

IQE

Strategy update

Leading innovation from within

The breadth of IQE's technology portfolio and ability to serve compound semiconductor chip customers in the US and Asia puts it in a good position to benefit from rising demand for compound semiconductor applications for 5G and connected devices. The share price has been hit by the shift to Asian-centric supply chains caused by US-Chinese trade tensions, and resultant reductions to management guidance. Although the timing of a recovery is difficult to gauge, we see scope for earnings recovery as IQE secures additional contracts in Asia and leverages its IP portfolio into sustainable profit growth and cash generation.

Year end	Revenue (£m)	PBT* (£m)	EPS* (p)	DPS (p)	P/E (x)	Yield (%)
12/17	154.5	24.5	3.38	0.0	14.8	N/A
12/18	156.3	14.0	1.38	0.0	36.2	N/A
12/19e	139.4	(8.0)	(0.82)	0.0	N/A	N/A
12/20e	152.1	3.0	0.28	0.0	178.6	N/A

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

Global platform gives access to Asian supply chains

The interconnected nature of semiconductor supply chains means it has taken time for IQE's customers to feel the full impact of the US Department of Commerce's decision in May to add Huawei to the Entity List. As noted in the November trading update, two of its major US wireless customers have been particularly badly affected by the ban. IQE's production footprint with facilities in the US, the UK and Asia mitigates the impact of these supply chain shifts. It is already qualifying production tools for wireless applications with a major Taiwanese foundry and is engaged with multiple Asian photonics manufacturers. Although it will take time for IQE to win business to completely offset the reduced demand from its US customers, the result will be a more diversified customer base.

Diversified revenue base

Investor attention tends to focus on the health of the major VCSEL programme where volumes have been consistently strong in recent months. Two recently announced vertical cavity surface emitting laser (VCSEL) production qualifications for Android-related supply chains reduce IQE's exposure to this programme. Moreover VCSELs, which are used in other applications in addition to 3D-sensing, account for only half of IQE's photonics related revenues, which form around half of the group total. The other half are derived from wireless applications, around two-thirds of which are hand-set related, the remainder infrastructure.

Valuation: Potential for share price recovery

The share price has fallen by c 33% since 1 November. Based on our estimates, which were revised following the November trading update, IQE is now trading at a discount to the average of its peers on a prospective EV/sales basis (2.7x vs 4.7x). This indicates potential for share price recovery once investor confidence returns. Key indicators will be further Asian contract wins in both wireless and photonics and additional VCSEL programmes progressing to volume production.

Tech hardware & equipment

14 January 2020

Price 50.0p
Market cap £398m

Net debt (£m) at 30 June 2019	0.8
Shares in issue	796.1m
Free float	86.6%
Code	IQE
Primary exchange	AIM
Secondary exchange	N/A

Share price performance



%	1m	3m	12m
Abs	(2.1)	(23.8)	(21.9)
Rel (local)	(5.1)	(28.1)	(29.9)
52-week high/low	98.00p	41.84p	

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 event

FY19 results	March 2020
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Investment summary

Company description: Compound semiconductor leader

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 gain around a 50% share of the wireless market (management estimates), where its wafers are used to make radio frequency chips, primarily for use in mobile devices. Investment in the technology portfolio and wafer manufacturing capacity has also enabled it to take a major share in the photonics market. The first mass-market VCSEL ramp up, which started at the end of H117 and we previously inferred was for 3D sensing in an Apple smartphone, has been followed by volume ramp ups for VCSELs deployed in Android supply chains, albeit at lower levels currently than the original VCSEL programme.

Financials: Market knocked by supply chain shifts

Wireless customers started to cut back on inventory levels in H119 in response to the uncertainty over future demand caused by lengthening mobile phone replacement cycles and the potential impact of Huawei's addition to the US Bureau of Industry and Security's Entity List in May. Wireless revenues fell by 29% year-on-year to £30.1m. Photonics revenues (including those previously categorised as attributable to infrared products) grew by 18% to £35.5m, supported by multiple VCSEL ramp ups. Group revenues decreased by 9% to £66.7m, causing the group to move from £7.6m adjusted EBIT profit in H118 to a £1.9m adjusted EBIT loss in H119. The group moved from £20.8m net cash at end December 2018 to £0.8m net debt at end-June 2019. Management agreed a £30m asset financing facility after end H119, increasing total available facilities to around £57m.

