EDISON

IQE

Interims

Capitalising on market transitions

Tech hardware & equipment

IQE is benefiting from multiple megatrends as it supplies epitaxy for the photonics chips that transmit data in the volumes required for full adoption of the Internet of Things and provide the accurate visual information required for autonomous vehicles, Industry 4.0, augmented reality and virtual reality. This is driving a second wave of growth, with an estimated 66% increase in PBT forecast between FY16 and FY19. Our DCF analysis indicates that the share price is undervalued if photonics growth resumes in Q219 and is sustained over a five-year period, in line with management guidance.

Year end	Revenue (£m)	PBT* (£m)	EPS* (p)	DPS (p)	P/E (x)	Yield (%)
12/16**	132.7	20.6	2.89	0.0	21.5	N/A
12/17	154.5	24.3	3.36	0.0	18.5	N/A
12/18e	162.5	16.8	1.81	0.0	34.3	N/A
12/19e	194.8	34.1	3.48	0.0	17.8	N/A

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

Beneficiary of multiple megatrends

IQE enjoyed stellar growth between 2004 and 2013 because of the wireless handset boom. More recently, advances in IQE's photonics capability underlie a second growth wave that accelerated in mid-2017 with VCSEL (vertical cavity surface emitting laser) volume ramp-ups that we infer were related to the face recognition functionality in the iPhone X. We expect photonics growth to resume in Q219 after a period of destocking related to this programme, having recently reported sales weakness in at least one new OEM product launched this autumn. Successful execution in the power electronics market with epitaxy for power conversion chips and 5G adoption could trigger a third wave of significant growth in two or three years' time.

Further VCSEL product qualifications herald ramp-up

The recent work on VCSEL product qualifications has resulted in IQE being in mass production with multiple VCSEL chip manufacturers and in final qualification stages with others. Volumes for these programmes, which include production for Android OEMs as well as applications for other markets segments, are already ramping up, underpinning management's expectation of a photonics ramp-up in FY19 and reducing exposure to an individual programme.

Valuation: Potential gains as confidence returns

IQE's share price has fallen by over 30% since the trading update on 12 November. Our DCF analysis gives an indicative valuation range of 64–132p, based on the lower and upper bounds of management guidance for segmental growth. We see potential for share price improvement as investor confidence in photonics demand returns.

23 November 2018

Price	**62.00p**
Market cap	**£481m**
Net cash (£m) at end June 2018	40.6
Shares in issue	776.02
Free float	95.5%
Code	IQE
Primary exchange	AIM
Secondary exchange	N/A

Share price performance

%	1m	3m	12m
Abs	(27.3)	(39.5)	(64.7)
Rel (local)	(26.4)	(33.9)	(62.3)
52-week high/low		174.2p	56.2p

Business description

IQE is the leading supplier of epitaxial compound semiconductor wafers globally. The principal applications include radio frequency semiconductors, devices for optical networks, vertical cavity lasers, infrared semiconductors and power electronics.

Next events

Prelims	March 2019

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Investment summary

Company description: Growth from multiple verticals

IQE is the largest supplier of compound semiconductor epitaxy wafers globally and has the most comprehensive product offering. This extensive technology range has helped it to gain over 55% (source: Yole Développement/management estimates) share of the wireless market and a dominant share of the photonics market. A significant majority of wafer sales (60% in FY17) are still generated from the wireless segment, where its wafers are used to make radio frequency chips, primarily for use in mobile devices. However, as smartphone growth slowed, management invested profits in developing technologies addressing other industry verticals with the potential to drive strong growth over a four- or five-year period. This policy is already bearing fruit. Demand for photonics wafers (31% of FY17 wafer revenues) is growing strongly, as the first mass-market ramp for a VCSEL application, which started at the end of H117, is being followed by volume ramp-ups for VCSELs deployed in other applications. Revenues from the supply of epitaxy for power electronics represent potential for a third wave of growth in future years.

Financials: Management adding capacity for continued growth

Total H118 revenues grew by 4% year-on-year to £73.4m, with the photonics segment growing by 30% in constant currency to 26% of the total. Adjusted profit before tax was depressed by several factors, including a currency headwind, the cost of multiple, low-margin VCSEL qualification programmes and the cost of staffing the new Newport facility prior to commencing production, falling by 21% to £7.6m. Collectively, these one-off effects totalled £3.5m. If these costs are stripped out, adjusted profit before tax becomes £11.1m, a 14% improvement on the prior year period. Net cash reduced by £5.0m during the period to £40.6m at the end of June, reflecting continued investment in multiple innovative technologies and capex for the new Newport foundry.

Valuation: Undervalued if management guidance achieved

Our DCF analysis gives an indicative valuation range of 64–132p, based on the lower and upper bounds of management guidance for segmental growth. The current share price is below the lower bound of this range. This indicates that, if IQE were to achieve segmental growth rates in line with the lower bound of management guidance or higher, the share price correction would appear excessive. Industry newsflow on resumption of volume deliveries for the iPhone programmes and updates on the other VCSEL programmes that have recently commenced production should therefore result in share price appreciation.

Sensitivities: Uncertainty in predicting rate of volume ramp-up

The key sensitivity remains the rate of growth of the current volume VCSEL programmes, which are not under IQE's control (eg the recent destocking/market softness for a recent OEM product launch), and ramp-up of newer technologies such as full-service DFB (distributed feedback) lasers using nanoimprint lithography and GaN-on-Si/SiC. While the growth in photonics has substantially diversified the business, IQE's financial performance remains heavily influenced by the health and inventory cycle of the handset industry. Sales and earnings are also exposed to changes in the US dollar/sterling exchange rate. The impact is largely translational, with minimal transactional exposure.

Company description: Forefront of compound semiconductor industry

IQE is the largest outsourced supplier of advanced wafer products and wafer services to the compound semiconductor industry. The fundamentals of its manufacturing process involve taking very thin discs of compound semiconductor material up to 150mm in diameter (substrates) and depositing successive thin 'epitaxial' layers, each consisting of different semiconductor combinations tailored for a specific function, on them. The complete layered structure on the substrate is an epitaxial wafer. IQE sells these epitaxial wafers to manufacturers of wireless chips and optical devices such as laser chips, who carry out further processing steps to create finished devices. IQE has reached its dominant position with respect to both market share and breadth of products offered. IQE's market position is supported by over 180 patents and a rich pool of trade secrets, generated through a combination of organic development and acquisitions. It has facilities in Europe, the US and Asia, giving it a presence in all three major semiconductor manufacturing regions and the ability to provide a back-up source of supply for customers from within the group.

