | undisclosed investors
Bringg	E and beyond	Services	$100m	Cambridge Capital | Global Logistics Providers (GLP) | Insight Partners | Pereg Ventures | private investors | Salesforce | Siemens | Viola Growth
Mainspring Energy	D	Energy	$95m	40 North Ventures | American Electric Power (AEP) | Chevron | ClearSky | Devonshire Investors | Equinor | KCK Group | Khosla Ventures | Princeville Global | private investors
Solidia Technologies	Undisclosed	Industrial	$78m	Air Liquide | BASF | BP | Breakthrough Energy Ventures | Canada Pension Plan | Imperative Ventures | Kleiner Perkins | LafargeHolcim | Oil and Gas Climate Initiative | PIVA | Prelude Ventures | private investors | Total | Zero Carbon Partners
Noname Security	B	IT	$60m	Cyberstarts | ForgePoint Capital | Insight Partners | Lightspeed Venture Partners | Siemens | The Syndicate
Nexa3D	Undisclosed	Industrial	$55m	OurCrowd | Saudi Aramco | undisclosed investors
Seeq Corporation	C	IT	$50m	Altira Group | Chevron | Cisco Systems | Insight Partners | Saudi Aramco | Second Avenue Partners
Seurat Technologies	B	Industrial	$41m	Capricorn Investment Group | Denso | General Motors | Porsche | Siemens
Infinitum Electric	C	Industrial	$40m	AJAX Strategies | Chevron | Cottonwood Technology Fund | Energy Innovation Capital
SignalWire	B	Telecoms	$30m	private investors | Samsung | Saudi Aramco | Storm Ventures

Source: GCV Analytics

1 US-based industrial cybersecurity technology producer Claroty raised $140m in a series D round co-led by 40 North, the investment subsidiary of industrial group Standard Industries. Venture capital firm Bessemer Venture Partner's Century II fund co-led the round, which included consumer electronics provider LG, manufacturing technology producer Rockwell Automation, industrial technology maker Siemens and energy and automation equipment manufacturer Schneider Electric.

Claroty provides cybersecurity software that helps industrial companies protect their internet-of-things and operational technology assets. Its platform includes solutions for threat detection, risk management, secure remote access and visibility.

2 US-based logistics software producer Bringg completed a $100m series E round that included logistics service provider GLP, enterprise software producer Salesforce and industrial technology company Siemens. Growth equity firm Insight Partners led the round, which also featured Cambridge Capital, Pereg Ventures, Viola Growth and private investor Shmuel Harlap, while Salesforce and Siemens took part through Salesforce Ventures and Next 47 respectively. Bringg has built a cloud-based software platform that uses artificial intelligence (AI) to help organisations fulfil their e-commerce deliveries. The round valued it at $1bn post-money and the cash will support strategic acquisitions .

3 On-site power generation technology developer Mainspring Energy received $95m in a series D round featuring energy utility American Electric Power (AEP) alongside Chevron and Equinor. The round in the US-based company was led by Devonshire Investors, a private equity firm affiliated with financial services and investment group Fidelity, and included Princeville Capital, 40 North Ventures, Khosla Ventures, ClearSky, KCK Group and private investor Bill Gates. Chevron was represented in the round by Chevron Technology Ventures.

Founded in 2010 as EtaGen, Mainspring has developed a linear generator which can run on multiple types of fuels such as biogas and hydrogen. Its technology is based on research conducted at Stanford University and uses low-temperature chemical reactions to move oscillators through copper coils to produce electricity. The company claims its generators produce almost no emissions of nitrogen oxide, a pollutant that comes from burning fossil fuels.

4 US-based sustainable construction materials producer Solidia

Technologies completed a $78m funding round featuring oil and gas supplier BP and building materials provider LafargeHolcim as well as BASF Venture Capital, Total Carbon Neutrality Ventures and Aliad, on behalf of chemical producer BASF, petroleum supplier Total and industrial gases producer Air Liquide. It last raised money, from OGCI Climate Investments in 2017.

Founded in 2008, Solidia Technologies has developed cement and concrete technology which it claims is more sustainable than standard concrete and cement.

5 Next47 contributed to a $60m series B round for US-headquartered API security platform operator Noname Security. Private equity and venture capital firm Insight Partners led the round with backing from ForgePoint Capital, The Syndicate Group, Cyberstarts and Lightspeed Venture Partners. Noname has built an online platform used by businesses to detect and resolve vulnerabilities in the security of application programming interfaces (APIs) and protect them from cyberattacks. It has secured 40 customers including a number of Fortune 500 companies.

6 US-based additive manufacturing technology producer Nexa3D revealed $55m in funding, raised across several rounds. The money was raised from Saudi Aramco Energy Ventures, a vehicle of Saudi Aramco; equity crowdfunding platform OurCrowd; an unnamed alternative asset manager and a range of undisclosed new investors.

Founded in 2014, Nexa3D produces stereolithography 3D printers it claims reduces printing cycles from hours to minutes. The printers are powered by the company's lubricant sublayer photo-curing technology.

7 Seeq Corporation, a US-based provider of industrial internet-of-things technology, completed a $50m series C round featuring Chevron Technology Ventures, Saudi Aramco Energy Ventures and Cisco Investments, on behalf of Chevron and Saudi Aramco and networking technology provider Cisco Systems. The round was led by Insight Partners and included Altira Group and Second Avenue Partners.