Noting the dislocation in the wireless semiconductor supply chains caused by US-Chinese trade tensions, management reduced its FY19 guidance in November. Following this we lowered our estimates to model an 11% drop in group revenues for FY19 generating £8.0m adjusted loss before tax. Management has not provided guidance for FY20. Our estimates assume a very modest (1%) year-on-year reduction in wireless revenues during FY20 (17.5%) supported by the major established VCSEL programme for the Apple supply chain and the first volume programme for the Android supply chain. This level of photonics growth should be sufficient to give a 9% improvement in group revenues for the year and a return to profit (£3.0m adjusted PBT). Medium term, additional VCSEL ramp ups and a shift to higher frequency 5G handsets should, we believe, drive stronger revenue growth that, given IQE's leveraged operating model and existing capacity, should deliver a faster rate of profit growth and meaningful levels of cash generation.

Valuation: Potential for share price recovery

IQE is now trading at a discount to the average of its peers on a prospective EV/sales basis (2.7x vs 4.7x). This indicates potential for share price recovery once investors gain confidence that IQE can use its extensive IP portfolio to generate sustainable profits growth and cash.

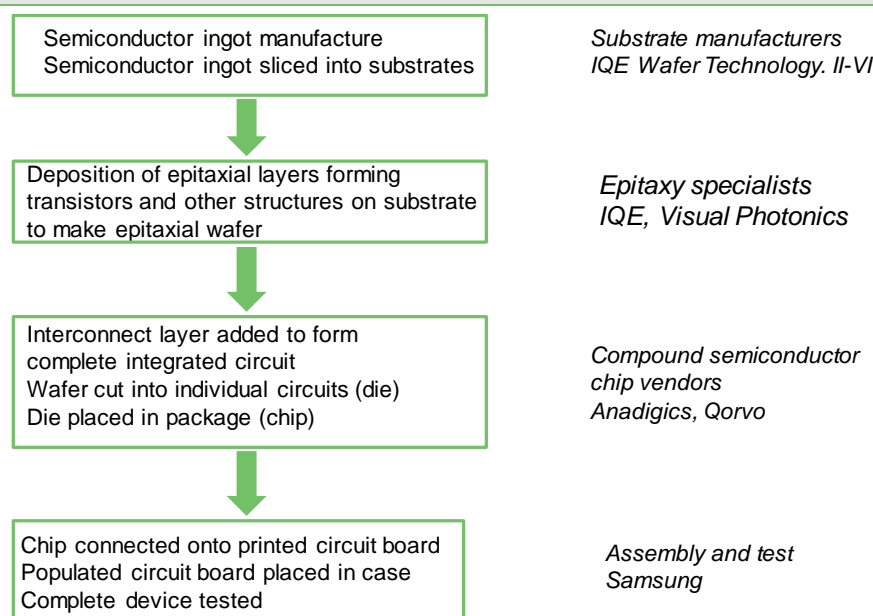
Sensitivities: Uncertainty in predicting rate of volume ramp up

IQE's financial performance remains heavily influenced by the health and inventory cycle of the handset industry. It is also dependent on several key customers, several of which (but not the major VCSEL customer) have been adversely affected by the US/China trade war. Because IQE has manufacturing facilities in the US, Europe and Asia, it is winning contracts with Asian customers, suggesting the impact of emerging Asia-centric supply chains should be neutral longer term. Sales and earnings are also affected by the US\$/£ exchange rate.

Company description: Key player in compound semiconductor supply chain

IQE is the largest outsourced supplier of advanced wafer products and wafer services to the compound semiconductor industry. Its wafer foundries take very thin discs of substrate (compound semiconductor, silicon or silicon carbide) up to 150mm in diameter 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 epitaxial wafers (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.

Exhibit 1: Compound semiconductor supply chain



Source: Edison Investment Research

IQE has over 200 patents and a rich pool of trade secrets, enabling it to offer a wider range of technologies than its competitors and many in-house epitaxy units. This gives a strong competitive advantage and means it can benefit from growth in multiple markets. The group 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 has facilities in Europe, the US and Asia, giving it a presence in all three major semiconductor manufacturing regions, supporting relationships with multiple non-US and US customers. As a result, although the current period of supply chain adjustment has affected profits short-term, IQE is beginning to gain replacement business with the Asian chip manufacturers who are picking up work from US chip manufacturers banned from supplying Huawei. This should make it relatively agnostic to any mid- to long-term shifts in market share between component manufacturers or OEMs.

IQE was founded in 1988, employs around 675 people and is headquartered in Cardiff, Wales. The shares were admitted to the London Stock Exchange in 2000.

Markets: IP accesses multiple 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, radio frequency (RF) or infrared (IR) 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.

The range of technologies that IQE offers 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 at 63% of FY18 revenues remains IQE's largest segment. However, photonics (36% FY18 revenues) has taken over as the primary growth engine and it is expected to retain this role during the rest of the forecast period.