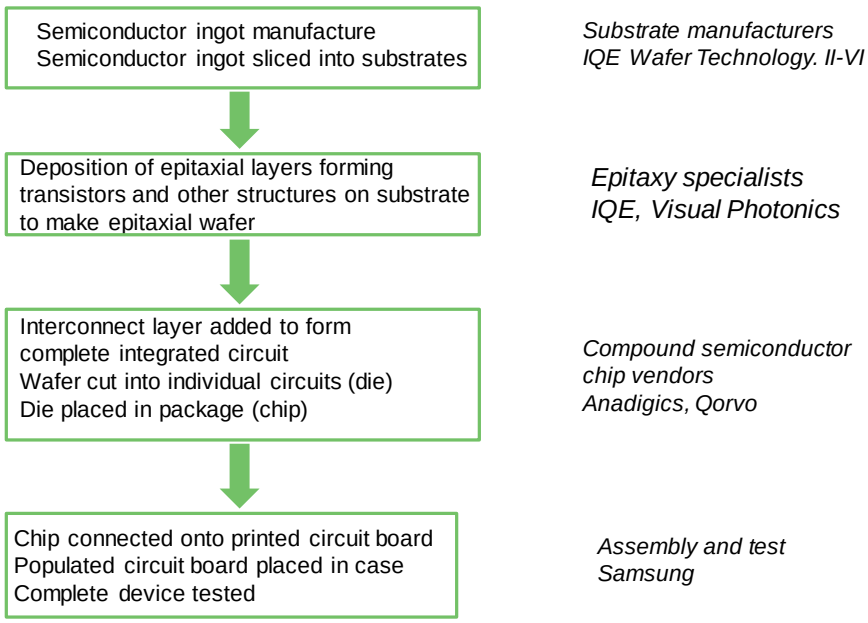
IQE is able offer a wider range of technologies than its competitors and many in-house epitaxy units. This gives it a strong competitive advantage and means that it can benefit from growth in multiple markets. IQE is continually refining its advanced epitaxy skills to create innovative value-added, materials-based solutions for its customers. As IQE's IP portfolio has expanded, the dynamics of customer engagement have changed from an outsourced epitaxy manufacturer to a sought-after technology adviser.

IQE employs over 560 people (excluding the joint ventures) and its headquarters are in Cardiff, Wales. The shares were admitted to the London Stock Exchange in 2000.

Technology overview

Epitaxy specialist

Exhibit 1: Compound semiconductor supply chain



Source: Edison Investment Research

IQE's wafer manufacturing service is a critical stage of the compound semiconductor supply chain. Its wafer foundries take very thin discs of substrate (compound semiconductor, silicon or silicon carbide) and deposit a succession of thin layers on them. Up to 400 epitaxial layers may be deposited, each of which may be only a few atoms thick. Each separate epitaxial layer contains a different combination of elements to give specific electrical or optical properties. By precisely controlling the thickness and composition of the layers deposited on the substrate, IQE provides customised epiwafers that meet each customer's specific electrical and optical requirements. The finished epiwafers are sold to manufacturers of high-frequency chipsets and laser chips. These carry out further processing steps to create finished chips, which are then integrated into products such as mobile phones, datacomms equipment and automobiles.

Tailoring compound semiconductors for multiple industry verticals

Compound semiconductors are made from a mixture of elements. By combining elements (eg gallium, arsenic, indium, antimony, phosphorus and aluminium) in different proportions, IQE can make compound semiconductor materials with a diverse range of optoelectronic and electronic properties, each optimised for a particular market segment. These include materials that transmit and receive wireless, RF (radio frequency) or IR (infrared) signals, emit and detect light (photonics), convert light energy to electrical energy (photovoltaics) and can function at high voltages (power electronics). This diversity contrasts with silicon semiconductors, which are based on a single element and therefore have a fixed set of electronic characteristics, limiting their performance in key optical, RF and high-power applications.

IP leader

IQE is continually refining its advanced epitaxy skills to create innovative, value-added, materials-based solutions for its customers. As its IP portfolio has expanded, the dynamics of customer engagement have changed from an outsourced epitaxy manufacturer to a sought-after technology adviser. IQE is now the market leader with respect to the breadth of its product portfolio, which encompasses over 180 patents, and with respect to scale. Its different technology platforms (see Exhibit 2) can be combined to create novel solutions that are applicable across multiple market sectors.

Exhibit 2: Materials tool box

Technology platform	Applications
Rare earth technologies	GaN power for EV charging, RF GaN for 5G transmitters, superior performance RF filters for 5G mobile phones, HBTs (heterojunction bipolar transistor) that process high-frequency signals in mobile phones, IR detectors used in night vision systems(demonstration devices in fabrication), silicon photonics for biometrics, III-Nitride for laser devices.
Dilute nitrides	Improved efficiency HBTs to improve mobile phone battery life (currently sampling), manufacturing photodetectors on GaAs substrate rather than InP means that larger diameter, less expensive substrates can be used, resulting in lower-cost devices, VCSELs operating with a longer wavelength light giving improved eye safety for applications such as LiDAR (prototype sampling H119).
Porous silicon	Higher-performance/lower-cost RF switches for mobile phones (sampling Q419), tuneable sensors, less expensive substrate for silicon photonics replacing silicon-on-insulator.
III-V on Group IV	Indium phosphide transistors integrated with NMOS and PMOS regions, quantum dot lasers layered on silicon substrate and GaAs photoconductive elements layered on silicon giving optical elements on the same chip as conventional memory and logic processing elements.
QPC (quasi-photonic crystals) NIL (nanoimprint lithography)	Enables integration of diffraction optics elements with VCSELs on a wafer (fabrication of demo scheduled Q119), reduced cost light diffusers, compact chip-to-chip coupling through silicon photonics.
Advanced III-N	Engineered substrates for power components used in EV charging, GaN-on-GaN for data centre and solar power applications, InAl(Ga)N for 5G devices.

Source: Company data

Dominant market share

IQE's extensive technology portfolio, combined with its scale, has given it the dominant share of the non-captive wireless market (over 55%) and a dominant share in both the photonics (c 90%) and

infrared (70-80%) markets. In our opinion, it would be difficult and time consuming for a competitor to replicate the breadth of product portfolio. IQE also benefits from having multiple sites, with fabrication facilities in the US, Europe and the Far East. This means that it is able to offer customers dual sourcing from within the group.

