EDISON

IQE

Strategy update

At the heart of 5G transformation

Tech hardware & equipment

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. Infrastructure roll-out appears relatively unaffected so far by the coronavirus pandemic. Global handset shipments are expected to pick up in 2021, potentially stimulated by new 'must-have' AR apps enabled by 5G connectivity and world-facing time-of-flight (ToF) devices, supporting a trebling of PBT in FY21.

Year end	Revenue (£m)	EBITDA (£m)	PBT* (£m)	EPS (p)	DPS (p)	P/E (x)
12/18	156.3	26.4	14.0	1.38	0.00	53.2
12/19	140.0	16.2	(7.0)	(2.46)	0.00	N/A
12/20e	170.6	30.3	4.2	0.38	0.00	N/A
12/21e	183.3	38.2	12.0	1.16	0.00	63.4

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

5G roll-out supports handset recovery

Consumers in many markets around the world have shifted their normal spending from travel, dining out and general leisure to items like consumer electronics that potentially ameliorate the lockdown experience. This trend is expected to support a return to growth in global handset shipments in 2021, supported by enhanced functionality provided by 5G. This will benefit IQE's wireless segment.

'Must-have' AR apps to drive photonics demand

IQE's photonics performance is closely linked to the output for its major VCSEL programme, which we have previously inferred is part of the Apple supply chain, where volumes have been consistently strong throughout the year so far. Demand for VCSELs is being boosted by the introduction of a world-facing ToF device to improve augmented reality (AR) experiences in the new iPhone 12 Pro. This increases the VCSEL content per phone by 1.5 times. The ability to integrate more accurate information about a handset user's physical environment into the AR world will potentially catalyse the launch of 'must-have' AR apps. This would be beneficial for iPhone 12 Pro sales. It would also encourage Android handset manufacturers, several of which already use modest amounts of IQE's VCSEL epitaxy to support facial recognition functionality, to deploy world-facing ToF devices too.

Valuation: Further gains depend on handset growth

IQE's share price has more than recovered the ground lost during the panic selling in March. At current levels, IQE is trading in line with the mean EV/EBITDA multiples of the sample of companies engaged in manufacturing VCSEL epitaxy. Given IQE's broader product portfolio, we believe it is reasonable for IQE to trade on multiples that are at the upper bound of this sample. However, we believe share price improvement will require greater visibility of how handset demand will be affected by any pandemic related recession in 2021 and whether the switch to 5G and the availability of as yet unknown 'must-have' AR apps will be sufficient motivation for cash-strapped consumers to justify upgrading their handsets.

10 December 2020

Price	**73.45p**
Market cap	**£588m**
Net debt (£m) at end June 2020 (excluding £48.1m finance leases)	7.4
Shares in issue	800.2m
Free float	86.6%
Code	IQE
Primary exchange	AIM
Secondary exchange	N/A

Share price performance

%	1m	3m	12m
Abs	21.9	28.8	37.7
Rel (local)	14.9	16.9	49.7

52-week high/low 73.45p 20.0p

Business description

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

Next event

FY20 results March 2021

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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 handsets and associated infrastructure. Segmental growth is being driven by roll-out of 5G infrastructure and handsets. Investment in its technology portfolio and wafer manufacturing capacity has also enabled IQE to take a major share in the outsourced photonics market. Here growth is being driven by the deployment of VCSELs (vertical cavity surface emitting lasers) in premium handsets, initially for facial recognitions systems, more recently for world-facing ToF devices used to create more compelling AR experiences.

Financials: Record first half revenues return group to profit

Group revenues grew by 35% year-on-year during H120 to a record £89.9m. Wireless revenues jumped by 51% to £45.5m as IQE's long-standing customers benefited from major design wins and investment in 5G infrastructure. Additionally, we believe IQE took market share in Asia. Photonics revenues rose by 22% to £43.4m. Production for IQE's major vertical cavity surface emitting laser (VCSEL) customer was consistently strong throughout the period. Given the high proportion of fixed costs, the strong year-on-year revenue growth took the group from a £1.9m adjusted operating loss in H119 to a £4.3m adjusted operating profit. Net debt reduced by £8.6m during H120 to £7.4m at the end of June (excluding £48.1m IFRS 16 lease liabilities). Cash generated from operations more than trebled year-on-year to £15.1m. In November management announced that the strong H120 performance had continued into the second half. It updated the FY20 revenue guidance given in September from at least £165m to over £170m, with adjusted EBIT guidance remaining at the mid-single-digit million level.

Valuation: Further gains depend on handset market growth

At current levels, IQE is trading in line with the mean EV/EBITDA multiples of the sample of companies engaged in manufacturing VCSEL epitaxy (year 1 IQE 19.9x vs 20.9x mean). Given IQE's broader product portfolio, we believe it is reasonable for IQE to trade on multiples that are at the upper bound of this sample. However, we believe share price improvement will require greater visibility of how handset demand will be affected by any pandemic related recession in 2021 and whether the switch to 5G and the availability of as yet unknown 'must-have' AR apps will be sufficient motivation for cash-strapped consumers to justify upgrading their handsets.