Exhibit 2: Growth drivers

Next 18 months	Next two to three years	Longer term
5G Infrastructure roll-out: 5G base stations; GaN-on-Si; GaN-on-SiC	5G infrastructure rollout: GaN for mm Wave/small cell network; lasers for backhaul networks	Environmental and health monitoring
Asian market wireless demand: power amplifiers for handsets	5G handset opportunity: filters and switches (cREO)	LiDAR for autonomous vehicles
High speed datacomms: 10G and 25G distributed feed-back lasers; 10G and 25G avalanche photo-diodes; PIN detectors	3D sensing: low end smartphone; wearables/consumer devices; commercial and industrial applications	Connected devices
3D sensing: Android market (high/mid end); world facing camera (time of flight)	Integrated optical front-end for smartphones	Smart grids

Source: Company data

Wireless market

The memory and data processing chips in a mobile phone 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.

Weak smartphone market in H119 exacerbated by US-China trade tension

Management estimates that prior to the supply chains shifts caused by US-China IQE had around 50% of the global merchant wireless epitaxy market so it provides a significant proportion of the epitaxial wafers used to make power amplifier chips. It is therefore highly sensitive to changes in demand for smartphones, with rising photonics revenues not always sufficient to compensate for a downturn in the smartphone market from causing a dip in IQE's revenues. During H119 weakness in the global smartphone market (down 4% year-on-year to 695.0m units, according to Counterpoint Research) caused by lengthening mobile phone replacement cycles was exacerbated by wireless customers serving the handset market cutting back on inventory levels in response to the uncertainty over future demand and the potential impact of Huawei's addition to the US Bureau of Industry and Security's Entity List. The interconnected nature of the semiconductor supply chain meant many of IQE's customers were affected either directly or indirectly. IQE's wireless revenues fell by 29% year-on-year to £30.1m (45% of total). In November the group noted that its major RF chip customers in the US had continued to place low volumes of orders and reduce inventory. Although it has already begun to win business from Asian chip manufacturers benefitting from this switch, with three production tools already qualified by a major Taiwanese foundry and a further two

in qualification, this is not sufficient to offset the reduction in the US short term, contributing to a reduction in FY19 guidance.

5G roll-out and demand for epitaxy in handsets

In November International Data Corporation noted that worldwide smartphone shipments increased by 0.8% year-on-year in Q319, reversing seven quarters of decline. Companies shipped a total of 358.3m smartphones during the quarter, which was up 8.1% from Q219. Counterpoint Research noted that 5G smartphones accounted for 2% of Q319 shipments, over 200% sequentially. Given that China has already started rolling out 5G networks ahead of an initial launch in November 2019, the research house believes the scale of the Chinese market should make 2020 the breakout year for 5G. It is not yet clear whether the additional functionality provided in the initial phase of 5G roll-out will be sufficiently compelling to reverse the reduction in smartphone volume demand seen over the past couple of years, particularly because the first phase appears very similar to 4G (see above), so we do not expect 5G to drive substantial growth in demand for IQE's wireless epitaxy in the short term. Nevertheless, industry analysts Yole Développement expects the technological advances required by 5G will support 8% CAGR between 2018 (US\$15bn) and 2025 (US\$25.8bn) for the RF front-end market. IQE is qualifying next generation higher efficiency power amplifiers suitable for 4G and 5G handsets.

When is 5G really 4G?

There are three main uses for 5G. Enhanced mobile broadband is effectively a progression from 4G LTE mobile broadband services with faster connections, higher throughput and more capacity. Ultra-reliable low-latency communications (URLLC) use the network for mission-critical applications that require uninterrupted and robust data exchange. Machine-type communications (mMTC) use the network to connect to a large number of low-power, low-cost devices in a wide area. Neither URLLC nor mMTC are expected to be deployed widely before 2021. In the first couple of years post launch, 5G will be transmitted at frequencies similar to 4G, so below 6GHz, and therefore achieve similar data throughput rates. 5G will not achieve faster throughput rates until it transmits at the higher frequencies (above 24GHz) available in the millimetre wave spectrum.

5G roll-out and demand for epitaxy in base stations

IQE is already supplying gallium nitride on silicon carbide (GaN-on-SiC) for low-volume, price-insensitive applications, primarily military communications and radar, and high-end base stations. Its newer, less expensive gallium nitride on silicon (GaN-on-Si) technology potentially opens up various more price-sensitive applications in the wireless infrastructure market from H220 onwards, displacing the incumbent silicon 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 will 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. Yole Développement predicts the global GaN RF market will increase from US\$632m in 2018 to US\$2bn in 2024, driven by telecom infrastructure and defence applications. We do not expect the first phase of 5G deployment, which will use some 4G infrastructure, to drive substantial growth in demand for IQE's wireless epitaxy in the short term. We anticipate modest revenues from GaN-on-Si epitaxy in FY20 followed by volume ramp-up in FY21.

