

Quadrise Fuels International

The clean solution to a global problem

Strategy update

Alternative energy

23 November 2020

Price 2.15p

Market cap £23m

Net cash (£m) at end June 2020 excluding £2.0m convertible securities and potential £2m from second tranche of Bergen convertible 2.4

Shares in issue 1,077.4m

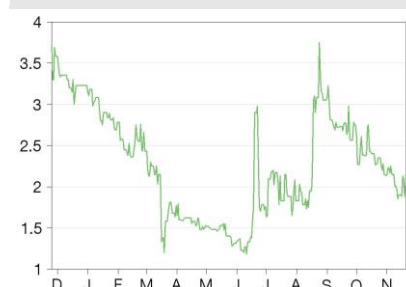
Free float 72.9%

Code QFI

Primary exchange AIM

Secondary exchange N/A

Share price performance



% 1m 3m 12m

Abs (4.9) (25.9) (41.7)

Rel (local) (12.1) (30.7) (34.7)

52-week high/low 4p 1p

Business description

Quadrise Fuels International is the innovator, supplier and global licensor of disruptive residual oil technology that produces a synthetic, enhanced heavy fuel oil called MSAR. The technology enables refiners to produce MSAR for use as a low-cost substitute for heavy fuel oil.

Next event

AGM 27 November 2020

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Quadrise has developed a synthetic heavy fuel oil technology that potentially improves the profitability of refineries producing heavy fuel oil (HFO) and upstream operations, as well as reducing costs and polluting emissions for HFO users in the power, industrial and marine bunker markets. The company has recently completed a pilot trial in Morocco, with a trial at a US site scheduled for completion in calendar Q121. These trials are to demonstrate the efficacy of MSAR ahead of potential progression to commercial supply in calendar H221. It is also in discussions about projects in Ecuador, Mexico and Saudi Arabia and with two major shipping companies.

Year end	Revenue (£m)	EBITDA (£m)	PBT* (£m)	EPS* (p)	DPS (p)	P/E (x)
06/17	0.1	(3.9)	(4.1)	(0.45)	0.0	N/A
06/18	0.0	(3.3)	(3.5)	(0.37)	0.0	N/A
06/19	0.0	(2.8)	(3.0)	(0.32)	0.0	N/A
06/20	0.0	(3.1)	(3.4)	(0.32)	0.0	N/A

Note: *PBT and EPS are normalised, excluding amortisation of acquired intangibles, exceptional items and share-based payments.

MSAR: The lower-cost fuel oil solution

Refineries adopting the MSAR process to convert their residues into a useful fuel would be able to sell all of their middle distillate as a premium product instead of having to use some to make heavy fuel oil (HFO), so are able to sell MSAR at a discount to conventional HFO. Adoption would improve the profitability of both the refineries themselves and their customers who are currently using HFO for power generation or providing heat in industrial applications such as cement manufacturing. MSAR can also be formulated as a lower cost bunker fuel

Commercial potential demonstrated

MSAR itself has been used successfully at Lithuania's main electrical generation plant and in extensive sea-based trials with Maersk that proved its suitability as an alternative bunker fuel. However, while these trials demonstrated the technical and economic case for MSAR adoption, they did not proceed to commercialisation because of external factors, primarily geopolitical in nature. Management is confident that the programme in Morocco will reconfirm the economic and environmental case for MSAR, potentially leading to the first commercial supply of the fuel in calendar H221. We note that management estimates it has sufficient cash to continue its business activities to mid-calendar Q221. A further tranche of up to £2.0m convertible loan from Bergen may be available during FY21 if certain precedent conditions are met.

Valuation: Modest adoption transformational

Based on data from the company, our scenario analysis calculates that even modest adoption of MSAR would generate material profits. A single refinery producing MSAR equivalent to 1.9Mtpa HFO under a licensing model would generate \$15.9m in annual EBITDA (see page 13 for more details).

Investment summary

Company description: Value from the bottom of the barrel

Quadrise has developed an enhanced, emulsified synthetic heavy fuel oil called MSAR. This is offered as a lower-cost substitute for conventional HFO for use in industrial applications, in land-based thermal and diesel power generation plants and in marine diesel engines. The opportunity addressed is substantial given the global HFO market is currently worth around \$135bn/year (source: Organisation of the Petroleum Exporting Countries/BP Statistical Review of World Energy). MSAR has been proven as a fuel for power generation in commercial-scale trials at Lithuania's main electrical generation plant and as an alternative marine bunker fuel through extended sea-based trials with Maersk. Over the last two years, Quadrise has reduced its reliance on the commercialisation of individual projects by establishing a global network of partner companies. This initiative has proved successful so far, despite the coronavirus pandemic, with an on-site pilot trial in Morocco completed in October and one in the US scheduled for completion in calendar Q121.

Financials: Cash runway to mid-calendar Q221

Quadrise is still pre-revenue. Stripping out share option and exceptional charges, operating losses widened by £0.2m y-o-y in FY20 to £3.2m, reflecting higher administrative expenses (largely associated with fund-raising) and a £140k non-cash commencement fee paid to Bergen. Free cash outflow increased by £0.5m to £3.0m. During the year, Quadrise raised £4.5m (gross) in total through the issue of convertible securities to Bergen, an open offer and a subscription, giving £2.4m cash at end June 2020. Management confirms this is sufficient to continue its business activities to mid-calendar Q221. A further tranche of up to £2.0m from Bergen may be available during FY21 if certain precedent conditions are met.

Valuation: Licensing model reduces cash requirement

Based on data from the company, our scenario analysis presents potential revenues, EBITDA and capex requirements for various levels of adoption by global refineries and penetration of the marine transportation market. We note that minimal capex is required for projects where MSAR is produced on a licensing basis, although the potential profit is substantially less than if Quadrise was manufacturing the MSAR itself. Even a single refinery producing, for example, MSAR equivalent to 1.9Mtpa HFO (32.4k barrels/day) under a licence arrangement would generate \$15.9m annual EBITDA, or adoption by 1% of the global shipping fleet would generate \$17.1m annual EBITDA (see page 13 for different scenarios of possible MSAR adoption and underlying assumptions).