Customer stickiness

Once customers have qualified an epitaxy vendor, they are extremely unlikely to risk compromising device performance by switching to alternative suppliers for the sake of saving several cents on a device that could be worth $1,000. IQE has direct experience of chip vendors being reluctant to change epitaxy supplier, purchasing Kopin's epitaxy activity in 2013 to secure key customers that would not risk switching suppliers.

Markets: IP accesses multiple verticals

The range of technologies that IQE offers (Exhibit 2) means it is engaged in multiple markets, each with different growth trajectories. The wireless segment was the principal driver in the decade from 2004 and remains IQE's largest segment. However, photonics has taken over as the primary growth engine and it is expected to retain this role during the remainder of the forecast period.

Wireless communications (59% of FY17 revenues)

Taking share in the handset market

Compound semiconductors have inherent material properties that are superior to silicon (eg higher electron mobility, higher breakdown voltage), making them the materials of choice for high-frequency applications with stringent efficiency, noise and linearity requirements. Their deployment enables the creation of higher-frequency, lower noise and more power-efficient power amplifiers, which is important in mobile, satellite and wireless communications applications. In a mobile phone, the memory and data processing chips are typically silicon, but the transmit and receive functions are gallium arsenide (GaAs), especially in higher-specification handsets. This is because GaAs power amplifiers operate at higher frequencies and are more efficient than their silicon counterparts, thus enabling longer times between battery charges.

Since IQE has the dominant share (management estimates over 55%) of the merchant wireless epitaxy market, it has provided a significant proportion of the epitaxial wafers used to make power amplifier chips, and thus benefited historically from growth in demand for smartphones. Although global smartphone unit sales appear to have plateaued, industry analyst Yole Développement predicts that the global power amplifier market will continue to grow with a 7% CAGR between 2017 and 2023, reflecting the increasing volumes of data being transmitted as the market transitions to 5G. IQE's dilute nitride technology, which is currently being sampled by customers, keeps it ahead of competitors by improving the efficiency of power amplifiers, thus extending battery life.

Exhibit 3: Size of front-end market

Component	2017 market size	2023 market size	CAGR	IQE technology	IQE target share 2023
Filters	$8bn	$22.5bn	19%	Rare earth oxide	5%
Antenna tuners	$0.5bn	$1bn	15%	-	0%
Switches	$1bn	$3bn	15%	Porous silicon	5%
Power amplifiers	$5bn	$7bn	7%	GaAs/dilute nitride	60%
Low noise amplifiers	$0.2m	$0.6bn	16%	GaAs	10%
Millimetre wave front-end module	$0m	$0.4bn	N/A	GaAs InP GaN	60%
Total	$15bn	$35bn	14%		

Source: Edison Investment Research, Yole Développement. Note: Shading indicates IQE's presence in segment.

IQE's newer technologies give scope for growing wireless revenues substantially more quickly than the market. For example, its new porous silicon technology provides a mechanism for regaining

share in the handset switch segment, which had migrated from compound semiconductor to lower-cost options. Management expects customers to start sampling this technology in Q419. IQE's single crystal epitaxial aluminium nitride (AlN) wafers give a route to capture share in the handset filter segment. IQE is currently engaged in AlN product qualification with multiple customers. By 2023, IQE intends to deploy all of these new technologies in an integrated front-end module combining power amplifiers, filters and switches on a single chip. Based on the Yole Développement forecasts, management estimates that the new technologies could result in IQE providing $200–250m epitaxy for wireless front-end applications by 2023, ie a 15-20% CAGR (see Exhibit 3). This estimate assumes that IQE retains its dominant share of the power amplifier market, takes modest shares in the switch, filter and low noise amplifier segments, and uses its unrivalled mix of technologies to take a dominant share of the integrated front-end module segment, all of which is feasible in our opinion.

Supporting the data demands of IoT, Industry 4.0 and autonomous vehicles

IQE is already supplying GaN-on-SiC for low-volume, price-insensitive applications, primarily military communications and radar, and high-end base stations. Its newer, less expensive GaN-on-Si technology potentially opens up various more price-sensitive applications in the wireless infrastructure market, displacing the incumbent LDMOS technology. This is particularly important as the wireless market shifts to 5G applications, as not only do GaN devices consume less power and last longer than their silicon counterparts, but they also enable the creation of smaller, denser arrays operating at higher frequencies. This is essential for 5G base stations, which need to be more compact than their 4G predecessors and handle the transmission and reception of multiple inputs and outputs in parallel to cope with the processing requirements of the Internet of Things (IoT), Industry 4.0 and autonomous vehicles. Noting that Yole Développement predicts that the GaN for RF infrastructure market will grow with c 23% CAGR between 2017 and 2023 to $1.3bn, management estimates that this market could represent $80–100m epitaxy revenues for IQE by 2023.

Modest growth as IQE takes share and expands infrastructure offer

IQE's wireless revenues remained at prior year levels during H118 at £47.8m, although there was an 11% increase in constant currency. During both H117 and H217, significant production capacity was allocated to the VCSEL ramp-up for a 3D sensing application. During H118, sales to the chip manufacturer servicing this application were similar to H117, as the supply chain absorbed inventory. This enabled the group to replenish wireless inventory channels, hence the y-o-y growth in constant currency. Management notes that capacity allocation started to shift back from wireless to photonics applications during June 2018, so we model a 4.0% increase in segmental revenues for FY18 as a whole compared to FY17 and 1.5% growth in FY19. Two key trends underpin these growth assumptions. First, we note that in July 2018 IQE announced that it had successfully renegotiated its long-term supply contract with a major customer, extending the range of products covered and increasing the overall share of the customers' epiwafer requirements (now c 80%). Secondly, it is securing business related to products based on GaN-on-SiC technology. We note that in February 2018 IQE's longstanding customer MACOM announced an agreement with STMicroelectronics under which MACOM would augment its GaN-on-Si existing wafer supply with ST's much higher-volume wafer manufacturing capacity, noting that the enhanced scale would accelerate adoption of the technology. Our estimates exclude taking share in the wireless filter or switch segments.