5G roll-out and penetration of switch and filter market

IQE's newer technologies give scope for growing wireless revenues substantially more quickly than the market. Customer engagement on projects using IQE's patented cREO technology to develop

filters and switches for higher frequency 5G handsets is progressing well, potentially progressing to volume sales from FY21 and driving substantial growth in demand for IQE's epitaxy. By 2023, IQE intends to deploy several of its new technologies including cREO, porous silicon and its single crystal epitaxial aluminium nitride wafers in an integrated front-end module combining power amplifiers, filters and switches on a single chip.

Exhibit 3: Size of front-end market

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

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

Segmental outlook

Our segmental estimates were revised downwards following the November trading update to reflect a greater than anticipated disruption to IQE's major US wireless customers as a result of the US/China trade war exacerbated by destocking. We therefore model a 30% year-on-year reduction in segmental revenues during FY19. IQE has stated it expects Q120 to be seasonally weak but beyond that is cautiously optimistic. While the qualification of products and tools in the Asian supply chain for wireless RF noted above and 5G handset opportunities including penetration of the filter and switch markets support our view of a recovery medium-term, we model a further 1% decline in segmental revenues during FY20 to reflect the shift in RF chip output from the US to Asia.

Photonics

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 visible light and light in the infra-red part of the spectrum. 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.

VCSELs: Arrays of lasers for consumer and industrial applications

IQE's growth during FY17 and FY18 was driven by demand for a specific type of photonics emitter: the VCSEL. We expect VCSELs to continue to be a key growth driver in future. 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.

A report from Yole Développement in June 2019 estimated the global VCSEL market should exceed US\$3.7bn by 2024, growing at a 31% CAGR between 2018 and 2024. This is based primarily on migration of VCSEL technology from flagship models to all smartphones and to a lesser extent the adoption of 3D sensing technologies in automobiles. In the long term, the VCSEL market for LiDAR could generate a revenue of around US\$800m by 2032. The report notes the total VCSEL cost (chip not epitaxy) per smartphone in 2018 was US\$2–3.

IQE was the first company to have a process for producing 6" diameter VCSEL wafers. Having a higher diameter means more devices can be manufactured at the same time, substantially reducing cost per device. Being the first vendor to offer larger diameter VCSEL wafers meant IQE has become the preferred outsourcing supplier for VCSEL epitaxy, working in some cases directly with OEMs rather than only chip or component vendors. Taiwan-based Visual Photonics, which develops and manufactures epitaxial wafers, now has 6" diameter VCSEL wafer capability. US-based Finisar, which manufactures optical communications products, expects to start production in H120. However, IQE is conducting internal trials processing VCSELs on 8" wafers.

InP: Enabling high data rate fibre optic communications

Telecommunications companies are increasingly deploying passive optical networks to deliver triple-play services including TV, voice over IP phone and internet services to subscribers. These networks are also referred to as fibre to the home, fibre to the premises or fibre to the curb. 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. However, IQE's major customer for InP is experiencing internal issues unrelated to IQE's epitaxy.

IQE's nanoimprint lithography (NIL) technology provides a route for manufacturing the distributed feedback (DFB) lasers used in short- (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. In July 2018 IQE announced the NIL technology had been production qualified by a leading supplier of DFB lasers to the telecoms and data centre markets. It is in multiple customer engagements, including qualifications regarding use of the NIL technology in DFB lasers for 10G and 25G network components. This includes Asian chip vendors who typically lack the in-house expertise required to create technology such as NIL themselves. Management expects this to result in some volume sales during FY20.

One-stop shop for all types of IR materials

Compound semiconductor materials tuned to infra-red frequencies have revolutionised image sensing, providing images that are 8x sharper and can be generated 4x more quickly. These 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 such as environmental monitoring. It also permits the manufacture of very large sensing arrays that can detect data from sources further away. Being able to offer a more economic solution also opens the market longer term for deployment of infra-red lasers in non-invasive blood monitoring or for checking on levels of carbon dioxide.

Photonics leading FY20 recovery

IQE retains > 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 H119 segmental revenues (which include those previously categorised as attributable to infrared products) grew by 18% to £35.5m (53% of total), reflecting multiple VCSEL ramp ups.