Seeq had raised a total of $65m as of a series B round in September 2020 backed by all three corporates and Siemens' Next47 unit. Founded in 2013, Seeq provides data analytics software that helps industrial clients monitor their manufacturing chains using real-time information extracted from connected devices such as sensors.

Nexa 3D's product range

8 Capricorn Investment Group's Technology Impact Fund led a $41m series B round for Seurat Technologies, a US-based developer of metal additive manufacturing technology that included Siemens Energy, a subsidiary of Siemens, as well as automotive component producer Denso and carmakers Porsche and General Motors (through GM Ventures). Founded in 2015, Seurat is developing an industrial 3D printer that can manufacture metal additives at what it describes as "unparalleled" speed and resolution.

9 US-based air-core motor developer Infinitum Electric raised $40m in a series C round that included Chevron Technology Ventures. The round was led by Energy Innovation Capital and also featured Cottonwood Technology Fund and Ajax Strategies, both of which joined Chevron Technology Ventures in a $12.5m series B round in late 2019 that increased Infinitum Electric's overall funding to $15.2m. Founded in 2013 as Fanergies, Infinitum Electric has developed electric-powered motors for use in commercial and industrial heating, ventilation and air conditioning units, and has plans to diversify into aerospace and oil and gas.

10 SignalWire, a US-based developer of software-defined telecoms technology, received $30m in a series B round featuring Samsung Next, a subsidiary of consumer electronics manufacturer Samsung. Prosperity7 Ventures led the round, which included Storm Ventures and private investors Jerry Yang and Dean Drako, and which came in the wake of an $11.5m series A round in 2019 led by Storm Ventures and backed by Samsung Next, Sequoia Scouts, AME Cloud Ventures, Yang, Drako, Ron Neuenberger and Erik Yang. Founded in 2017, SignalWire has created a technology platform that can be reprogrammed by enterprise clients to facilitate secure communications through media including telephone calls, internet voice calls and text messages.

Saudi Aramco's Prosperity7 Ventures led a Series B into SignalWire

11 US-based geothermal energy technology developer Fervo Energy closed a $28m series B round backed by petroleum drilling services provider Helmerich & Payne. Investment firm Capricorn Investment Group led the round, which also featured Congruent Ventures, the VC firm backed by University of California, as well as Breakthrough Energy Ventures, 3X5 Partners and Elemental Excelerator.

Fervo has created technology intended to increase the efficiency and lower the cost of harnessing carbon-free geothermal energy, and will use the financing to support geothermal projects across the western United States.

12 US-based nuclear fusion reactor developer Zap Energy has pocketed $27.5m in series B funding led by Addition, with contributions from Chevron Technology Ventures, Energy Impact Partners, GA Capital, Fourth Realm and LowerCarbon Capital. Zap Energy closed a $6.5m series A round, it revealed, after a report in August 2020 suggested Chevron Technology Ventures had supplied an undisclosed sum. Further details about the series A were not revealed. Zap Energy advances work conducted at University of Washington and Lawrence Livermore National Laboratory.

13 Circulor, a UK-based developer of supply chain tracking technology, completed a $14m series A round featuring Salesforce Ventures, BHP Ventures, Boeing HorizonX, TotalEnergies Ventures, Volvo Cars Technology Fund and InMotion Ventures, on behalf of

ZeroAvia was backed by Shell and Amazon

enterprise software producer Salesforce, mining company BHP, aerospace manufacturer Boeing, oil and gas producer Total and automotive manufacturers Volvo Cars and Jaguar Land Rover.

Founded in 2017, Circulor provides an enterprise software platform that uses a combination of technologies including blockchain, business logic and machine learning. It assigns a digital identity to commodities and tracks the supply chain data and embedded carbon at each stage of production, recycling and end-of-life.

14 SeekOps, the US-based creator of a sensor for the detection of methane leaks, secured $14m in a series B round led by oil and gas services firm Schlumberger. Oil and gas provider Equinor and construction equipment manufacturer Caterpillar also took part in the round, investing through Equinor Ventures and Caterpillar Venture Capital respectively, as did OGCI Climate Investments. The company had received an undisclosed amount from Equinor Ventures and OGCI in 2019, following $3.3m from unnamed investors the previous year.

Founded in 2017, SeekOps provides end-to-end gas emissions inspection operations to oil and gas customers, including a proprietary sensor technology and Unmanned Aerial System deployment.

15 ZeroAvia, a UK-based developer of zero-emission aviation technology, received $13m from investors including Shell Ventures, the corporate VC arm of oil and gas supplier Shell, as well as e-commerce group Amazon's Climate Pledge Fund. The round was led by AP Ventures, the VC firm backed by mining group Anglo American Platinum and oil and gas provider Equinor, and also featured Alumni Ventures Group, among many other investors in the round. Founded in 2018, ZeroAvia is developing a zero-emission powertrain for commercial air travel. The company is targeting hydrogen power to accelerate the world's transition to sustainable aviation.