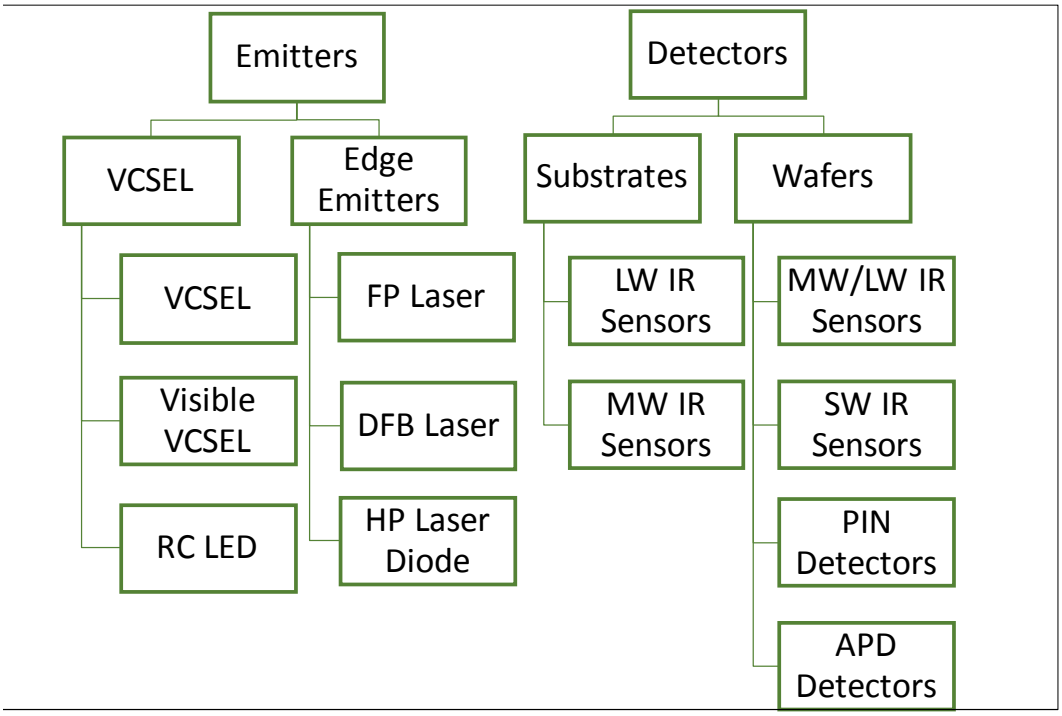
Photonics (31% of FY17 revenues)

Efficient conversion of light to electricity and vice versa

Compound semiconductors exhibit properties that convert light to electricity and electricity to light extremely efficiently. IQE has developed a range of epitaxial wafers and substrates, which may be

used to either emit or detect light (see Exhibit 4). Photonics devices are used in many different markets, so demand is not dependent on any one application in the way that historically, wireless revenues, and consequently IQE's fortunes, were reliant on the health of the handset market. Market segments include data communications, lighting, medical diagnostics, heating and consumer devices. Wafer prices for photonic applications are at least twice that for wireless applications. This gives a beneficial impact on IQE's margins even though there are many more processing steps required than for wireless epitaxy.

Exhibit 4: IQE photonics epitaxial applications



Source: Company data

VCSELs – arrays of lasers for consumer and industrial applications

IQE's current growth wave is being driven by demand for a specific type of photonics emitter: the VCSEL. VCSELs modulate signals at frequencies up to and exceeding 25Gbps, so are ideal for high-speed communications and precision sensing applications. They provide reliable operation at distances ranging from close proximity links (centimetres) up to 500m in data centre, enterprise and campus networks. Arrays of VCSELs are deployed in consumer electronics devices (including gaming devices, smartphones and tablets) for laser focusing, 3D imaging, facial recognition, proximity sensing, hand and body tracking and gesture recognition, and in automobiles for pedestrian detection, collision avoidance, parking assistance, traffic sign recognition and lane departure warning. Two-dimensional arrays consisting of hundreds of individual VCSEL light sources can collectively output a high power beam tuned to a specific frequency. This has applications in industrial illumination, 3D printing, drying and curing plastics and sintering metals. Yole Développement estimates that the 3D imaging and sensing market will grow from below $2bn in 2017 to $9bn in 2022. This strong growth will be supported by a combination of demand from multiple sectors combined with a shift to much larger VCSEL arrays for advanced driver assistance LiDAR and industrial cutting.

IQE was the first company to have a process for producing 6" diameter VCSEL wafers. Having a higher diameter means that more devices can be manufactured at the same time, substantially reducing cost per device. Being the first and, we believe, the only vendor so far to offer larger diameter VCSEL wafers means that IQE has become the preferred outsourcing supplier for VCSEL

epitaxy, working in some cases directly with OEMs rather than only chip or component vendors. IQE is extending its VCSEL capability in its Newport facility so that it will be able to process VCSELs on 8" wafers.

InP – enabling high data rate fibre optic communications

Telecommunications companies are increasingly deploying passive optical networks (PONs) to deliver triple-play services including TV, voice over IP (VoIP) phone and internet services to subscribers. These networks are also referred to as FTTH (fibre to the home), FTTP (fibre to the premises) or FTTC (fibre to the curb) networks. These optical networks can deliver the much higher data rates that are essential for distribution of video and other internet services. Optical connections are also much more efficient than their electronic counterparts, which is particularly desirable in data centres, where power, including that required for cooling purposes, is a significant proportion of operating costs. Demand for these applications is being driven by 5G connectivity and the adoption of IoT. IQE's NIL (nanoimprint lithography) technology noted in Exhibit 2 provides a route for manufacturing the DFB lasers used in short-haul (up to 20km) and long-haul networks with higher performance and lower manufacturing costs. DFB lasers may also be deployed in a wide range of emerging sensing applications such as 3D sensing, monitoring environmental emissions and air quality, detecting chemical weapons and explosives, and monitoring breath and blood vessels to aid disease diagnosis.

Photonics is driving IQE's second growth wave

IQE has c 90% of the outsourced VCSEL market, which management estimates is between one-third and one-half of the total market. The company is benefiting from underlying market growth, a strong market position and component vendors transitioning from a vertically integrated business model towards outsourcing wafer supply from IQE. During H118, IQE's photonics revenues grew by 24% to £18.9m (30% on a constant currency basis). We noted earlier that during both H117 and H217, significant production capacity was allocated to the VCSEL ramp-up for a 3D sensing application. During H118, sales to the chip manufacturer servicing this application were similar to H117, as the supply chain absorbed inventory. Revenues from the other photonics customers grew by c 40% in constant currency, as capacity was allocated to multiple VCSEL production qualifications. This activity has resulted in IQE being in mass production with eight VCSEL chip manufacturers and in final qualification stages with another four (at the time of the Capital Markets Day in September), with volumes already ramping up in H218. These are for mobile, sensing, automotive and datacom applications. At the end of September there were also eight customers sampling VCSELs and a further four where epitaxy was being developed for them. In July 2018 IQE announced that the NIL technology had been production qualified by a leading supplier of DFB lasers to the telecoms and data centre markets, and that work on the first production order (for US$0.25m) had commenced. In addition to DFB applications, IQE is engaged in multiple other NIL qualification programmes across a range of wafer sizes and end-applications.