In July, IQE announced it had commenced VCSEL production at Newport (UK) for a second major customer, this one for 3D sensing in Android devices, and has extensive product qualification ongoing for several other VCSEL projects (currently 10 other chip customers). It is also engaging with multiple Asian chip companies on 10G and 25G lasers for data comms. Importantly, the chip customer behind the 2017 VCSEL production ramp up, which we have previously inferred is involved in the Apple supply chain, has extended its current contract until the end of 2021. Although Apple iPhone shipments were down 4% in Q319, Apple's price cuts in China and elsewhere with the iPhone 11 and XR, as well as the introduction of a new palette of colours, appears to have stimulated demand during the last week of September offsetting the sharp annual decline earlier months which is a good sign going into the holiday season quarter. These observations support our assumption of sequential segmental revenue growth in H219 and 13.6% segmental revenue growth for FY19 as a whole. This is followed by segmental revenue growth of 17.5% in FY20. We note that a recent report from Mordor Intelligence stated the global photonic integrated circuit market was valued at US\$472.5m in 2018 and predicted it would grow with a CAGR of 26.4% between 2019 and 2024.

Strategy

Investing in the future of compound semiconductors

IQE is continually refining its advanced epitaxy skills to create innovative, value-added, materials-based solutions for its customers. Its different technology platforms (see Exhibit 4) can be combined to create novel solutions that are applicable across multiple market sectors. In our opinion, it would be difficult and time consuming for a competitor to replicate the breadth of product portfolio.

Exhibit 4: Materials toolbox

Technology platform	Applications
Rare earth technologies	GaN power for EV charging, RF GaN for 5G transmitters, superior performance RF filters for 5G mobile phones, heterojunction bipolar transistors (HBTs) 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 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, 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

Scaling the business for growth

The construction and fit-out of the new foundry in Newport, UK, is now complete with 10 tools installed, seven of which are in production or production ready, and space to add another 90. The factory already has dedicated bays for 20 reactors, enabling IQE to double capacity if required to meet demand. The additional capacity is critical for IQE to maintain its leading position in the VCSEL market as it grows. Capacity in Taiwan, which is the focus of the group's wireless activity, was increased by 40% during H119. This was initially authorised to reduce the need to re-qualify reactors for different technologies in the future as reactor conversions had previously cost c £3m over an 18-month period. Its availability is very timely now that wireless chip production is shifting to Asia in response to the US-China trade issues. There has also been investment in capacity in Massachusetts, which is IQE's main GaN production site, to support 5G infrastructure deployments.

Expanding margins and cash flows

Management is tackling margin improvement in several ways. The first is through higher utilisation of existing assets through securing new projects. The second is through enhanced yields. Management notes that yields and tool throughput in the new Newport facility already exceed those modelled in its business plan. The third is through the investment in IP, which has enabled the transition from outsourced epitaxy manufacturer to a materials solution provider.

In addition, management is taking steps to reduce costs while creating a platform able to respond to the anticipated growth in both the wireless and photonics markets. For example, production at the smaller GaN facility in New Jersey was transferred to Massachusetts and the site closed at the end of FY18, generating annual savings of US\$4m. For a similar reason, in October 2019 IQE acquired the third-party shareholdings in its CSDC joint venture in Singapore for a nominal fee of US\$1 to WIN Semiconductors and each of the other third-party shareholders. CSDC was formed in 2015 as a joint venture between IQE's Singapore subsidiary (51% stake), WIN Semiconductors (25%) and Nanyang Technological University and related parties (24%) with the intention of developing and commercialising molecular beam epitaxy (MBE) technologies for sale to customers in Asia. The operation generated SG\$8.9m losses (c £5.3m) in FY18 because of under-utilisation of assets, including MBE reactors, and property lease obligations. This transaction gives IQE control of the operation enabling it to restructure the business and reduce losses. It also enables IQE to focus the development and manufacturing assets on MBE opportunities in Asia that are emerging because of the localisation of Asian technology supply chains in response to the US-China trade war.

Considering management's intention to improve cash flows, we note that future investment will be primarily only in reactors rather than the supporting infrastructure and thus proportional to incremental revenue development.

Management changes

In March, Phil Smith became non-executive chairman. He was previously chairman of Cisco UK and Ireland and joined the IQE board in December 2016. He took over his current role from Dr Godfrey Ainsworth, who stepped down as executive chairman at the AGM. Tim Pullen, who was previously chief financial officer of ARM Holdings, took up his role as chief financial officer in February. Carol Chesney was appointed as a non-executive director in May. Carol is also a non-executive director of Renishaw, Hunting and Biffa and has served as the company secretary and group financial controller of Halma.