Sensitivities: MSAR still to gain customer acceptance

The key sensitivity in our opinion is customer acceptance, because although MSAR has been proven in extensive field trials, it still needs to be accepted as a marketable, economic and low nitrogen oxide (NOx) substitute for HFO by the power and marine bunker sectors, which are inherently conservative. The economic attractiveness of MSAR adoption is driven by the refinery price 'spread' between diesel and HFO, which is currently compressed. Tightening of environmental regulations on marine engine emissions is supportive of MSAR adoption in shipping, but environmental concerns may lead to some HFO-consuming power stations switching to gas rather than MSAR. Only one-third of refineries globally are suitable for producing MSAR. We note the dilutive impact of the £2.0m convertible security issued to Bergen Opportunity Fund and that while management estimates that the recent financing activities (excluding potential £2.0m draw-down) should provide sufficient funding to mid-calendar Q221, depending on project requirements, there is no clarity on the likely timing of any material commercial agreements or the progression to break-even.

Company description: The lower-cost fuel oil solution

Quadrise is the innovator, supplier and global licensor of a disruptive residual oil technology for producing an enhanced, emulsified synthetic heavy fuel oil called MSAR (multiphase superfine atomised residue). Installing MSAR production technology increases profitability for oil refiners without incurring the significant expenditure typically associated with infrastructure upgrades. This is because it frees up valuable distillates traditionally used for HFO manufacture. The savings achieved enable refineries to price MSAR at a discount to conventional HFO. MSAR can be used for the same applications as conventional HFO, ie in industrial processes, in thermal and diesel power generation plants and in marine diesel engines, collectively worth around \$135bn/year. The economic case depends on the differential in price between diesel and HFO, and not directly on the price of crude oil.

Quadrise is focusing on four significant market segments. These are a replacement for fuel oil or crude oil in industrial processes and in power generation, as an alternative fuel in upstream oil production operations where MSAR may be used to provide an alternative fuel source for on-site utilities or to produce a low-viscosity finished fuel product that significantly reduces pipeline transport costs and as marine bunker fuel.

The market for MSAR is already proven because more than 60Mt of a first-generation oil-in-water emulsion fuel, BP and PDVSA's Orimulsion, was supplied to the global market for power generation between 1993 and 2006, when Orimulsion production in Venezuela was discontinued because of issues in the wider economy. Key members of Quadrise's management including CEO Jason Miles were instrumental in the development and commercialisation of Orimulsion. They have since continued this work in developing a technically improved second-generation emulsion fuel, MSAR. This has been proven as a substitute for marine bunker fuel through extended sea-based trials with Maersk and commercial-scale trials at Lithuania's main electrical generation plant. As neither of these projects proceeded to commercialisation, Quadrise has reduced dependence on individual projects by building up a global network of partner companies in the refining, shipping, power generation and trading markets. This initiative has proved successful so far, despite the coronavirus pandemic, with an on-site pilot trial in Morocco completing in October and an on-site trial in the US, scheduled for completion by the end of calendar Q121. The earliest that these or other projects may proceed to commercial supply of MSAR is calendar H221.

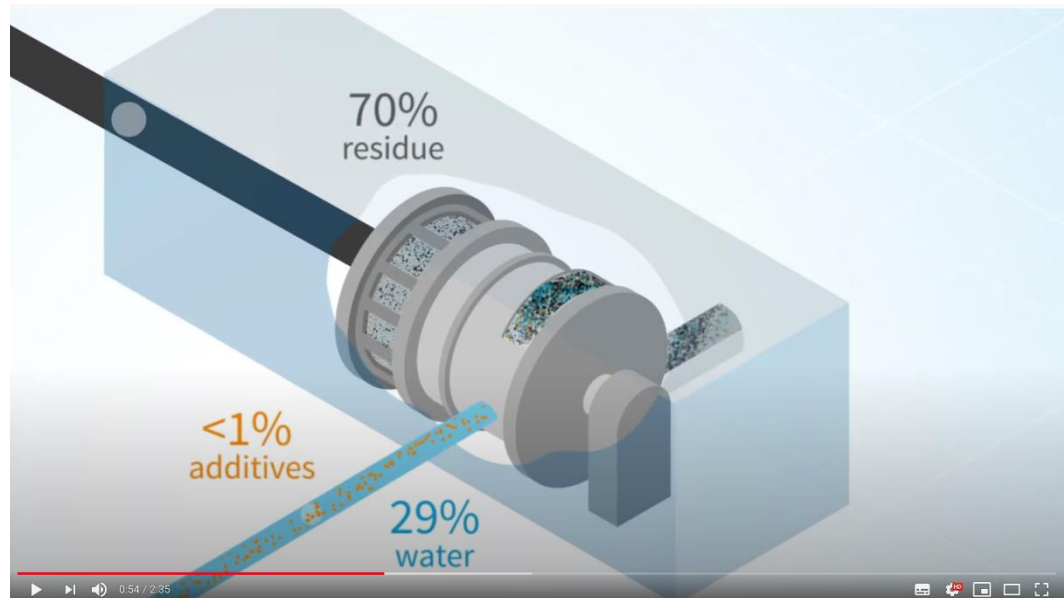
Quadrise was admitted to AIM in April 2006 and its headquarters are in London. In order to promote adoption of MSAR technology, it is developing bespoke MSAR solutions for refinery residual oils at its R&D facility in the UK, some of which activity is paid for by the potential customer, and project managing MSAR conversion projects at major refineries, marine vessels and power plants from feasibility studies through to commercial fuel production and consumption. There are three basic business models post-commercialisation. The first is for Quadrise to sell the production equipment to a refiner at a margin and grant a licence for its operation and the provision of additives. Here the refiner is responsible for selling the MSAR produced to its end customers. In the second option, toll-processing, Quadrise manufactures MSAR on behalf of the refiner, charging a fee per tonne of fuel produced, with the refiner still being responsible for the sale of MSAR to its end-customers. The third option is for Quadrise to undertake a project on a build-own-operate basis, with Quadrise purchasing suitable residue and taking responsibility for the manufacture and sale of MSAR to its own end customers. In these latter two scenarios, it is likely that Quadrise would form a JV with a local partner and seek finance specifically for that project, minimising shareholder dilution.

MSAR: Proven, established technology

Traditional refining and MSAR process compared

After refining, 70% of the output from a typical semi-complex refinery is high-value transportation fuel and 30% low-value residue. The residue is solid at room temperature and, if not processed further, can only be used for limited volume applications such as road surfacing material. Refineries widen the market for this residue by blending it with some of the high-value transportation fuel to create HFO in a mix that is 60–80% low-value residue and 20–40% valuable distillate.