A report from Mordor Intelligence published in March 2018 valued the photonics market (which includes complete devices as well as epitaxy) at $590bn in 2017 and predicted it would reach $929bn by 2023, representing a CAGR of 7.8% over the forecast period 2018-23. We model above market growth for IQE: 11% in FY18 despite the temporary destocking and 50% in FY19 (assuming that deliveries on the original volume VCSEL programme resume in Q219), to reflect the impact of the multiple VCSEL and InP programmes that have recently progressed to volume production.

Infrared sensing (8% of FY17 revenues)

One-stop-shop for all types of IR materials

Compound semiconductors are used to manufacture emitters and detectors of light in the infrared part of the spectrum. By mixing elements, the material can be tuned to be sensitive to different wavelengths of light. These compound semiconductor materials have revolutionised image sensing, providing images that are 8x sharper and can be generated 4x more quickly. Higher resolution images are key for AI applications that analyse visual data. Historically, this has been a high-margin business focused on defence applications such as night vision equipment. However, since IQE started to produce the industry's first (and so far only) 6" indium antimonide wafers, the economics of production have improved. This permits the deployment of infrared chips in a wide range of high-volume, cost-sensitive applications (see Exhibit 5). It also permits the manufacture of very large sensing arrays that can detect data from further away. IQE is working directly with manufacturers of military aircraft to provide sensors giving 360º awareness. IQE estimates that the total available market for IR materials will be $500m by 2023 compared with around $20m at present.

Exhibit 5: IR product portfolio

Category	Material	Applications	CAGR 2017-22	TAM* 2022
IR detectors	2"-3" InP/GaInAs 3"-4" GaSb/InAs	Pilot vision, LiDAR for autonomous vehicles, night vision, environmental sensing	10-20%	$125m
IR lasers	2"-3" InP/AlGaInAs 3"-4" GaSb/AlGaSb	Wearable health monitoring aircraft protection, 3D displays, advanced biometrics	30-50%	$250m
Advanced materials	2"-4" InSb/InAs/GaSb/Inp	Quantum computing, novel sensors, renewable energy, silicon photonics	10-15%	$35m

Source: Company data. Note: *Total accessible market.

Potential for strong growth as IQE moves into consumer applications

IQE is the largest supplier of infrared materials globally. Management estimates that it has a 70-80% market share. It has the broadest product portfolio globally, making it a 'one-stop-shop' for all types of IR materials. It would be very difficult for potential competitors to replicate this range. Importantly, it has its own in-house source of high-purity substrate, which is a key competitive advantage. Sectoral revenues grew by 3% year-on-year (11% constant currency) during H118 to £5.8m. Our estimates model a 7% rise in sectoral sales during both FY18 and FY19. We believe faster growth is achievable in the medium term given that IQE is currently working with major OEM and device companies in developing IR products for consumer applications.

Potential third growth wave from power electronics

We discussed the role of GaN-on-Si in the wireless infrastructure market earlier in this note. Since GaN can withstand higher voltages than silicon, is better at removing waste heat energy and exhibits a lower resistance when the same voltage is applied across it, thus making power transistors more efficient. GaN-on-Si may also be used for making power electronics chips. Additionally, GaN devices are substantially smaller than their silicon counterparts. By changing the substrate on which the GaN is deposited, the voltage range may be extended from 200V currently achievable to over 1,200V. Emerging applications include power supplies for data-centres, inverters for solar panels, chargers and power train components for electric vehicles, and wireless chargers for consumer electronic devices. The GaN market is very attractive for IQE as it represents one of the largest growth opportunities for compound semiconductors. Management estimates that the power switching market (AC/DC and DC/DC) on its own has the potential to be three to four times larger than the current wireless power amplifier chip market. In October 2017, market analyst Yole Développement estimated that the GaN power semiconductor device market was worth $14m in 2016 compared with less than $10m in 2015 (note: the wafer market will be smaller), and forecasts that this will grow at an estimated 79% CAGR through 2017-22 to reach $460m. IQE's patented rare earth oxide technology provides a significant competitive advantage in this segment.

Revenues attributable to the power semiconductor market are not material at present and are included in advanced electronics (CMOS++) revenues. Until IQE begins to ship meaningful volumes of the material, which management estimates is two to three years off, we will treat revenues from this sector as upside to our estimates.

CMOS++ (1% of FY17 revenues)

IQE has been developing techniques for combining compound semiconductor material with silicon since 2000. Its GaN-on-Si technology is already being used for some wireless applications that are close to commercialisation and the revenues attributed to the wireless segment. Other compound semiconductor/silicon technologies that are further from commercialisation are categorised as CMOS++: compound semiconductor on silicon. These include technology for the power electronics market discussed above and technology suitable for both next-generation wireless and photonics chips. For example, a smartphone front-end module could combine the three material systems for the filters, switches and power amplifiers (see Exhibit 4) on a single chip. Alternatively, a VCSEL light source, wafer level optic and diffractive optical element, both of which use NIL technology and a silicon sensor could be combined to form an integrated 3D sensing solution. These developments are still in the research phase. Management expects this novel technology to deliver significant revenues over the next three to five years.

Revenues attributable to this segment totalled £0.8m during H118 (H117: £0.7m). We model segmental revenues remaining at FY17 levels (£1.4m) in both FY18 and FY19 to reflect the long gestation period for the hybrid compound semiconductor/silicon chips.

Licence income (1% of FY17 revenues)

Licence income is currently generated from two JVs. The JV in Singapore is with WIN Semiconductors and Nanyang Technological University. The JV in the UK is with Cardiff University. These JVs form the nuclei of compound semiconductor clusters in which IQE can commercialise the academic research that has been prototyped by the JVs, taking novel materials from prototypes to high-volume production for industry partners. For example, the Cardiff JV is at the centre of a new £150m UK National Catapult to develop and build next-generation compound semiconductors, creating a national and European centre of excellence in South Wales. The capacity expansion at the Newport facility in South Wales is being supported by this Catapult project, which enables IQE to occupy the new facility rent-free for the first three years. IQE's policy of building a portfolio of over 180 patents is creating a platform for monetising IP through licensing more widely.