16 Red Sea Farms, a Saudi Arabia-based developer of technology that facilitates produce farming with salt water, raised

$10m from investors including Wa'ed, a vehicle of Saudi Aramco. The round also featured Future Investment Initiative Institute, Global Ventures and King Abdullah University for Science and Technology (Kaust), and it came after Kaust Innovation Fund and Research Products Development Company provided $1.9m for the company in May 2019. Red Sea Farms is an agritech company that has developed smart and sustainable agriculture systems to produce pesticide-free vegetables.

17 BP Ventures, the strategic investment arm of BP, supplied $7m to lead a $13.2m funding round for IoTecha, a US-based provider of smart vehicle charging products. Shaun Healey, principal at BP Ventures, took a seat on the board of directors. The round is on top of a $1.5m round led by electronics producer ECS in 2018. Founded in 2015, IoTecha has developed an integrated platform that includes software, hardware and cloud components for smart charging infrastructure of electric vehicles (EVs). The company claims its customers are prominent global charge point operators and manufacturers of EVs and charging stations.

18 US-based smart oil and gas technology developer mIQrotech has secured "nearly double" its $6m target for its series A round, with Chevron Technology Ventures among the participants. The round was co-led by Page Angel Investor Fund and an unnamed investor, according to Tampa Bay Inno. Founded in 2016, mIQrotech has developed an AI-powered technology that enables users to monitor pipelines and sending instant notifications to stakeholders . The technology can be used tominimise leak duration, detection time, pinpoint location and reduce annual clean-up costs.

19 Carmaker Hyundai led a $9m funding round for Israel-based automotive teleoperation technology developer Ottopia. The round included IN Venture, the Israeli corporate venturing arm of diversified industrial conglomerate Sumitomo, which has oil and gas interests. nVentures, MizMaa Ventures and Next Gear Ventures also contributed. It came after MizMaa Ventures led a $3m seed round in 2018 that also featured Next Gear Ventures, Glory Ventures and Plug and Play.

Founded in 2018, Ottopia Technologies is a software company which develops teleoperation systems that control vehicles remotely and safely. Its platform handles all types of vehicles, including cars, trucks, forklifts and shuttles.

20 EV.Energy, a UK-headquartered provider of EV charging services, secured $8.8m in series A funding from investors including energy utility Eon's corporate venturing and collaboration vehicle, Future Energy Ventures.

Energy investment platform Energy Impact Partners led the round, which also featured merchant bank Cyan Finance, private investment vehicle Dunelm Energy and unnamed individuals. The transaction came after the company received a $330,000 grant from Innovate UK in December 2019.

21 IN Venture, a Sumitomo CVC vehicle, led an $8m funding round for Genoox, a US-based creator of a community-driven genomic data platform. Infinity Medical also took part in the round, as did Inimiti, Glilot Capital Partners and Triventures, the three investors that had provided $6m for the company in 2018. It had secured a total of $6m from an Inimiti-led seed round and a series A round led by Glilot Capital Partners, which were disclosed at the same time in 2017.

BP Ventures backed a vehicle-charging product provider

22 Japan-based electric scooter sharing app Luup has raised ¥750m ($6.9m) in a round led by Spiral Capital and backed by fellow venture capital firm Anri, casual clothing vendor Adastria, Eneos Innovation Partners, a corporate venturing arm of petroleum supplier Eneos Group, and multiple unnamed private investors. The fundraising effort for the round is ongoing and is set to close in the summer of this year. Luup secured an investment of undisclosed size from Daito Trust Corporation in December 2020.

23 Malaysia-based digital health services provider Naluri completed a $5m funding round featuring pharmaceutical company Duopharma Biotech, laboratory services provider BioMark and Sumitomo Corporation Equity Asia, part of Sumitomo. Integra Partners, M Venture Partners, Palm Drive Capital, INP Capital, RHL Ventures and KB Investment also invested. The company received $240,000 in seed capital from BioMark and 500 Durians in 2018, $1.5m in pre-series A funding from Global Founders Capital, Stanford StartX Fund, TH Capital and unnamed private and existing investors in July 2019, and $1.1m from Duopharma, M Venture Partners and RHL Ventures in April 2020.

24 US-based carbon removal technology developer Boomitra raised $4m in a round led by agricultural chemical producer Yara through corporate venturing subsidiary Yara Growth Ventures. Chevron also took part in the round through Chevron Technology Ventures, along with private investors Jerry Yang, Tom Steyer and Kat Taylor.

Founded in 2016 and formerly known as ConserWater, Boomitra operates the world's first international soil carbon market, where corporations and governments can purchase carbon credits, while farmers worldwide are incentivised to increase their soil carbon levels, sequestering CO2 out of the atmosphere. The company uses satellites to measure soil carbon levels without using any hardware or soil sampling.

Shell backed a University of Texas at Austin spinout

25 Australia-based hydrogen power technology developer Endua was spun out of Commonwealth Scientific and Industrial Research Organisation with A$5m ($3.9m) in funding from petroleum supplier Ampol and Main Sequence Ventures. Endua is using electrolysis to make hydrogen-based power generators more accessible and less reliant on solar, hydro and wind power.

26 Germany-based actuator developer MetisMotion has raised €1.5m ($1.8m) from Siemens' Technology Accelerator, High-Tech Gründerfonds and ZFHN Zukunftsfonds Heilbronn's Born2Grow subsidiary. The same three investors provided $1.1m in 2018 after it was spun off by Siemens.