Exhibit 1: Introduction to MSAR



Source: Quadrise Fuels International

The MSAR process significantly improves refinery yields by eliminating the need to blend the heavy residues with distillates to make HFO. MSAR is made by mixing the hydrocarbon residue (70%) with water (30%) and small amounts (<1%) of specialised surfactants and emulsifiers from long-term partner Nouryon (formerly AkzoNobel Specialty Chemicals). This is done through a proprietary process whereby the hydrocarbon residue is reduced to particles of approximately five to 10 microns in diameter:

- Stage One: Oil residues are taken directly from refinery rundown lines and cooled to achieve the required viscosity (c 350–500 centistoke at 100–200°C) for the colloid mill. This is a machine used to reduce the particle size of a solid in suspension in a liquid, or to reduce the droplet size in emulsions.
- Stage Two: Water, which can be derived from several waste-water utility sources, is added to the residue. Special additives are included in the water phase to stabilise the emulsion for long-term storage and conventional transport, and to promote complete combustion.
- Stage Three: The mixture is processed in a proprietary MSAR manufacturing module to a high hydrocarbon content (typically 70%) oil-in-water emulsion with enhanced fuel properties.

The surfactant chemicals ensure that the resultant emulsion is stable throughout transportation, storage, fuel handling and consumption. Quadrise is able to tailor the MSAR production process to suit different residue types and applications, broadening its applicability.

As the oil phase in MSAR is pre-atomised to very small sizes (5–10 microns) compared with atomised HFO droplets (100 microns), this increased surface area enables almost complete combustion, leaving virtually no carbon particulates in the exhaust gases. This makes MSAR more

environmentally friendly. In addition, the water in MSAR reduces the temperature of combustion, which tests carried out by Wärtsilä have shown reduces NOx emissions by 20–50%. Since the MSAR production process uses less energy than other techniques for refining residue, which may involve cracking at high temperatures or the use of solvents, it can be considered a more environmentally process in this regard as well. As the amount of sulphur in MSAR depends on the composition of the residue, MSAR is potentially available in both high sulphur and low sulphur variants.

Quadrise currently supplies two lower-cost synthetic fuel solutions: power MSAR for use in stationary applications such as boilers and kilns; and marine MSAR for shipping companies.

Adoption by oil refineries

Adoption of the MSAR process means all of the high-value middle distillate can now be sold as transportation fuel enabling the refinery to offer MSAR at a discount to HFO and still improve overall profitability. Quadrise has carried out extensive assessment work for a wide variety of refineries. This has included detailed front-end engineering design studies and determination of MSAR formulation costs for residues from individual refineries. It also has data from the installation, commissioning and operation of the 1,000t/d (6,000bpd) MSAR manufacturing unit at the CEPSPA refinery (see below).

The value generated by the refinery is not linked directly to the price of crude oil but is a function of the pricing spread between diesel and residue-based fuel oil. Using the Med (Platts) Futures for 3.5% and Gasoil 0.1% spread value for calendar 2022 of \$149/tonne as at 28 October, Quadrise calculates that for a 100kbpd semi-complex refinery producing 15kbpd of residue, a switch to MSAR would save 10kbpd of middle distillate and produce c 22kbpd of MSAR, generating an additional gross profit of \$12m each year. If spreads were to return to a more typical level of \$250/t the savings associated with a switch to MSAR would be \$64m annually. (Most refineries are operating at a loss. The breakeven spread value varies from refinery to refinery; Quadrise estimates it is around \$130/tonne.)

The studies show that a refinery can switch to MSAR relatively swiftly and inexpensively because the production technology is modular and can be integrated into an oil refinery's existing operations in less than 12 months. Quadrise calculates that the total capital expenditure required for full conversion of the 100kbpd refinery in our example would be around \$15m. The alternative approach for this type of refinery to achieve a comparable increase in crude 'yield' would be to undertake a substantial facility upgrade costing c \$1.1bn and taking four to six years. In addition, MSAR is a low viscosity liquid at room temperature so it can be stored and transported at ambient temperatures (c 20–30°C), while HFO must be heated to much higher temperatures (60–100°C). Consequently, less energy is required to handle and transport MSAR, generating further savings.

Adoption in the power industry

In 2008 Quadrise successfully completed a commercial demonstration of MSAR as boiler fuel in Lithuania. Over 22,000 tonnes of MSAR was produced at ORLEN Lietuva's 200,000bpd refinery from Urals crude-based residues. The MSAR was transported c 300km by rail to the 1,800MWe Elektrėnai power plant in Lithuania. This plant is operated by Lietuvos Elektrinė, a former Orimulsion customer, and is the primary source of Lithuania's electrical power. The systems for loading and offloading HFO were used at either end. MSAR was fired on the 2 × 150MWe Unit 7, confirming Alstom APC operational viability. Lietuvos Elektrinė concluded that the performance of MSAR was similar to or better than Orimulsion and 'suitable for long-term operation in those of our units installed with our new air pollution control equipment.' The trial results were independently verified by consultants from the European Bank for Reconstruction and Development (EBRD), but the project did not proceed to commercialisation because of the financial crash in 2009.

Exhibit 2: Elektrėnai power plant

Source: Quadrise Fuels International

Based on the studies discussed earlier and using the Cal 22 spread value of \$149/tonne as at 28 October, Quadrise calculates that converting a 400MWe boiler to MSAR, which would cost \$2.5m, would generate fuel savings of \$4.5m/year. This represents a payback time of less than a year. Quadrise estimates that 85–90% of the running costs for a boiler are related to fuel costs.

Adoption in the shipping industry

Fuel accounted for the largest proportion of a fleet's operating costs, typically c 70% for container ships, prior to the collapse in oil prices caused by the coronavirus pandemic, so switching from HFO to a lower-cost fuel such as MSAR represents an attractive option. Management estimates that, based on the spread value stated earlier, which determines the level of discount to HFO that refineries can offer, converting a very large container ship consuming 25,000 tonnes of fuel annually to MSAR would cost c \$400k and save up to \$650k/year. These savings arising from switching from HFO to MSAR are a potential way of offsetting the cost of installing scrubbers that enable a vessel to continue to use heavy sulphur fuel, which could be either a high sulphur fuel oil (HSFO) or high sulphur MSAR variant, while meeting IMO 2020 sulphur emission requirements. The main alternative to scrubbers for a shipping line is to switch to very low sulphur fuel oil (VLSFO), which is more expensive than HSFO and can be hypersensitive to mixing with other fuels on board, resulting in the precipitation of particles that can block filters and fuel injection systems, potentially causing loss of power. Prior to the introduction of the low sulphur cap, there was some concern as to whether there would be sufficient VLSFO available. Given the depressed demand for HFO from shipping at present, there is no visibility of whether this concern is justified. Switching to a low sulphur variant of marine MSAR is also an option.