Licensing income is lumpy. Although this segment generated £1.0m revenues in H117, there were none in H118 as management reinvested licence fees in the JVs, so we do not model any income from this source in either FY18 or FY19. This revenue stream is likely to become more significant in the longer term if IQE's technology is deployed in applications where IQE would not be able to meet demand for the volume of epitaxy required from its own resources.

Management

Following the tragic death of CFO Phillip Rasmussen in April 2018, chairman Dr Godfrey Ainsworth moved from a non-executive to an executive role. In this capacity he is providing investor relations support to the CEO and oversight to the group finance team. Tim Pullen, who is currently CFO of ARM, will become CFO in early FY19. Dr Ainsworth will retire from his position as chairman at the end of March 2019 and be succeeded by Phil Smith, former chairman of Cisco, who joined the board in December 2016.

Sensitivities

- **Handset exposure:** with 60% of FY17 wafer sales coming from wireless, IQE's financial performance remains exposed to changes in dynamics in this segment. In the medium term, we expect IQE's reliance on the handset market to diminish as multiple VCSEL and InP programmes move to volume production. In the short term, the ramp-up in volumes for programmes connected to face recognition in several smartphone models increases exposure to the handset market generally and to individual handset suppliers, eg the recent destocking/product market softness on the VSCEL programmes we infer are related to iPhones. As discussed in the section on market position, we believe these handset OEMs are effectively locked in to the existing epitaxy supply chain for several years. Were these OEMs to decide to switch epitaxy provider at the end of this period, the recent completion of multiple VCSEL product qualifications provides alternative revenue sources, reducing the impact of a move.
- **Impact of individual programmes:** Some of the programmes in which IQE is involved are sufficiently large to have a distorting effect on short-term revenue trends. For example, we believe that H118 revenues were affected by a reduction in demand related to iPhone VCSELs while inventory manufactured during FY17 was worked through.
- **Uncertainties in markets that are still not yet developed:** IQE has opportunities in many end-markets: power electronics, chip-to-chip interconnect, gesture recognition, industrial heating, CPV, environmental monitoring and non-invasive blood monitoring. If any of these opportunities is successful and the wireless market remains stable, there could be significant upside to our estimates, but the timing and rate at which revenues from these applications could grow is difficult to gauge.
- **US-China trade war:** Since IQE has fabrication facilities in the US, Europe and the Far East, it would not be directly affected by a potential trade war, as it could continue to supply customers in both the US and the Far East. It would, however, be indirectly affected if the trade war was sufficiently intense to cause a reduction in the production of electronic devices such as mobile phones in China that was not offset by an increase in production elsewhere.
- **Currency:** IQE's presentational currency is sterling, but the company earns the large majority of revenues in US dollars. Translational risk is therefore unavoidable. Transactional risk is reduced, where possible, through matching input costs with revenues, although a proportion of costs is in sterling. Debt is denominated primarily in dollars.

Investment in future growth a short-term drag on profit

Double-digit constant currency revenue growth in key segments

Total revenues grew by 4% year-on-year to £73.4m during H118, as double-digit sales growth on a constant currency basis in each of the three primary markets was tempered by a c 10% currency headwind. Adjusted profit before tax fell by 21% to £7.6m, depressed by several factors. These were the currency headwind (£2.0m), the cost of multiple low-margin VCSEL qualification programmes (£0.6m) and the cost of staffing the new Newport facility prior to commencing production (£0.9m), which is scheduled for H218. Collectively, these one-off effects totalled £3.5m. If these costs are stripped out, adjusted profit before tax becomes £11.1m, a 14% improvement on the prior year period. In addition, the cost of converting reactors from photonics applications to wireless and back again was c £0.5m. We note that management has authorised an expansion of wireless capacity in the Taiwan facility to reduce the need to requalify reactors for different

technologies in the future. Management estimates that reactor conversions cost c £3m over the last 18 months.

Cash from operations reinvested in R&D and capacity

Net cash reduced by £5.0m during the period to £40.6m at the end of June. Working capital increased by £6.6m compared with end FY17, capitalised development expenditure totalled £9.4m as the group continued work on multiple innovative technologies, and capex totalled £5.8m, half of which related to the new Newport foundry.

Management guidance

In November, management announced that one of its customers in the VCSEL supply chain (which we have previously inferred is Lumentum) had received notice from one of its largest customers for 3D sensing laser diodes that it was materially reducing shipments for the current quarter. As noted earlier, IQE ramped up production for this application (which we have previously inferred is for Face ID in new iPhones) during H217, following which production dropped back as the inventory overbuild was worked through, so IQE only started to build up inventory for this application again this quarter. It has now had to cut back production for this application. The temporary dip in production materially affects FY18 revenues and profitability. We note that the lull in VCSEL production for Apple is not the result of IQE losing a customer to a competitor, so shipments are expected to resume by Q219. Although Apple warned in June that demand for new iPhone parts could decline by 20% in H218, Face ID is included in three of the models launched in H218, rather than just one model in H217, so we believe consumer demand is less likely to be the cause of the setback than availability of OLED panels, where Apple is rumoured to have issues. Component availability can be addressed relatively easily, supporting our view that volume production will resume by Q219.

Exhibit 6: Management revenue guidance

	FY18 guidance*	FY18e Edison	FY19 guidance*	FY19e Edison	3-5 year guidance*	Upside to 3-5 year guidance
Wireless growth	8%	4.5%	0-5%	5.0%	0-10%	Filters and switches, integrated front-end modules
Photonics growth	11%	9.0%	40-60%	50.0%	40-60%	Integrated optical modules
Infrared growth	15%+	12.0%	5-15%	12.0%	5-15%	Consumer applications
Licence income	£0m	£0m	£0m	£0m	£0-2m	
Power growth	N/A	None	N/A	None	N/A	Power switches
Solar growth	N/A	None	N/A	None	N/A	Satellite applications

Source: Edison Investment Research, company statements. Note: *Constant currency.

Management updated its guidance following the trading update. This guidance is summarised in Exhibit 6, together with the growth rates adopted in our estimates, those programmes included in the guidance and those presenting upside to the guidance. We model an improvement in photonics margin between FY18 and FY19 related to improvements in yield and production efficiencies as knowledge gained from the VCSEL ramp-up last year is applied during the commissioning of the Newport facility. There is most variance with regard to photonics growth because IQE has no control over when the new products will be launched and what end-user uptake will be. Our estimates adopt photonics revenue growth towards the lower bound of management guidance.