27 Shell Ventures provided an undisclosed amount for Celadyne Technologies, a US-based developer of technology intended to enhance the performance of hydrogen fuel cells and electrolysers. Celadyne, a University of Texas at Austin spinout, secured the funding in relation to its participation in the Third Derivative accelerator.

28 Saudi Aramco invested an undisclosed amount in Energy Vault, a Switzerland-headquartered developer of renewable energy storage systems, through Saudi Aramco Energy Ventures. Energy Vault received $110m in an August 2019 series B round led by telecoms and internet group SoftBank's Vision

An XCharge installation in Beijing

Fund, having raised an undisclosed amount from Cemex Ventures, the investment arm of building materials producer Cemex. Founded in 2017, Energy Vault has created a modular, gravity-based system designed to store large amounts of solar or wind energy, in theory allowing it to be used as a baseload power source 24 hours a day.

29 Ocergy, the US-headquartered creator of a low-cost foundation for floating offshore wind turbines, received an undisclosed amount of series A funding from Moreld Ocean Wind and Chevron Technology Ventures, which invested on behalf of industrial group Moreld and Chevron respectively. The company did not reveal how much it had raised but a regulatory filing indicates it had been targeting $2.2m.

Founded in 2019, Ocerg's OCG-Wind is a low-cost foundation supporting very large turbines. Its other offering, OCG-Data, is an innovative multi-disciplinary ocean observer for complete offshore site assessment.

30 XCharge, a China-headquartered developer of electric vehicle charging technology, completed a series B round of undisclosed size that included Shell Ventures. The company's website states that VC firms GGV Capital and ZhenFund co-led a series A round of undisclosed size for the company in 2017, following funding from consumer electronics producer Samsung and ZhenFund. The company was founded in 2015.

31 Starfire Energy, a US-based developer of carbon-free ammonia and hydrogen production technology, secured an undisclosed amount from investors including clean power producer New Energy Technologies, Chevron, gas utility Osaka Gas USA and industrial equipment manufacturer Mitsubishi Heavy Industries.

The round was led by VC firm AP Ventures, and Chevron took part through Chevron Technology

Ventures. Founded in 2007, Starfire Energy has developed production technology of carbon-free ammonia and derived hydrogen fuel, using a proprietary and flexible process for making ammonia from air, water, and clean energy. It also has a proprietary process for harvesting hydrogen from ammonia.

32 Oil and gas supplier Shell has provided an undisclosed amount of funding for LanzaJet, the jet fuel offshoot of sustainable fuel producer LanzaTech. The parent company was spun off in June 2020 with $36m in equity funding from oil and gas supplier Suncor, diversified conglomerate Mitsui and air carrier ANA and a $14m grant from the US Department of Energy (DoE). It then raised an undisclosed sum from airline operator British Airways.

LanzaJet has developed a process that can turn any source of sustainable ethanol into airplane fuel, including ethanol generated from recycled pollution. LanzaTech developed its alcohol-to-jet technology in partnership with the DoE Pacific Northwest National Laboratory.

33 Electrochaea, a Germany-based developer of renewable methane production technology, raised an undisclosed amount from investors including energy technology producer Baker Hughes, which acquired a 15% stake, gas distributor Energie 360° and energy utility Engie's energy storage subsidiary, Storengy.

They were joined by Munich Venture Partners (MVP), KfW, Caliza, Focus First and Btov Partners. The company had raised an undisclosed sum from Nidus Investment Partners in 2011 and 'several million euros' in series A funding from MVP, Btov Partners, Caliza, Focus First, KfW and Sirius Venture Partners in 2014.

34 Leasing services provider Sumitomo Mitsui Finance and Leasing Company, energy utility Shikoku Electric Power Company and Sumitomo have combined to provide an undisclosed amount of series E funding for renewable power producer Sunseap. The company last raised money in February 2020 when another energy utility, Banpu, supplied $72m in series D4 financing to take its overall funding to approximately $368m. Its earlier backers include conglomerate Chow Tai Fook Enterprises and Shell Ventures.

Founded in 2011, Sunseap operates several subsidiaries focused on solar energy, including a solar leasing business, an off-site renewable energy supply arm, and an engineering, procurement and construction division for photovoltaic projects.

Electrochea develops renewable methane technology

We also reported other deals partially related to the oil and gas sector.

1 Thailand-based e-commerce shipping service Flash Group raised 4.6bn baht ($148m) in series D-plus and E rounds featuring a host of corporates. The series D-plus round was led by SCB10X on behalf of financial services firm Siam Commercial Bank and included printing services firm Chanwanich Security Printing Company.

SCB10X also took part in a series E round co-led by Founder's Fund and Buer Capital and backed by eWTP Capital, PTT Oil and Retail, Durbell and Krungsri Finnovate, subsidiaries of e-commerce trade association Electronic World Trade Platform (affiliated with e-commerce group Alibaba), conglomerates PTT and TCP Group, and financial services firm Bank of Ayudhya.

Founded in 2018, Flash Group provides diversified digital supply chain services through e-commerce logistics service Flash Express, the large item-focused Flash Logistics, warehouse network Flash Fulfillment, parcel delivery agency Flash Home and financial services platform Flash Money.