At the moment the prices of VLSO and HSFO are at a level where the economics do not favour scrubber installation. In June, Lloyd's List noted that with a difference in price between HSFO and the compliant fuel oil of only \$52 per tonne in north-west Europe, the payback period for a scrubber on a capesize bulk carrier had extended beyond five years, and beyond three years for a very large crude carrier. In contrast, at the end of 2019 the difference between VLSFO and HSFO was over \$300 per tonne ahead of the implementation of the lower sulphur cap, resulting in payback times of less than a year for a very large crude carrier and just over a year for a capesize bulk carrier. Technavio expects the market to normalise between Q321 and Q122 and as it does, the economic case for switching to MSAR and scrubbers could be reinstated. Until then, there is still a material proportion of vessels that already have scrubbers installed and are able to benefit from the cost savings available from adopting high sulphur MSAR variants. As of June 2020, Lloyd's List

estimated that over 2,750 operational vessels totalling nearly 329m deadweight had scrubbers installed, representing less than 3% of all vessels by number but 16.4% of the trading crude tanker fleet, 12.2% of bulk carriers, 12.7% of containerships and 7.5% of product tankers when measured by deadweight tonnes.

We note that the potential switch to marine MSAR is relatively straightforward because it can be transported to end-users in the same way as HFO and may be used in conventional electronically controlled two-stroke and four-stroke diesel engines without the need for major modification or retuning. This compares favourably with liquefied natural gas (LNG), which is often cited as an alternative marine fuel, but has specialised and expensive storage and handling requirements. A switch from HFO to marine MSAR would also give a reduction in both NOx and black soot emissions. This may help drive demand for marine MSAR in the longer term because the International Maritime Organisation (IMO) has imposed an 80% reduction in NOx emissions for the North American and US Caribbean emission control areas, applicable for ships whose keels are laid from January 2016. From January 2021 these limits will also apply to the Baltic Sea and the North Sea, and the IMO has initiated discussions to extend this to include the Mediterranean. It is considering regulating particulate (soot) emissions.

Exhibit 3: MSAR production plant at Cepsa Refinery Gibraltar-San Roque



Source: Quadrise Fuels International

Exhibit 4: Seago Istanbul sailing its normal route during the marine MSAR trial



Source: Quadrise Fuels International

Shipping giant Maersk initially considered addressing the pending IMO legislation by switching from HFO to MSAR and spent seven years on a programme that conclusively proved that MSAR was a viable marine bunker fuel in both two- and four-stroke engines. This culminated in an operational trial on its 52,000DWT/4,300TEU container vessel, the Seago Istanbul, which took place during 2016 and 2017. The vessel completed c 1,500 MSAR running hours following its normal route, using a total of 7,000 tonnes of MSAR produced at Cepsa's Refinery Gibraltar-San Roque in Spain. The MSAR fuel performed well and feedback from engine manufacturer Wärtsilä and from Maersk was very positive. As a result, Quadrise received an interim letter of no objection (LONO) for MSAR for Wärtsilä RT-flex96C-B engines. Despite this successful outcome, in 2017 Maersk decided not to install scrubbers on the majority of its fleet and to use VLSFO instead, possibly because the IMO decided to bring forward implementation of the low sulphur legislation from 2025 to 2020, requiring a massive investment in scrubbers, estimated at around \$2m/large vessel, over a much shortened timescale.

Green MSAR

Quadrise's research, development and innovation team has been investigating the potential for manufacturing an MSAR variant that replaces some of the water and residue with biofuels or their derivatives. This would lead to significant reductions in both carbon dioxide and sulphur oxide emissions when compared with HFO, as well as the reductions in NOx and particulates that MSAR already offers consumers. Development is still at a very early stage, and details have not been

disclosed because Quadrise intends to patent the formulation. If Quadrise is able to manufacture this variant at scale, this would substantially increase the market opportunity and the speed and scale of market penetration.

Route to commercialisation

Broadening the project pipeline

The termination of the programme with Maersk in CY17 and protracted delays in setting up a trial linking an oil refinery and power station in the Kingdom of Saudi Arabia (KSA) highlighted the risk of over-reliance on a very small number of potential projects. Since then Quadrise has reduced dependence on individual projects by building up a global network of partner companies, each of which are identifying and progressing commercial opportunities involving the production and supply of MSAR (see Exhibit 5).