Investment to support ambitious growth trajectory

In July 2017 IQE announced a major capacity expansion plan. This involves leasing new premises in Newport, South Wales for a new 'mega foundry'. The construction and fit-out of this new facility is on schedule to commence production by the end of FY18. The first five reactors, which accounted for c £12m capex in FY17 and give a c 5% increase in capacity, were installed during H118. A further two were delivered in August and three more will be delivered during H218. Commissioning and qualifications are ongoing. The factory already has dedicated bays for 20 reactors, enabling

IQE to double capacity in the facility to meet demand. The premises have the space to hold up to 100 reactors, roughly the same as IQE has at present. This additional capacity is critical for IQE to maintain its dominant position in the VCSEL market as it grows. We note that payback time on a fully loaded reactor is around one year and that the additional capacity in South Wales will be suitable for multiple types of photonics programmes, not just smartphone VCSELs.

Management has also approved a programme to expand wireless capacity at its plant in Taiwan by over 40%. This will enable certain reactors in the US to be dedicated for photonics applications, removing the need to switch reactors from wireless to photonics applications, which depressed margins during H118. As more capacity becomes available in South Wales, management will take the opportunity to reduce the number of sites it operates. The New Jersey site will close in December 2018, realising an estimated US$4m annual cost savings. Further consolidation will take place over the following two years, realising an estimated US$8m of annualised cost savings.

Valuation

DCF analysis

Exhibit 7: DCF analysis

Base case					
Wireless growth	4.5%	5.0%	2.0%	2.0%	2.0%
Photonics growth	9.0%	50.0%	40.0%	40.0%	40.0%
IR growth	12.0%	12.0%	7.0%	7.0%	7.0%
Licence revenues (£m)	0.0	0.0	0.0	0.0	0.0
Group revenues (£m)	162.5	194.8	229.0	275.8	340.2
EBIT (£m)	16.7	34.1	51.3	68.9	93.4
Indicative valuation (WACC 10% Terminal growth 2%) 73p/share					
Low case					
Wireless growth	4.5%	0.0%	0.0%	0.0%	0.0%
Photonics growth	9.0%	40.0%	40.0%	40.0%	40.0%
IR growth	12.0%	5.0%	5.0%	5.0%	5.0%
Licence revenues (£m)	0.0	0.0	0.0	0.0	0.0
Group revenues (£m)	162.5	183.9	213.7	255.1	312.9
EBIT (£m)	16.7	31.3	47.0	63.0	85.5
Indicative valuation (WACC 10% Terminal growth 2%) 64p/share					
High case					
Wireless growth	4.5%	5.0%	10.0%	10.0%	10.0%
Photonics growth	9.0%	60.0%	60.0%	60.0%	60.0%
IR growth	12.0%	15.0%	15.0%	15.0%	15.0%
Licence revenues (£m)	0.0	0.0	2.0	2.0	2.0
Group revenues (£m)	162.5	200.4	264.6	358.1	500.9
EBIT (£m)	16.7	36.0	62.5	96.3	149.5
Indicative valuation (WACC 10% Terminal growth 2%) 132p/share					

Source: Edison Investment Research

As the share prices of stocks in this sector are highly volatile at present, we have focused on a DCF analysis rather than a peer multiples approach. Moreover, for the reasons stated above, we believe that the reduction in VCSEL shipments is temporary and that photonics will continue to grow at 40% or more pa from FY19 onwards, and a DCF methodology captures the impact of this medium-term growth. We present three scenarios: the base case adopts the rate of market growth used in our estimates; the low case adopts the lower bound of the market growth given in management. guidance; and the high case adopts the higher bound of the market growth given in management guidance. All three cases use the segmental margins provided in management guidance. Our analysis gives a valuation range of 64p–132p depending on whether the lower or upper bound of management guidance is adopted. The current share price is below the lower bound of this range, indicating that investors do not share management's conviction that the VCSEL destocking is temporary and photonics growth will resume in Q219. Newsflow on resumption of volume deliveries

for the iPhone programmes and updates on the other VCSEL programmes that have recently commenced production should help address this.

Peer multiples

Like most of its peers, IQE has experienced a substantial reduction in share price over the last year as investors have taken a more cautious approach to photonics growth. Based on our current estimates, which assume photonics growth towards the lower end of management guidance, the shares are trading at a discount to the mean for its peers with regard to EV/Sales multiples, but at a premium to the mean for all other metrics (Exhibit 8). If we restrict the comparison to the three listed companies offering epitaxy for VCSELs: IntelliEPI, LandMark Optoelectronics and Visual Photonics, then based on current estimates, which model a recovery in photonics revenues from Q219 onwards, IQE is trading on a Year 2 P/E multiples that are below all three of these companies. IQE has a much stronger market position than the other three, so trading towards the upper end of this smaller sample seems reasonable.

Exhibit 8: Peer multiple analysis

Company name	Market cap ($m)	Year 1 EV/Sales (x)	Year 2 EV/Sales (x)	Year 1 EV/ EBITDA (x)	Year 2 EV/ EBITDA (x)	Year 1 P/E (x)	Year 2 P/E (x)
Epitaxy							
GCS Holdings	4,289	1.5	1.4	7.1	5.2	11.1	11.2
IntelliEPI Inc (Cayman)	1,569	2.1	1.9	12.3	11.4	23.2	21.7
LandMark Optoelectronics Corp	21,471	8.2	6.7	16.3	12.1	30.4	22.1
Soitec SA	1,517	3.5	2.6	11.9	8.8	18.3	14.0
Visual Photonics Epitaxy	9,948	4.7	4.1	13.6	10.8	22.9	18.4
WIN Semiconductors	44,712	2.6	2.5	7.6	6.3	15.2	14.8
Opto-electronics							
II-VI	2,192	1.8	1.6	-	-	13.3	11.1
Finisar Corp	2,562	1.6	1.4	9.7	7.0	24.8	14.7
Lumentum Holdings	2,529	1.6	1.4	5.8	4.8	9.2	8.0
Mean		**3.1**	**2.6**	**10.5**	**8.3**	**18.7**	**15.1**
IQE	471	2.6	2.2	13.6	8.5	33.5	17.5

Source: I/B/E/S, Edison Investment Research estimates. Note: Prices as at 21 November 2018.

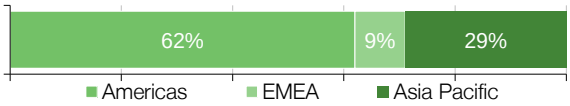
Exit multiples

On 9 November 2018, II-VI announced the acquisition of Finisar, subject to regulatory approval. The transaction values Finisar at $26.00 per share, or approximately $3.2bn in equity value and represents a premium of 37.7% to Finisar's closing price on 8 November 2018. For the year ending April 2018, Finisar reported revenues of $1,316m and non-GAAP EPS of $0.88, so this represents a historic EV/Sales multiple of 2.4x and historic P/E multiple of 29.5x.