2 US-based gas management technology provider Crusoe Energy Systems completed a $128m series B round featuring diversified holding group Exor, crypto exchange operator Coinbase and principal trading firm DRW. Investment firm Valor Equity Partners led the round, which included Bain Capital Ventures, the VC arm of private equity firm Bain Capital, among other investors. The equity funding was raised alongside a $40m project financing facility from growth financing provider Upper90. Coinbase and DRW participated through their Coinbase Ventures and DRW Venture Capital subsidiaries respectively.

Crusoe manages a network of 40 data centres which are powered by flared gas that would otherwise be wasted. They use its Digital Flare Mitigation technology, and the company intends to expand to 100 units over the course of the next year.

Crusoe Energy reuses flared gas

3 Wasabi, a US-based hot cloud storage provider backed by mobile network operator NTT Docomo, collected $112m in a series C round led by investment and financial services firm Fidelity. The round included unnamed existing backers as well as Saudi Aramco's Prosperity7 Ventures unit, which participated alongside the venturing arm of disk-drive maker Western Digital.

Founded in 2017, Wasabi provides hot cloud storage services that enable businesses to quickly access their data. It claims its services are cheaper than traditional cold cloud storage offerings and faster than other hot cloud storage services. The company will use the series C funding to open data centres in new international markets, hire staff and expand its network of resellers, technology alliance partners and distributors.

4 Transport infrastructure producer Ferrovial has invested an undisclosed amount in Finland-based mobility app developer MaaS Global. The company had raised $33m in November 2019 from BP Ventures, as well as conglomerate Mitsubishi and Nordic Ninja. It had secured a total of $29.7m as of a $10.4m round in 2018, and its earlier investors include corporates Toyota, Karsan, Denso, Aioi Nissay Dowa, Swiftcom, Veho, Transdev, Korsisaari, Good Sign, GoSwift, IQ Payments and Neocard.

5 India-based electric vehicle charging technology developer Magenta EV Solutions secured $15m in series A financing from private backer Kiran Patel. Magenta had secured an undisclosed amount of seed financing from oil company Hindustan Petroleum in 2018, before securing an unspecified amount of funding from JITO Angel Network and LetsVenture in 2020.

Analytics

Exits

In the second quarter of 2021 we also reported some notable exits from corporate venturers in the oil and gas space.

1 ESS, a US-based energy storage technology producer backed by corporate investors SoftBank, PTT Global, Evergy and BASF, agreed a reverse takeover with special purpose acquisition company (SPAC) Acon S2 Acquisition Corp. Acon S2 floated on in a $250m initial public offering (IPO) on the Nasdaq Capital Market in September, and the merged business will take its listing. The deal values ESS at $1.1bn.

Investment and financial services group Fidelity led a $250m private investment in public equity (PIPE) financing supporting the deal that included SB Energy, part of toftBank, as well as chemicals producer BASF and Breakthrough Energy Ventures. Founded in 2011, ESS produces grid-scale energy storage systems for use with renewable energy sources. They rely on iron-flow batteries, which ESS claims are sustainable and contain no hazardous waste.

2 Sarcos Robotics, a US-based industrial robotics technology manufacturer backed by software producer Microsoft, construction equipment maker Caterpillar, air carrier Delta and Schlumberger, agreed to a reverse merger. The company joined forces with SPAC Rotor Acquisition Corp in a transaction that valued them at a combined $1.3bn. Sarcos produces robotic exoskeletons that help users lift heavy objects. The merged business, Sarcos Technology, will take the spot on the New York Stock Exchange secured by Rotor in a $240m IPO in January 2021. Caterpillar subsidiary Caterpillar Venture Capital, Schlumberger and data analytics provider Palantir backed a $220m PIPE for the deal with Millennium Management, Jaws Estates Capital, Michael F Price and funds and accounts managed by BlackRock.

3 UK-based encryption technology developer Arqit agreed to a reverse merger with SPAC Centricus Acquisition Corp that will be backed by corporates Sumitomo and Virgin Orbit. The deal creates a new company called Arqit Quantum, valued at $1.4bn, which will take the listing Nasdaq Capital Market Centricus Acquisition got in a $300m IPO in February.

The merged business will receive approximately $70m from a PIPE deal featuring satellite launch services provider Virgin Orbit – which is contributing $5m – conglomerate Sumitomo Corporation and investment holding company Heritage Group.

Founded in 2017, Arqit has developed a software platform which uses cloud-based quantum encryption technology to secure digital communication. It has operated in stealth mode until recently. The proceeds from the deal will be used to commercialise the company's products and support the launch of two satellites.

4 US-based 3D printing technology developer Shapeways, which has enterprise technology producer Hewlett Packard Enterprise and Sumitomo as backers, agreed a reverse merger with SPAC Galileo Acquisition Corp. The merged business will take the spot secured by Galileo Acquisition Corp on the New York Stock Exchange. Galileo listed in a $120m IPO in October 2019. The combined company is also set to raise $75m in PIPE financing from a consortium including 3D printing system provider Desktop Metal, Miller Value Partners, XN, Lux Capital, Union Square Ventures, Inkef Capital and Andreesen Horowitz.

Founded in 2007 as a spinout from electronics and medical technology producer Philips' lifestyle incubator,

Robotics company Sarcos agreed to list in a reverse merger

GreenFlux was acquired by DKV

Shapeways provides digital additive manufacturing design software and services through an online platform. Users upload their creations and choose from more than 60 different materials and finishes before selling on a dedicated marketplace.