Exhibit 5: Alliances

Partner	Details	Date	Geographies	Initial focus
Aleph Commodities	UK company. Small group of commodities traders with significant experience in the Middle East.	Service agreement February 2019 (Kuwait) Service agreement June 2019 (Kingdom of Saudi Arabia)	Kingdom of Saudi Arabia, Kuwait	Power and Marine
Al Khafrah Holding Group	Portfolio of 42 industrial companies employing around 45,000 people, with partners in the oil, gas and petrochemical sectors that include Air Liquide and Gulf Chemicals & Industrial Oils. Replaces partnership with Rafid Group, which terminated in May 2019.	Memorandum of agreement May 2019	Kingdom of Saudi Arabia	Power
API POLY-GCL	Project origination and development company in the downstream oil, gas and power sectors both in China and globally. Energy conglomerate Golden Concord Holdings is an indirect shareholder.	Memorandum of understanding May 2019	China	Power and Marine
Bitumina	Global producer, trader and supplier of bitumen products for road construction. Also manufactures colloidal mills for bituminous products. MSAR adds value to its terminal assets and technology.	Memorandum of understanding March 2019	CIS, Poland, Romania, Vietnam	Power and Marine
Energy & Petroleum Consultants	Former Orimulsion fuel specialists	Agency agreement August 2020	Caribbean, Central and South America	Power and Marine
Freepoint Commodities	Global merchant of physical commodities and financier of upper- and mid-stream commodity-producing assets.	Co-marketing and project development agreement November 2018	Americas, Middle East, Asia	Power
Greenfield Energy	JV between Valkor and AIM-listed oil exploration company TomCo Energy planning to develop heavy and paraffinic oil deposits in Utah using technology developed by Petroteq.	Commercial trial agreement August 2020	Utah, USA	Upstream heavy oil
Hawazin Regional Trading Company	Investor and provider of expert services to the oil and gas industry in Kuwait. Major shareholder of Petroleum Dynamics Oil & Gas.	Agency agreement May 2019 Memorandum of understanding with Quadrise and Aleph May 2019	Kuwait	Power and Marine
JGC Corp	Largest engineering contractor in Japan. Offers engineering, procurement, construction, operation and maintenance, and planning and investment services to major corporate and governmental customers globally.	Memorandum of agreement November 2017	Japan, Columbia, Peru	Power and Marine
Merlin Energy Resources	Upstream oil and gas consultancy specialising in geological and geophysical exploration and production-related services.	Memorandum of understanding August 2019	Not specific to geography	Upstream heavy oil
Redliner	Industrial infrastructure rehabilitation in Mexico for the oil and gas, water and chemical industries. Has worked in PEMEX (Petróleos Mexicanos) owned refineries.	Agency agreement June 2019	Mexico	Power
Pacific Green Technologies	Provider of marine and land-based exhaust gas scrubbers	Agency agreement autumn 2020	Ecuador	None specified
Valkor Technologies	Energy services company providing engineering, design, fabrication, procurement, transportation and installation for offshore and onshore energy projects.	Memorandum of understanding Spring 2020	Utah, US	Upstream heavy oil
Younes Maamar	Former CEO of Moroccan state electricity company.	March 2019	Morocco	Power and Industrial

Source: Quadrise Fuels International

In most cases, eg Aleph or Younes Maamar, the partner is effectively a sales agent and paid only on success. For others, including Al Khafrah and Freepoint, in addition to the sales agent role there is opportunity for Quadrise and the partner to form a JV to license or manufacture MSAR. We note

that there is no guarantee that any of these partnerships will result in commercial deployments of MSAR, but having more projects in the pipeline reduces the risk associated with any one partnership failing to generate business.

Active projects

Industrial

Quadrise had hoped to conduct a pilot trial with an international chemicals and mining group headquartered in Morocco in March this year. The group is considering using MSAR as a substitute for HFO in some of its kilns. Unfortunately the trial was delayed by COVID-19 restrictions. In October, Quadrise's personnel were finally able to gain access to the site and the combined Quadrise and client project team successfully completed the Phase 1 pilot trial.

Preparations for Phase 2 of the trials are already underway as, with the approval of the client, in order to keep the MSAR validation programme broadly on track, Quadrise started work on the front-end engineering and design study earlier this year even though the pilot trial had not yet taken place. In addition, Quadrise and the client are currently working on detailed studies for a larger, industrial-scale MSAR trial at one of the client's other sites. This industrial scale trial is planned for early calendar Q121 ahead of commercial-scale Phase 2 trials, de-risking the validation programme and extending the potential for deployment across the client's facilities. This industrial-scale trial was not included in the original agreement signed in calendar Q419. The client is paying Quadrise a total of £100k, in agreed stages, for the Phase 2 work. Management is confident that this programme will enable it to validate the economic and environmental benefits of MSAR at an industrial scale, potentially leading to the first commercial supply of MSAR in calendar H221. We think it is likely that the decision-making process for this project is much less complicated than that for the Maersk and earlier KSA projects, increasing the chance of success.

Exhibit 6: Pumping and heating unit on site during initial Morocco trial



Source: Quadrise Fuels International

Exhibit 7: Pilot kiln burning MSAR in initial Morocco trial



Source: Quadrise Fuels International

Upstream

In August 2020 Quadrise announced that it had entered into a commercial trial agreement with Greenfield Energy LLC. The trial phase includes testing Greenfield's oil samples at Quadrise's research facility, lending Greenfield commercial MSAR production and test equipment, supplying specialist MSAR additives for the trial and supporting the commercial-scale demonstration. Greenfield intends to produce over 600 barrels of power-grade MSAR during the trial. Quadrise is currently completing work on the MSAR Manufacturing Unit required for the trial, which it intends to

install at the customer site during December 2020, subject to any lockdown restrictions. The schedule is also contingent on the client being able to reactivate oil sand extraction and processing at the site in November so it can supply Quadrise with samples for checking on the appropriate MSAR formulation ahead of the trial. Quadrise will receive \$150k for providing equipment and support during the trial.

Greenfield Energy is a joint venture established in June 2020 between oil exploration and technology company TomCo Energy and engineering services provider Valkor Technologies. Greenfield has taken over the management and operations of Petroteq Energy's existing oil sands plant at Asphalt Ridge in Utah. This plant uses Petroteq's patented solvent extraction technology to extract crude oil from oil sands. Greenfield intends to expand capacity at the site to support extensive trials, complementing the Petroteq process with Quadrise's patented MSAR technology. This step is designed to convert the crude oil into a premium, heavy fuel oil product for retail sale as a diesel replacement for medium speed engines, boilers and other heavy machinery. Alternatively, since the bituminous sands in Utah have a relatively low sulphur content, the crude oil could be converted via the MSAR process into a bunker fuel that is compliant with the latest regulations from the IMO. If the trial is successful and it can identify a suitable market for its oil, Greenfield intends to work with Quadrise to develop its own commercial-scale (up to 10,000 barrels of oil per day) oil sands plants in Utah that will license MSAR technology.

Quadrise notes that if the initial trial is successfully completed in calendar Q121 and Greenfield progresses its plans to commercialise the assets, it would be in a position to start providing equipment to site in calendar 2021. However the timing of any progression to commercial operations will be determined by Greenfield's assessment of the economics of field development, which will include a decision on the use of the technology used to extract the heavy oil from the oil sand.