Sensitivities

- **Handset exposure:** with 63% of FY17 revenues 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 for applications such as autonomous vehicles move to volume production. In the short term, however, the ramp-up in volumes for programmes connected to face recognition in several smartphone models increases exposure to the handset market.
- **Impact of individual programmes:** several of the programmes in which IQE is involved are sufficiently large to have a distorting effect on short-term revenue trends. These include two US customers making wireless chips for handsets, a major InP customer and the VCSEL customer who we have previously inferred to be involved in the Apple supply chain. We believe the main problems with this customer concentration is the big impact that changes in demand for phones for an individual smartphone vendor or shifts further down the supply chain can have on IQE's revenues. This is more significant than the risk of a major customer changing to a different supplier, which we believe is relatively low because once a customer has qualified an epitaxy vendor, it is extremely unlikely to risk compromising device performance by switching to an alternative supplier 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. In the specific case of IQE's largest customer for VCSEL epitaxy, the one behind the 2017 volume ramp up, it has extended its current contract until the end of 2021. Moreover, if this customer switched epitaxy provider at the end of this period, the recent completion of multiple VCSEL product qualifications for Android supply chains provides alternative revenue sources, reducing the impact of a move.
- **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, concentrated photovoltaics, 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:** IQE has been adversely affected in the short term by the change to supply chains in response to the Huawei issue, experiencing reduced demand from certain US chip manufacturers for wireless epitaxy. Because IQE has fabrication facilities in the US, Europe and the Far East, the impact in the longer term should be neutral. It is already gaining new work with Asian customers.
- **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.

Financials

H119 performance in line with guidance

As flagged in the June trading update, wireless customers cut back on inventory levels during H119 in response to the uncertainty over future demand caused by lengthening mobile phone replacement cycles and the potential impact of Huawei's addition to the US Bureau of Industry and Security's Entity List. Wireless revenues fell by 29% year-on-year to £30.1m, 45% of the group total. Although Photonics revenues (which include those previously categorised as attributable to

infrared products) grew by 18% to £35.5m (53% of the total) reflecting multiple VCSEL ramp ups, this was not sufficient to offset the wireless slowdown. Group revenues decreased by 9% to £66.7m, in line with management guidance of £65–68m.

The drop in revenue caused the group to move from £7.6m adjusted operating profit in H118 to a £1.9m adjusted operating loss in H119. The adjusted cost of sales was similar to the prior year period because most of these costs are fixed and cannot be reduced significantly without affecting future capacity. Adjusted indirect costs rose by £3.0m, £2.4m of which relates to an increase in depreciation and amortisation resulting from investment in capacity. The group incurred a c £8m non-cash tax charge relating to a reduction in deferred US tax losses given the expected shift in manufacturing from the US to the UK and Asia. This is the result of the change to supply chains in response to the Huawei issue, with IQE experiencing reduced demand from certain US chip manufacturers but gaining new work with Asian customers. Adjusted diluted EPS moved from 0.76p/share profit in H118 to 1.29p/share loss in H119.

Major investment programme in capacity completed

Operating cash flow halved to £4.0m as a result of lower revenues, an increase in inventories at the period end reflecting the multiple VCSEL ramp-ups, a decrease in payables corresponding to capex payments, restructuring costs associated with closure of the New Jersey facility and transfer of trade and assets to Massachusetts and legal fees incurred in respect of a patent dispute defence. Capitalised development expenditure totalled £4.8m (£6.4m in H118) as the group continued work on multiple innovative technologies and capex totalled £19.0m (£6.3m H118). This included completing the infrastructure phase at the Mega Foundry in Newport, South Wales as well as capacity expansion in Taiwan and Massachusetts (see below). The group moved from £20.8m net cash at end December 2018 to £0.8m net debt at end-June 2019.

FY19 guidance reduced in November

In November management reduced the FY19 guidance issued in the trading update in June from £140–160m revenue at an adjusted operating margin significantly below the previously guided 10% to £136–142m revenue and a mid-single-digit adjusted operating loss. This guidance is based on the dislocation to the wireless semiconductor supply chain caused by US-Chinese trade tensions and internal issues at a major customer for InP epitaxy. Encouragingly, however, volume shipments to the group's largest VCSEL customer have been consistently strong so far in H219. These developments are discussed in more detail in the sections on the wireless and photonics segments. Noting this guidance, we lowered our estimates in November to model a substantial decline (30%) in wireless revenues in FY19, which the more muted photonics growth (14% compared with 25% modelled in our October estimates) was not sufficient to offset. Our estimates show the resultant 11% drop in group revenues generating £8.0m adjusted loss before tax. This includes the adverse effect of acquiring the outstanding stake in the loss-making JV in Singapore in October 2019.

Management has not provided guidance for FY20 or mid-term growth, as this would be premature before the wireless market has stabilised and until there is better visibility of the number and scale of new VCSEL ramp ups. Our estimates assume a very modest (1%) year-on-year reduction in wireless revenues during FY20 to reflect the shift in RF chip output from the US to Asia and moderately strong photonics growth (17.5%) supported by the major established VCSEL programme for the Apple supply chain and the first volume programme for the Android supply chain. Our model shows this level of photonics growth is sufficient to give a 9% improvement in group revenues for the year and a return to profit (£3.0m adjusted PBT).