5 On-demand consumer product supplier Gopuff agreed to purchase US-based mobility software provider RideOS in a deal reportedly sized at $115m. Siemens and engineering firm ST will exit. They backed a $25m series B round for RideOS through CVC units Next47 and ST Engineering Ventures with VC firm Sequoia Capital in 2018, following a $9m series A led by Sequoia that featured Graph Ventures and SV Angel.

RideOS has created a software platform that helps on-demand transport providers manage their businesses, covering the positioning and dispatch of vehicles as well as organising single and multi-rider journeys.

6 Nostromo, an Israel-based cold-energy storage technology developer backed by corporates Shell, road haulage and logistics provider Taavura Group and insurance firm Menora Mivtachim, raised $13.6m through a merger with Tel Aviv Stock Exchange-listed distribution and monetisation software producer Somoto. Founded in 2017, Nostromo has developed a cold energy storage system which uses electricity to cool modular thermal ice cells when energy demand is low and discharges cooling when consumption is high. The technology is for use in large buildings with a high demand for air conditioning.

7 Mobility services provider DKV acquired Netherlands-based vehicle charging technology provider GreenFlux for an undisclosed amount, enabling energy utility Eneco and industrial technology and services provider ICT Group to exit. The company secured $13m in series B funding from Eneco, ICT, Set Ventures and Brabantse Ontwikkelingsmaatschappij (BOM) in 2018, identifying ICT and BOM as existing investors. Founded in 2011, GreenFlux has developed charging for electric mobility.

8 Smart meter technology producer Geo acquired Onzo, an energy data analytics provider that has counted energy utilities SSE and Eneco as investors, for an undisclosed sum. Eneco had invested an undisclosed amount in the UK-based company in 2017, following $4m from SSE and Sigma Capital Group in 2008, $1.7m from West Coast Capital and Cipio Partners in June 2014 and $6.3m from the latter two six months later. Founded in 2007, the company has developed an analytics tool for energy consumption.

Funds

1 US-based venture capital firm G2 Venture Partners (G2VP) closed its Fund II at $500m with commitments from Shell, diversified conglomerate Mitsui, carmaker Daimler and industrial technology producer ABB Switzerland. The McKnight Foundation and John Doerr, chairman of VC firm Kleiner Perkins, also committed to the fund. Shell contributed through its venture arm. It was also a limited partner in G2VP's inaugural fund, which was sized at $350m.

G2VP was founded in 2017 as a spinoff from Kleiner Perkins' Green Growth fund. It focuses on companies developing emerging technologies that could accelerate sustainable transformation in traditional industries.

The firm's portfolio companies include Proterra, the electric bus producer that agreed a $1.6bn reverse takeover in February 2021, as well as computer vision software provider Scandit and autonomous commercial vehicle developer Seegrid.

2 Japan-headquartered automotive manufacturer Toyota committed another $300m in capital to its corporate venturing unit and rebranded it from Toyota AI Ventures to Toyota Ventures. Toyota AI Ventures launched under the auspices of the company's Toyota Research Institute in 2017 with $100m in capital. Toyota provided a further $100m for its Fund II in late 2019.

The capital will be divided evenly between two funds. Toyota Ventures Climate Fund will concentrate on developers of innovative technologies to promote carbon neutrality, such as renewable energy and hydrogen production. Toyota Ventures Frontier Fund will invest in developers of technology in areas like AI, cloud computing, autonomy, mobility, robotics, smart cities, digital health, advanced materials, energy and financial technology.

3 US-based VC firm Congruent Ventures has raised $175m for an early-stage climate technology fund, from limited partners including software producer Microsoft. The firm targeted $125m for the close but surpassed that figure with commitments from Microsoft's Climate Innovation Fund and VC firm Prelude Ventures.

Founded in 2017, Congruent typically invests in technology companies that are addressing sustainability issues across sectors such as energy transition, mobility, agriculture and sustainable production. The fund has completed seven investments including in Parallel Systems, the developer of an autonomous, electric freight transportation system.

4 UK-headquartered energy utility National Grid committed an additional $150m to its corporate venturing arm, National Grid Partners (NGP). NGP was launched in 2018 with $250m in capital, $227m of which has been invested in approximately 25 companies including conversational speech software provider Uniphore, which raised $140m recently, and Dragos, the cybersecurity technology producer which secured $110m in December 2020.

The two newest companies in the portfolio, US-based spatial intelligence software developer Pathr and US-based container cybersecurity technology provider AccuKnox, have received a total of $7.5m from the unit. Lisa Lambert, NGP's founder and president, said: "We are investing in and deploying technologies across National Grid's networks to enhance resilience and reliability, while more easily integrating renewable energy."

Daimler has backed G2VP's Fund II

5 TDK Ventures, the CVC subsidiary of Japan-based electronics producer TDK, closed its second fund at $150m. The unit intends to tap the fund to build a portfolio of 50 early-stage companies over the next three years. It will focus on sectors including clean technology, advanced materials, industrial, robotics, energy, autonomous vehicles, EVs and health technology.

TDK Ventures typically invests between $250,000 and $5m in each funding round. Incubator Mach49 advises TDK Ventures, which launched in July 2019 with the close of its $50m first fund. It has since exited fuel cell technology developer GenCell, laser manufacturer SLD Laser and 3D printing technology provider Origin. It has 16 companies in its portfolio and $200m of assets under management.