Power

Quadrise made rapid progress in Ecuador in calendar H120. Quadrise held an initial meeting with senior management of the national oil company in January to review the potential to use MSAR for refinery refuelling, leading to domestic power generation and export opportunities that would reduce energy costs and emissions for the country. This is a refinery well known to Quadrise because it worked on a project there several years earlier. Following the initial meeting this year, a three-person team from Quadrise visited the site and adjacent power utility in early March 2020. During the next two months there was extensive dialogue with the client's technical and economic teams, following which Quadrise remotely presented to the client team its extensive Techno-Economic Study, which was positively received. Subsequent changes in the client's management team mean that so far the anticipated review of the study and the agreement of next steps including proof-of-concept testing at Quadrise's research facility and trialling MSAR at the refinery as a precursor to commercial implementation have not happened. Management is working with in-country representatives at Freeport to progress the opportunity with both the potential client and the relevant ministries and has recently provided a briefing to the energy minister. In parallel Quadrise has initiated a programme to investigate upstream applications for MSAR in the country, commencing with a recent presentation to the Society of Petroleum Engineers Ecuador.

The work carried out by Quadrise and its former partner Rafid in KSA did not proceed to a full-scale trial in early CY18 because of issues between the oil company and the power company in KSA that were unrelated to the MSAR project. Quadrise's new local partner in KSA, Al Khafrah, organised a meeting in Riyadh in March 2020 between Quadrise and representatives from KSA's major power utility and a major boiler OEM to discuss resuming the planned 400MWe boiler trial using MSAR manufactured in KSA. Following the March meeting, Al Khafrah maintained contact with the power utility, holding a further meeting via conference call, with follow-up over the summer. In parallel, Quadrise and Al Khafrah are jointly progressing contacts at the highest levels with other major

stakeholders. Quadrise is supporting this drive through the publication in August of a White Paper available in both English and Arabic, which outlines the economic and environmental advantages that adoption of MSAR would deliver to KSA and the Middle East and by launching an Arabic version of its website. We note that the economic benefits of MSAR in reducing the volume of diesel and HFO imports to KSA, which management estimates to be worth c \$400m annually, remain valid.

Quadrise continues to work with Redliner in Mexico. Redliner has been progressing opportunities with the national oil company and has engaged with stakeholders at very senior levels. As well as upstream, the opportunities include refinery refuelling and domestic power generation. Adopting MSAR would be doubly beneficial for the national oil company because at the moment limited demand for HFO means that oil production is constrained to match HFO demand. If residues were converted to MSAR and sold as marine bunker fuel, this would not only release distillates for export but also allow expansion of production. However, the COVID-19 pandemic has so far prevented the client from collating the information that Quadrise needs to prepare the techno-economic study for multiple refineries as planned. Redliner recently submitted MSAR briefings directly to Mexico's energy secretary and key directors of the national oil company.

Marine

Quadrise is discussing potential MSAR trials with two shipping companies, both with large fleets, that have installed scrubbers to address the IMO regulations. One is in the bulk shipment segment, one in the container segment. Quadrise is aiming to initiate at least one letter of no objection (LONO) project with at least one of these shipping line operators by Christmas as these trials are lengthy, typically involving 4,000 operating hours and lasting six to nine months.

Management

Quadrise's management has the breadth and depth of experience required to commercialise the MSAR technology. CEO Jason Miles spent the first 12 years of his career developing emulsified fuel projects, initially as a process engineer for BP and subsequently as business development manager for PDVSA, where he implemented numerous Orimulsion power projects globally, and now has around 26 years' technical and commercial experience in the emulsion fuels industry. He joined Quadrise in 2006, and was promoted from COO to CEO in February 2020. COO Mark Whittle is a chemical engineer with over 25 years' experience in the energy industry, covering both the downstream oil and renewables sectors. He started his career at Esso's Fawley refinery, then worked for Criterion Catalysts & Technologies (part of Royal Dutch Shell), Louis Dreyfus and ConocoPhillips on a worldwide basis. His experience includes refining, technology transfer, asset optimisation, refinery economics, strategic planning, project development and trading. He joined Quadrise in July 2015 as general manager – refining and was promoted from head of projects to COO in February 2020.

These skills are complemented by significant downstream oil, financial and capital markets experience. For example, Mike Kirk became a non-executive director in December 2015, stepping up to the executive chairman's role in April 2016 on the retirement of Ian Williams. He served as a corporate finance partner at Cazenove providing advisory services to a number of clients in the utilities, oil and gas and oilfield service sectors. While at Cazenove, Mike led the flotation of Wood Group, Expro International and KBC Advanced Technologies, where he also served as a non-executive director for nine years. Since leaving the City, Mike has held a portfolio of non-executive directorships for a variety of companies and is chairman of Vivid Homes. Prior to working in the City, Mike worked in the chemical and nuclear industries.

Sensitivities

Customer acceptance: Quadrise's MSAR has been proven both in extensive marine trials with Maersk and in a commercial and technical demonstration in Lithuania. However, MSAR still needs to be adopted as a marketable, environmentally friendly and economic substitute for HFO by the power and marine bunker sectors, which are inherently conservative. Moreover, unless refineries intend to use the MSAR they produce within their own operations, there needs to be enough customers using MSAR for power generation, providing heat for industrial processes or transportation for refineries to start manufacturing the fuel.

Fuel oil spreads: The refinery price 'spread' between diesel and HFO determines the economic attractiveness of a switch in converting heavy residue to MSAR, rather than HFO, and thus the amount by which MSAR may be discounted with respect to HFO. In addition, depressed oil prices tend to extend decision-making cycles. This differential or spread was expected to increase following the implementation of the IMO regulations in January 2020, which reduced the global sulphur cap outside emission control areas from 3.5% to 0.5% because of reduced demand for HSFO and increased demand for diesel from shipping. However demand for both HFO for shipping and for diesel for automotive vehicles has substantially reduced because of the coronavirus pandemic, resulting in a broadly similar percentage price reduction for both fuels and therefore a compression of the price differential and a reduction in the cost saving associated with a switch to MSAR.

Not applicable to all refineries: Only one-third of refineries globally are suitable for producing MSAR because some do not produce any liquid residue and some inland refineries would have logistics issues. However, this still offers substantial scope for MSAR uptake.

Environmental: The IMO 2020 increases in environmental restrictions on marine engine emission characteristics play to the advantage of MSAR as a marine fuel. However, for power generation, environmental and supply concerns as well as the availability of cheap gas in certain regions may lead to a number of oil-consuming power stations converting to gas where they can.

Partner risk: Quadrise has been working with Nouryon since 2004. It has recently signed a three-year contract with Nouryon for the exclusive global collaboration and supply of goods and services for future MSAR projects to October 2022.