Exhibit 5: Revenue analysis

	2018	2019e	2020e
Wireless (£m)	87.9	61.5	60.9
Photonics (£m)	66.8	75.9	89.2
CMOS++ (£m)	1.6	1.9	2.0
Total (£m)	156.3	139.4	152.1

Source: IQE data, Edison Investment Research estimates

Potential sources of upside and downside to these estimates are:

- Upside if Apple deploys world-facing cameras across its range, not just top-of-the range handsets or incorporates a more powerful flood illuminator.
- Upside if second VCSEL programme for Android supply chain, which is at the product qualification stage, moves to mass volume production for handsets in H220.
- Upside if additional VCSEL programmes pass into volume production.
- Upside if major US customer for indium phosphide has recovery in demand.
- Downside if IQE loses VCSEL share to Finisar, which is scheduled to start production of epitaxy for VCSELs at its Sherman facility in H120.

With regards to cash flow, the revised management guidance in November is for FY19 capex to be towards the bottom end of its previous guidance of £30–40m with net debt at the year end of £15–20m. The group has sufficient installed capacity to meet initial forecasts for FY20 but may need to place orders for additional reactors in Q120 if these forecasts are raised. Management agreed a £30m asset financing facility after end H119, increasing total available facilities to around £57m, which will support further investment in reactors if required.

Valuation: Recovery not priced in

We include a comparative valuation of IQE versus its broader (if imperfect) peer group below. Our forecasts of losses this year and marginal profitability next year renders a relative P/E valuation meaningless, so we focus on EV/sales multiples. With the shares having fallen c 33% since 1 November, based on our estimates, which were reduced following the November trading update, IQE is now trading at a discount to most peers on an EV/sales basis. In particular it is worth highlighting the re-rating upwards (67% increase in share price over the last 12 months) of Visual Photonics, IQE's Taiwanese peer, which has been benefiting from an upgrade trajectory because of its beneficial near-term exposure to the Asian supply chain. We note also that at current levels IQE is trading on similar prospective EV/sales multiples to the 2.4x historic EV/sales multiple that II-VI paid for Finisar in November 2018.

Exhibit 6: Peer multiples

Name	Market cap (\$m)	EV/Sales 1FY (x)	EV/Sales 2FY (x)	EV/EBITDA 1FY (x)	EV/EBITDA 2FY (x)	P/E 1FY (x)	P/E 2FY (x)
Epitaxy							
GCS Holdings Inc	206	2.3	2.1	9.7	8.7	23.5	19.3
IntelliEPI Inc (Cayman)	76	2.9	2.6	15.1	10.1	31.5	22.9
LandMark Optoelectronics Corp	923	11.2	8.9	24.9	17.5	51.8	32.7
Soitec SA	3,539	5.5	4.5	18.3	14.7	29.5	23.3
Visual Photonics Epitaxy Co	675	8.1	6.5	22.0	17.1	36.7	27.3
WIN Semiconductors Corp	4,019	5.6	4.5	13.4	10.6	26.8	19.2
Opto-electronics							
II-VI Inc	3,365	2.4	2.0	11.8	8.7	20.3	12.5
EMCORE Corp	97	0.7	0.6	(13.2)	10.2	(6.8)	(335.0)
Lumentum Holdings Inc	6,405	3.7	3.3	11.6	10.3	17.0	14.7
Mean - Epitaxy and Opto-electronics		4.7	3.9	15.9	12.0	29.6	21.5
IntelliEPI Inc (Cayman)	76	2.9	2.6	15.1	10.1	31.5	22.9
LandMark Optoelectronics Corp	923	11.2	8.9	24.9	17.5	51.8	32.7
Visual Photonics Epitaxy Co	675	8.1	6.5	22.0	17.1	36.7	27.3
Mean - VCSELs		7.4	6.0	20.7	14.9	40.0	27.6
IQE	521	2.7	2.5	41.5	18.0	(61.0)	178.6

Source: Edison Investment Research, Factset. Note: Prices as at 9 January 2020. Grey shading indicates exclusion from mean.

IQE's relatively low EV/sales multiples compared with its peers indicate potential for share price recovery as investors regain confidence in the group's ability to turn its unrivalled IP portfolio into sustainable profits growth and cash generation. Key indicators will be further Asian contract wins in both wireless and photonics and additional VCSEL programmes progressing to volume production.