6 UK-headquartered insurance provider Phoenix Group has formed a CVC unit dubbed Phoenix Venture Capital Partners, putting up an initial capital allocation of more than £100m ($137m). Asset manager Aberdeen Standard Investments will help run the fund, which will target local startups adhering to its environmental, social and governance criteria in areas including clean energy, financial and health technologies in a bid to boost employment opportunities in the UK. Founded in 1857 as The Pearl Loan Company, Phoenix Group runs multiple insurance, savings and retirement services. The company should not be confused with its Israel-based namesake, which is also a corporate venturing insurer.

7 Advanced materials producer Saint-Gobain has committed an undisclosed amount to China-based investment firm Richland Capital's third VC fund. Founded in 2011, Richland invests across technology sectors including advanced materials, advanced manufacturing equipment, semiconductors, artificial intelligence and 5G networks. The firm is targeting up to RMB800m ($123m) for the close of Richland Capital Fund III, which it was expecting to take place by the end of June 2021.

The vehicle's first close, in August 2020, was backed by Solvay Ventures, the investment arm of chemicals producer Solvay, as well as Nipsea, which invests on behalf of paint producer Nippon Paint, and Redbud, a fund-of-funds formed by Tsinghua Asset Management, part of Tsinghua University.

8 MetaVC Partners, a US-based VC firm, made a first close of its planned $100m debut fund, with commitments from Bill Gates, a co-founder of software provider Microsoft, and Nathan Myhrvold, formerly chief technology officer at Microsoft who runs intellectual

TDK Ventures closed its second fund at $150m

property firm Intellectual Ventures. MetaVC has licensed about 200 patents on metamaterials from Intellectual Ventures for its companies to use, managing partner Conrad Burke told Wall Street Journal.

Burke and co-managing partner Chris Alliegro were previously executives at Invention Science Fund, a startup incubator at Intellectual Ventures that spun out several startups commercialising advances in metamaterials including Kymeta and threat-detection company Evolv Technologies, which is going public through a SPAC.

MetaVC has already backed optical computing company Neurophos and satellite-enabled telecommunication services provider Mangata Networks.

9 Spain-based asset manager Alantra reached the first close at more than €80m ($97m) for its Klima Energy Transition Fund including commitments from Enagás, a Spain-based gas grid operator.

The fund aims to raise €150m ito back companies accelerating the energy transition: low carbon gases, such as hydrogen, carbon capture, and biomethane; smart power grids, energy storage and renewable technologies; digitisation of the whole energy equation; and sustainable transportation.

Managing directors Bastien Gambini, former MD of Norway state-owned Equinor's corporate venturing unit in Europe, and Lucille Bonnet, previously a principal at state and corporate-backed High-Tech Gründerfonds, lead Alantra's team of six managing the fund.

Enagás committed to an energy transition fund

10 Japan-headquartered infrastructure group JGC Holdings and its engineering subsidiary, JGC Corporation, have earmarked ¥10bn ($92m) for open innovation investments, half of which will go to a new corporate venturing arm. JGC Mirai Innovation Fund is set to operate for 10 years and will be managed by venture capital firm Global Brain. It will target developers of carbon neutrality, sustainable infrastructure, lifestyle improvement and smart industry technologies and products, in Japan and internationally.

Founded in 1928 as Japan Gasoline, JGC initially manufactured petroleum products. It has pivoted its focus to engineering services and diversified its business to cover construction, nuclear power, renewable energy, pharmaceuticals and healthcare globally. The group also intends to solve domestic social issues caused by factors such as an ageing population, declining birth rates and outdated infrastructure.

11 US-based venture capital firm Energy Transition Ventures (ETV) publicly launched its first vehicle, which is anchored by conglomerate GS Group's corporate venturing arm, GS Futures, and GS Energy, its energy technology unit. ETV is targeting $75m for the fund and intends to raise additional capital from new investors, having reached an initial close in February 2021 and made its first investment in March.

The vehicle will target North America-based early-stage developers of technologies in areas including clean energy, distributed generation, electrification, sustainable mobility and resource optimisation.

Neal Dikeman, a partner at ETV, was a senior investor and head of North America for Shell Ventures for more than three years from 2013.

12 Brightlands Venture Partners, a Netherlands-based VC firm, has held the first closing of its fourth fund at €45m ($53m) including corporate commitments from DSM and Rabo. Joining the chemicals company and the bank as limited partners in BVP Fund IV were the Dutch province of Limburg and its regional development agency, LIOF. The Netherlands Enterprise Agency committed €10m was committed for investments in renewable chemistry .

Brightlands will invest in cleantech and health startups and scaleups in the Netherlands, Belgium and North Rhine Westphalia. Its prior deals include QC Polymers (mechanical recycling of commodity plastics), Ioniqa Technologies (chemical upcycling of PET), Black Bear Carbon and Fuenix (pyrolysis of used tyres and of mixed plastic waste), Neuroplast (treatment of paraplegia), Triplemed (aortic aneurysmas) and Matisse Pharmaceuticals (sepsis).