Financial: In October 2020 management advised that it had sufficient cash to continue its business activities to mid-calendar Q221 with a further tranche of up to £2.0m from Bergen potentially available during FY21 if certain precedent conditions are met. The convertible security issued to Bergen Opportunity Fund in August 2019 (see below) is materially dilutive.

Financials

Still at a pre-revenue stage

Quadrise is still at a pre-revenue stage. Stripping out share option and exceptional charges, operating losses widened by £0.2m y-o-y in FY20 to £3.2m. Production and development costs were £0.1m lower year-on-year at £1.4m because the prior year included the costs of decommissioning equipment left at the CEPESA site following the production of MSAR for the Maersk LONO trials. Administrative expenses were £0.4m higher at £1.8m because of professional fees associated with fund-raising and director bonuses. Reported losses before tax widened by £1.8m to £5.0m, the difference being primarily attributable to £1.1m fair value adjustments on the convertible securities issued to Bergen and a £0.1m non-cash commencement fee paid to Bergen.

Conserving cash

The group commenced FY20 with £1.1m cash and no debt and finished the year with £2.4m cash and £2.0m convertible securities. Working capital increased by £0.1m. Capital expenditure was minimal. Free cash outflow increased by £0.5m to £3.0m. This was offset by a programme raising a total of £4.5m (gross). This began with the receipt of £2.0m cash resulting from the issue of a convertible security to Bergen Global Opportunity Fund on 30 August 2019, which is the first tranche of zero-coupon convertible securities potentially generating up to £4.0m cash. This was supplemented by an open offer raising £1.8m (gross) at 3.96p/share with warrants attached and a subscription raising £0.7m (gross), also at 3.96p/share with warrants attached. 46.6m new shares and 23.3m warrants were issued in connection with the open offer.

Net assets totalled £4.0m at the period end compared with £4.8m at the start. The period end total included £0.6m fixed tangible assets, mainly plant and equipment in the R&D facility, and £2.9m intangibles associated with the MSAR trade name.

In October 2020 management stated that it expected the cash levels at that point to be sufficient to continue its business activities to mid-calendar Q221 and that it would explore fundraising possibilities before this point. This includes, but is not restricted to a further tranche of up to £2.0m cash from Bergen that may be available during FY21 provided the aggregate nominal value (up to £2.15m) does not exceed 3.5% of the company's market capitalisation on issue and the share price has not remained below 3p for 60 days. Both the initial tranche and the second tranche have 24-month maturity dates from the dates of their respective issuance. Any convertible securities not converted prior to the maturity dates will automatically convert into ordinary shares at that point. Up to £0.8m of the convertibles may be converted at 5.78p/share, and the conversion price of the remainder will be the average of five daily volume-weighted average prices during a specified period before the conversion date (see Exhibit 8 for conversion so far). Bergen is contractually precluded from short selling Quadrise shares. Quadrise is precluded from entering into certain prohibited transactions that would adversely affect Bergen's position for a period of 120 days after all the convertibles have converted. Quadrise has also issued 4.9m 36-month warrants to Bergen, initially exercisable at 5.78p/share.

Exhibit 8: Convertible securities

Conversion notice date	Balance converted	Conversion price (p)	Number of shares	Share price on conversion date (p)	Fair Value (£)
Total issued	2,150,000.00				
23-Mar-20	100,000.00	1.2	8,333,333.33	1.675	139,583.33
15-Apr-20	100,000.00	1.2	8,333,333.33	1.533	127,750.00
22-Jun-20	250,000.00	1.1	22,727,272.73	2.975	676,136.36
20-Aug-20	300,000.00	1.6	18,750,000.00	2.900	543,750.00
07-Sep-20	400,000.00	1.7	23,529,411.76	2.755	648,235.29
Remaining	1,150,000.00		81,673,351.16		

Source: Quadrise Fuels International data

Valuation

As Quadrise has yet to generate commercial revenues, its value resides in the potential future cash flow generated from volume production of MSAR. Since there is little visibility on when any of the projects Quadrise is working on with its partners will progress to commercialisation, precluding the preparation of estimates, we present a high-level scenario analysis based on data from the company that we understand is derived from numerous detailed case studies it has carried out for prospective clients. This shows potential revenues, EBITDA and capex requirements attributable to Quadrise for various levels of adoption by global refineries and penetration of the marine transportation market. We note that minimal capex is required for projects where MSAR is

produced on a licensing basis, although the potential profit and risk is substantially less than if Quadrise was manufacturing the MSAR itself on either a toll (charging a fee per tonne of MSAR manufactured) or merchant (selling MSAR itself) basis. We expect that Quadrise will form a separately financed JV with a partner for projects involving production on a tolling or merchant basis, thus avoiding substantial investment in capex and minimising shareholder dilution.

Exhibit 9: Possible financial implications for Quadrise from different MSAR adoption scenarios

Power market				
Number of MSAR manufacturing units	8	40	80	200
Production capacity (HFO equivalents mtpa)	1.9	9.3	18.6	46.6
% global HFO market*	0.5%	2.3%	4.6%	11.6%
Revenues – licence model (\$m)	63.3	316.7	633.4	1,583.6
EBITDA – licence model (\$m)	15.9	79.4	158.8	397.1
Revenues – tolling model (\$m)	122.1	610.6	1,221.1	3,052.9
EBITDA – tolling model (\$m)	41.2	205.8	411.6	1,029.1
Capex – tolling model (\$m)	(53.5)	(267.5)	(535.0)	(1,337.5)
Revenues – merchant model (\$m)	419.2	2,095.9	4,191.8	10,479.4
EBITDA – merchant model (\$m)	64.8	323.9	647.8	1,619.4
Capex – merchant model (\$m)	(68.1)	(340.5)	(681.0)	(1,702.5)
Marine market				
Number of vessels using MSAR	75	375	750	1,875
% global fleet	1.3%	6.3%	12.6%	31.5%
Revenues – licence model (\$m)	99.7	498.6	997.1	2,492.8
EBITDA – licence model (\$m)	17.1	85.5	171.0	427.5
Revenues – tolling model (\$m)	153.2	766.1	1,532.1	3,830.3
EBITDA – tolling model (\$m)	37.1	185.5	371.1	927.7
Capex – tolling model (\$m)	(53.5)	(267.5)	(535.0)	(1,337.5)
Revenues – merchant model (\$m)	419.2	2,095.9	4,191.8	10,479.4
EBITDA – merchant model (\$m)	29.6	148.1	296.2	740.6
Capex – merchant model (\$m)	(68.1)	(340.5)	(681.0)	(1,702.5)

Source: Edison Investment Research based on company data. Note: *2019 volumes (source: BP 2020 Statistical Review).