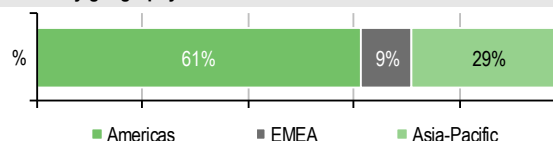
Exhibit 7: Financial summary

	£'000s	2017	2018	2019e	2020e
Year End 31 December		IFRS	IFRS	IFRS	IFRS
PROFIT & LOSS		restated			
Revenue		154,553	156,291	139,361	152,123
Cost of Sales (Inc D&A + SBP)		(115,857)	(111,748)	(117,063)	(116,374)
Gross Profit		38,696	44,543	22,298	35,749
EBITDA		37,130	28,404	9,081	20,931
Depreciation and Amortisation		(10,596)	(12,364)	(15,081)	(17,931)
Operating Profit (before amort. and except.)		26,534	16,040	(6,000)	3,000
Acquired Intangible Amortisation		(1,429)	(518)	(518)	(518)
Exceptionals		(385)	(7,906)	0	0
Share based payments		(7,526)	1,044	0	0
Operating Profit		17,194	8,660	(6,518)	2,482
Underlying interest		(2,019)	(66)	0	0
Exceptionals and losses from JVs		80	(1,847)	(2,000)	0
Profit Before Tax (norm)		24,515	13,974	(8,000)	3,000
Profit Before Tax (FRS 3)		15,095	6,747	(8,518)	2,482
Reported tax		(435)	(5,558)	1,533	(447)
Profit After Tax (norm)		24,998	11,229	(6,467)	2,553
Profit After Tax (FRS 3)		14,660	1,189	(6,985)	2,035
Average Number of Shares Outstanding (m)		689.5	761.8	787.3	795.9
EPS - normalised (p)		3.38	1.38	(0.82)	0.28
EPS - (IFRS) (p)		2.11	0.13	(0.92)	0.23
Dividend per share (p)		0.0	0.0	0.0	0.0
BALANCE SHEET					
Fixed Assets		224,836	267,476	295,877	299,427
Intangible Assets		108,513	121,775	127,467	131,860
Tangible Assets		90,875	124,520	147,228	146,387
Other		25,448	21,181	21,181	21,181
Current Assets		111,925	94,531	79,067	80,130
Stocks		33,044	35,709	32,187	34,592
Debtors		33,269	38,015	34,439	37,093
Cash		45,612	20,807	12,441	8,445
Other		0	0	0	0
Current Liabilities		(44,916)	(48,893)	(71,548)	(75,079)
Creditors		(44,916)	(48,893)	(41,548)	(45,079)
Short term borrowings		0	0	(30,000)	(30,000)
Long Term Liabilities		(666)	(3,836)	(3,836)	(3,836)
Long term borrowings		0	0	0	0
Other long term liabilities		(666)	(3,836)	(3,836)	(3,836)
Net Assets		291,179	309,278	299,560	300,642
CASH FLOW					
Operating Cash Flow		29,717	16,988	6,834	19,404
Net Interest		(2,125)	(66)	0	0
Tax		(5,844)	(665)	(1,200)	(1,400)
Capex		(28,190)	(42,362)	(44,000)	(22,000)
Acquisitions/disposals		0	0	0	0
Financing		94,912	813	0	0
Dividends		0	0	0	0
Net Cash Flow		88,470	(25,292)	(38,366)	(3,996)
Opening net debt/(cash)		39,549	(45,612)	(20,807)	17,559
HP finance leases initiated		0	0	0	0
Other		(3,309)	487	0	0
Closing net debt/(cash)		(45,612)	(20,807)	17,559	21,555

Source: Company data, Edison Investment Research. Note: Capex shown above includes capitalised R&D.

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Revenue by geography

Management team
CEO: Dr Andrew Nelson

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.

CFO: Tim Pullen

Mr Pullen joined IQE as the chief financial officer in February 2019, having previously been chief financial official of ARM. Prior to that he was 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. He has also worked in a number of technology and services businesses, including Serco, Fujitsu and Dell.

Non-exec chairman: Dr Phil Smith

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 36-year track record in the technology industry in leading companies including Philips Electronics and IBM. He joined the IQE board in December 2016 and became Non-executive chairman of IQE in March 2019.

Principal shareholders

	(%)
Oppenheimer Holdings	17.9
OFI Global Asset Management	17.6
T Rowe Price Group	11.3
Schroders	5.0
Massachusetts Mutual Life Insurance	5.0
Drew Nelson	4.5
Hargreaves Lansdown Asset Management	4.4

Companies named in this report

II-VI Inc (IIVI:US), Apple (AAPL:US), Finisar Corp (FNSR:US), GCS Holdings (4991:TT), IntellEPI (4971:TT), Kopin Corp (KOPN:US), Landmark Optoelectronics Corp (3081:TT), Lumentum Holdings (LITE:US), Soitec (SOI:FP), Visual Photonics Epitaxy (2455:TT), WIN Semiconductors (3105:TT)

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