Exhibit 9: Financial summary

£'000s	2016	2017	2018e	2019e
Year End 31 December	IFRS	IFRS	IFRS	IFRS
PROFIT & LOSS	**Restated**			
Revenue	132,707	154,480	162,449	194,807
Cost of Sales (Inc D&A + SBP)	(98,538)	(115,857)	(116,151)	(137,339)
Gross Profit	34,169	38,623	46,298	57,468
EBITDA	33,057	38,384	31,238	50,008
Depreciation and Amortisation	(10,938)	(12,025)	(14,527)	(15,932)
Operating Profit (before amort. and except.)	22,119	26,359	16,711	34,076
Acquired Intangible Amortisation	(1,374)	(1,429)	(1,429)	(1,429)
Exceptionals	1,962	(385)	0	0
Share based payments	(2,881)	(7,526)	(3,000)	(3,000)
Operating Profit	19,826	17,019	12,282	29,647
Underlying interest	(1,463)	(2,099)	100	0
Exceptionals	(26)	80	0	0
Profit Before Tax (norm)	20,630	24,340	16,811	34,076
Profit Before Tax (FRS 3)	18,363	14,920	12,382	29,647
Tax	(340)	(435)	(2,229)	(5,336)
Profit After Tax (norm)	20,692	24,823	14,582	28,739
Profit After Tax (FRS 3)	18,023	14,485	10,153	24,310
Average Number of Shares Outstanding (m)	671.5	689.5	751.7	776.0
EPS - normalised (p)	2.89	3.36	1.81	3.48
EPS - (IFRS) (p)	2.66	2.09	1.34	3.12
Dividend per share (p)	0.0	0.0	0.0	0.0
BALANCE SHEET				
Fixed Assets	214,043	224,836	254,880	275,519
Intangible Assets	103,972	108,513	113,057	116,196
Tangible Assets	85,001	90,875	116,375	133,875
Other	25,070	25,448	25,448	25,448
Current Assets	64,323	111,559	95,470	114,812
Stocks	28,498	33,707	36,940	44,299
Debtors	30,868	32,240	36,050	47,501
Cash	4,957	45,612	22,479	23,012
Other	0	0	0	0
Current Liabilities	(51,522)	(44,916)	(44,589)	(53,123)
Creditors	(43,870)	(44,916)	(44,589)	(53,123)
Short term borrowings	(7,652)	0	0	0
Long Term Liabilities	(39,021)	(666)	(666)	(666)
Long term borrowings	(36,854)	0	0	0
Other long term liabilities	(2,167)	(666)	(666)	(666)
Net Assets	187,823	290,813	305,095	336,542
CASH FLOW				
Operating Cash Flow	22,463	29,717	23,867	39,733
Net Interest	(1,489)	(2,125)	100	0
Tax	(839)	(5,844)	(1,100)	(1,200)
Capex	(19,060)	(28,190)	(46,000)	(38,000)
Acquisitions/disposals	(11,250)	0	(3,846)	0
Financing	578	94,912	3,846	0
Dividends	0	0	0	0
Net Cash Flow	(9,597)	88,470	(23,133)	533
Opening net debt/(cash)	23,223	39,549	(45,612)	(22,479)
HP finance leases initiated	0	0	0	0
Other	(6,729)	(3,309)	0	0
Closing net debt/(cash)	39,549	(45,612)	(22,479)	(23,012)

Source: Company accounts, Edison Investment Research

Contact details	Revenue by geography
IQE 2 Pascal Close St. Mellons, Cardiff CF3 0LW +44 (0)2920 839 400 www.iqep.com	

Management team

CEO: Dr Andrew Nelson OBE, BSc, PhD, FREng	Executive chairman: Dr Godfrey Ainsworth BSc, PhD, FCA
Dr Nelson joined BT in 1981, where he led the group responsible for the development of advanced optoelectronic devices for optical fibre communications and subsequently managed the technology transfer from BT to Agilent for mass production. He co-founded EPI in 1988. This merged with QED in 1999 to form IQE. He was appointed CEO of IQE in April 1999. He is a member of the high-level group appointed by the EC to oversee the implementation of key enabling technologies throughout Europe.	Dr Ainsworth qualified as a chartered accountant. After a period in the accountancy profession, he founded Gambit Corporate Finance in 1992, specialising in corporate finance services. He was appointed to the board of IQE in 1997 and became chairman in 2002, moving to an executive role in April 2018. He has held several non-executive directorship appointments, including assignments for 3i plc, the Business Growth Fund and the Welsh Development Agency.
Designate chairman: Dr Phil Smith, BSc, Hon LLD, DUniv., CEng, FIET	**Designate CFO: Tim Pullen, CA**
Dr Smith became chairman of Cisco for the UK and Ireland in August 2016, after eight years as chief executive. He is also the chairman of Innovate UK and chairman of the Tech Partnership and sits on the board of the National Centre for Universities and Business. He has a 35-year track record in the technology industry in leading companies including Philips Electronics and IBM.	Mr Pullen is currently CFO of ARM. He was previously at O2/Telefonica UK where he held a variety of positions including finance director for Technology Operations and Transformation, finance director for O2's B2B and digital products segments, head of finance operations and was a non-executive director at Tesco Mobile. Prior to O2, Tim worked in a number of technology and services businesses, including Serco, Fujitsu and Dell. He will take up his appointment at IQE in early 2019.

Principal shareholders	(%)
T Rowe	10.5%
OEI Global Asset Management	9.2%
Hargreaves Lansdown	6.9%
Canaccord Genuity Group	5.6%
Massachusetts Mutual Life Insurance Company	5.1%
Schroders	5.1%

Companies named in this report

II-VI Inc (IIVI:US), Apple (AAPL:US), AXT (AXTI:US), Finisar Corp (FNSR:US), GCS Holdings (4991:TT), IntelliEPI (4971:TT), Kopin Corp (KOPN:US), Landmark Optoelectronics Corp (3081:TT), Lumentum Holdings (LITE:US), MACOM (MTSI:US), Qorvo (QRVO:US), Skyworks (SWKS:US), Soitec (SOI:FP), STMicroelectronic (STM:FP), Visual Photonics Epitaxy (2455:TT), WIN Semiconductors (3105:TT)

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