Even a single refinery producing MSAR equivalent to 1.9m tonnes of HFO annually (32.4kbd), or adoption by 1% of the world's shipping fleet, would make the group materially cash generative. For example, based on current fuel prices and spreads, one refinery producing MSAR equivalent to 1.9m tonnes of HFO annually would generate annual licence revenues of \$63.3m and EBITDA of \$15.9m and require minimal capex. In our opinion, adoption of MSAR by one refinery or shipping line would encourage competitors to deploy the technology, supporting the upper range of the analysis.

Exhibit 10: Financial summary

	£000s	2016	2017	2018	2019	2020
Year end 30 June		IFRS	IFRS	IFRS	IFRS	IFRS
INCOME STATEMENT						
Revenue		2	126	9	22	0
EBITDA		(3,989)	(3,858)	(3,284)	(2,780)	(3,072)
Operating Profit (before amort. and except.)		(4,137)	(4,069)	(3,514)	(3,010)	(3,244)
Amortisation of acquired intangibles		0	0	0	0	0
Exceptionals		0	0	0	0	(1,133)
Share-based payments		(802)	(242)	(53)	(154)	(474)
Reported operating profit		(4,939)	(4,311)	(3,567)	(3,164)	(4,851)
Net Interest		33	9	11	(3)	(139)
Profit Before Tax (norm)		(4,104)	(4,060)	(3,503)	(3,013)	(3,383)
Profit Before Tax (reported)		(4,906)	(4,302)	(3,556)	(3,167)	(4,990)
Reported tax		149	213	294	184	147
Profit After Tax (norm)		(3,955)	(3,847)	(3,209)	(2,829)	(3,236)
Profit After Tax (reported)		(4,757)	(4,089)	(3,262)	(2,983)	(4,843)
Minority interests		0	0	0	0	0
Discontinued operations		0	0	0	0	0
Net income (normalised)		(3,955)	(3,847)	(3,209)	(2,829)	(3,236)
Net income (reported)		(4,757)	(4,089)	(3,262)	(2,983)	(4,843)
Average Number of Shares Outstanding (m)		809.6	846.1	862.2	888.7	982.8
EPS - normalised (p)		(0.49)	(0.45)	(0.37)	(0.32)	(0.32)
EPS - diluted normalised (p)		(0.49)	(0.45)	(0.37)	(0.32)	(0.33)
EPS - basic reported (p)		(0.59)	(0.48)	(0.38)	(0.34)	(0.49)
Dividend per share (p)		0.00	0.00	0.00	0.00	0.00
BALANCE SHEET						
Fixed Assets		4,080	3,980	3,885	3,654	3,506
Intangible Assets		2,924	2,924	2,924	2,924	2,924
Tangible Assets		1,156	1,056	961	730	582
Investments & other		0	0	0	0	0
Current Assets		4,685	5,561	2,600	1,396	2,766
Stocks		0	61	61	61	61
Debtors		297	302	188	169	213
Cash & cash equivalents		4,268	5,045	2,229	1,060	2,380
Other		120	153	122	106	112
Current Liabilities		(576)	(247)	(400)	(288)	(2,243)
Creditors		(576)	(247)	(400)	(288)	(198)
Tax and social security		0	0	0	0	0
Short term borrowings		0	0	0	0	0
Convertible securities		0	0	0	0	(2,045)
Long Term Liabilities		0	0	0	0	0
Long term borrowings		0	0	0	0	0
Other long term liabilities		0	0	0	0	0
Net Assets		8,189	9,294	6,085	4,762	4,029
Minority interests		0	0	0	0	0
Shareholders' equity		8,189	9,294	6,085	4,762	4,029
CASH FLOW						
Op Cash Flow before WC and tax		(3,989)	(3,858)	(3,284)	(2,780)	(3,072)
Working capital		308	(428)	298	(77)	(140)
Exceptional & other		2	0	0	130	65
Tax		149	213	294	184	147
Net operating cash flow		(3,530)	(4,073)	(2,692)	(2,543)	(3,000)
Capex		(596)	(111)	(135)	(24)	(24)
Acquisitions/disposals		0	0	0	0	0
Net interest		33	9	11	(3)	1
Equity financing		0	4,952	0	1,401	2,343
Dividends		0	0	0	0	0
Other		0	0	0	0	0
Net Cash Flow		(4,093)	777	(2,816)	(1,169)	(680)
Opening net debt/(cash)		(8,361)	(4,268)	(5,045)	(2,229)	(1,060)
FX		0	0	0	0	0
Other non-cash movements		0	0	0	0	2,000
Closing net debt/(cash)		(4,268)	(5,045)	(2,229)	(1,060)	(2,380)*

Source: Quadrisse Fuels International data. Note: *Excluding convertible securities

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Management team	
Executive chairman: Mike Kirk	CEO: Jason Miles
Mike Kirk was managing director of Weber Shandwick Square Mile until 2005. Prior to that he worked in the corporate finance department of Cazenove for over 13 years, advising on the demerger of Centrica from British Gas and the UK listings of John Wood Group and KBC Advanced Technologies. He is currently non-executive chairman of Vivid Homes.	Jason Miles spent 12 years developing emulsion fuel projects, initially as a process engineer with BP and subsequently as business development manager for PDVSA, where he implemented various Orimulsion projects globally. He joined Quadrise in 2006 and now has around 26 years' technical and commercial experience in the emulsion fuels industry.

COO: Mark Whittle	
Mark Whittle is a chemical engineer with over 25 years' experience in both the downstream oil and renewables sectors. He started his career at Esso's Fawley refinery, then worked for Criterion Catalysts & Technologies (part of Royal Dutch Shell), Louis Dreyfus and ConocoPhillips on a worldwide basis. His experience includes refining, technology transfer, asset optimisation, refinery economics, strategic planning, project development and trading.	

Principal shareholders	(%)
Hargreaves Lansdown	12.3%
Interactive Investor Services Limited	10.2%
Ruudowen Limited	5.8%
Halifax Share Dealing	5.1%
Phibatec Limited	4.9%
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