13 Samsung Engineering, part of the South Korea-listed conglomerate Samsung, said it would invest about KRW30bn ($27m) in its CVC fund targeting hydrogen and carbon neutral technologies. Samsung Venture

Petronas, headquartered in the towers, has started its second accelerator

Investment, the group's local CVC unit, will manage the Samsung Engineering New Technology Business Investment Association (SVIC Number 51).

This is the first time Samsung Engineering has invested in its CVC fund, which manages money for other business units from electronics to industrials. Samsung Engineering is planning to actively develop blue hydrogen, carbon capture and plastic recycling technology and wants the CVC portfolio companies to help.

14 Petronas, a Malaysia state-owned oil major, has started the second edition of its technology accelerator programme for local startups. The Petronas FutureTech 2.0 accelerator is run by VC firm 500 Startups and has partnerships with government-linked companies Telekom Malaysia and Sime Darby Plantation.

The themes for the batch are industry 4.0, future of energy, digital transformation, retail innovation and specialty chemicals and advanced materials.

Petronas Ventures funded two companies from the first cohort: sustainable energy startup Sols Energy and Braintree Technologies, a developer of robotics and automation for agriculture technology.

15 US-headquartered gaming accessory producer Razer launched a $50m investment vehicle that will invest in sustainable product and environmental technology developers. Razer Green Fund's capital will be deployed through the company's corporate venturing unit, zVentures, and will concentrate on areas such as renewable energy, carbon and plastic management, with an eye on its youthful customer base. The vehicle's first investment is in The Nurturing Co, a Singapore-based producer of sustainable consumer brands including Bambooloo, which offers toilet paper made from bamboo.

16 Tenacious Ventures, an Australia-based VC firm focused on agriculture and food technology, closed its first fund at A$35m ($27m). The local state-backed Clean Energy Finance Corporation and family office Grok Ventures have committed to the fund, Tenacious Ventures Fund I. The fund is targeting pre-series A businesses.

Matthew Pryor, co-founder of Observant, and Sarah Nolet, founder of AgThentic, founded the firm, which has backed Goterra, SwarmFarm Robotics, Nori, Vow, RapidAIM and Nowadays. Tenacious is part of the Australian government's Early Stage Venture Capital Limited Partnerships scheme.

People

Alexander Hain, lead for venture building and investment activities for Sweden-based utility Vattenfall's wind (renewables) sector, moved to local peer EWE to be senior investment manager and executive director. Hain joined Vattenfall in May 2019 from Wincubator, Wilo's innovation subsidiary. At Vattenfall, his venture building initiatives from its green:field innovation platform had included spin-offs of Proteqnic at the end of 2020 and Solytic in 2018. Vattenfall remains as a minority shareholder, strategic partner and customer. Proteqnic, an automated health monitoring and decision support for wind power operators, had its origin as one of the ideas in the Vattenfall Innovation Contest, Vattenfall's internal idea competition for employees.

Daniel Wedberg, founder and managing director of Sweden-based truck maker Scania's corporate venturing unit, has left to join electric vehicle startup Inzile as chief executive. Wedberg set up Scania Growth Capital in early 2017 and its deals include battery provider Northvolt, which recently raised $2.75bn. Inzile develops a fossil-free, modular transport and service and previous CEO and founder, Ragnar Åhgren, will remain within the company in business development. Wedberg said: "Inzile is a fantastic company that is perfectly positioned for the future in sustainable urban transport."

Jelena Markovic, senior associate for BayWa Renewable Energy (BayWa RE), Germany-based trading conglomerate BayWa Group's clean energy subsidiary, joined LBBW Venture Capital as an investment manager for the universal bank in the state of Baden-Württemberg. She said her investment focus was now business-to-business software startups in the German-speaking region of Europe (Germany, Austria and Switzerland – known by the acronym DACH), in late seed and series A rounds.

Markovic, a GCV Rising Stars 2020 award winner, joined BayWa RE Energy Ventures as a VC analyst shortly after it was formed in mid-2018. BayWa RE Energy Ventures backs early and growth-stage renewable energy technology developers based in Europe and Israel. Markovic told GCV she helped generate dealflow for the fund that resulted in its first three investments: Blixt, Raycatch and Zolar.

Adiari Vazquez joined US-listed online retailer Amazon's sustainability-focused corporate venturing unit as an investment manager. Vazquez said in her LinkedIn profile she was "investing to bend Amazon's carbon emissions curve". She had spent a year as a UK-based associate at Next47, a CVC vehicle owned by Siemens, before leaving in 2020 to set up Braver Ventures. Vazquez had been a Portugal-based investment manager at Caixa Capital, the corporate venturing fund operated by financial services firm Caixa Geral de Depósitos, for more than three years from late 2015, and oversaw early-stage deals in smart energy and materials.

Momenta, a US-based venture capital firm, hired Michael Dolbec as managing partner. For more than 30 years, Dolbec has been an executive in institutional and CVC in Silicon Valley, most recently serving as executive managing director for GE Ventures, the corporate venturing unit of industrial conglomerate General Electric, since late 2012. Dolbec began his investment career with Kleiner Perkins Caufield & Byers and continued with Greylock. He went on to venture capital leadership roles at IBM, 3Com, Orange, and LG Electronics.

Momenta has made more 50 investments and recently closed its third digital industry fund, the AIoT Ecosystem Fund, at $50m with limited partners including Advantech, an industrial intelligence corporation.

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