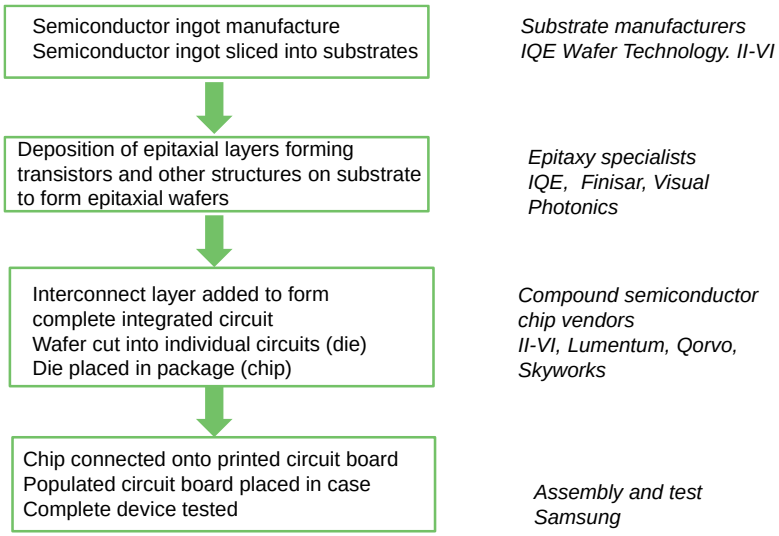
Sensitivities: Performance linked to individual customers in the global handset market

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 programme) were adversely affected in FY19 by the US/China trade war, though have since recovered. Because IQE has manufacturing facilities in the US, Europe and Asia, it is establishing itself as a participant in emerging Asia-centric supply chains. Sales and earnings are also affected by the US dollar/sterling exchange rate.

Company description: A key player in the 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 radio-frequency (RF) 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 150 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, IQE has been able to gain replacement business with the Asian chip manufacturers that are picking up work from US chip manufacturers banned from supplying Huawei. This geographic diversity should make IQE relatively resilient to any mid- to long-term shifts in market share between component manufacturers or OEMs.

IQE was founded in 1988, employs around 650 people and its headquarters are 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, RF or infrared (IR) signals, emit and detect light (photonics), or convert light energy to electrical energy (photovoltaics). 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 and RF 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 51% of H120 revenues remains IQE's largest segment. However, photonics (48% of H120 revenues) has taken over as the primary growth engine and we expect it to retain this role during the rest of the forecast period.

Exhibit 2: Growth drivers for IQE

Short term	Medium term	Longer term
5G Infrastructure roll-out: 5G base stations; GaN-on-SiC	Continued 5G infrastructure rollout: GaN-on-SiC and GaN-on-Si for mmWave/small cell network; high speed lasers and detectors for backhaul networks	Environmental and health monitoring
5G handsets: high efficiency power amplifiers; Integrated power amplifier and switch (BiHEMT)	5G handsets: broader Android adoption of 3D sensing driven by augmented reality applications; integrated front-end module powering mmWave handsets; 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: wearables/consumer devices; commercial and industrial applications	Connected devices
3D sensing: Android market (high/mid end); world facing camera (ToF)	Integrated optical front-end for smartphones (quasi photonic crystal)	Efficient power and smart grids

Source: Company data

5G roll-out supports demand for IQE's epitaxy in wireless applications

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. Similarly, the transmit and receive functions in mobile phone base stations are made from gallium nitride-on-silicon carbide (GaN-on-SiC) semiconductor material. Management estimates that IQE has slightly above 50% of the global merchant wireless epitaxy market so it provides a significant proportion of the epitaxial wafers used to make power amplifier chips. IQE's performance is therefore highly sensitive to changes in demand for smartphones and mobile phone infrastructure, both of which are closely linked at present to the roll-out of 5G mobile phone networks.

Benefits of 5G

Exhibit 3: 3G, 4G and 5G compared

Network type	Average/maximum download speeds	Time to download a full HD film	Approximate latency
3G	8/20Mbps	Over a day	65ms (actual)
4G	32.5/100Mbps	Over 7 minutes	35–50ms (actual)
5G	130–240Mbps/1–10Gbps+ (theoretical)	4–40 seconds	21–26ms (actual) 1ms (theoretical)

Source: Edison Investment Research

5G is the new generation of wireless technology. It is much faster than previous generations of wireless technology; it offers greater capacity, allowing thousands of devices in a small area to be connected at the same time and a significant reduction in latency, which is the time between instructing a wireless device to perform an action and that action being completed, so it is more responsive. While 3G led to the launch of smartphones and 4G supported faster browsing, enabling consumers to watch videos on their phones, 5G will also lead to new applications. For example, one local council is helping social care patients by installing a network of 5G nodes on lamp posts. This network is being used to keep patients and their families connected via virtual reality, to check on bio-monitors that detect whether patients are dehydrated and to allow pharmacists to determine whether patients are taking their medication without needing to visit them. Many potential applications have not yet been thought of.

Exhibit 4: 5G and innovation

More data	More capacity	Instant response
Improved consumer experience	E-health	Autonomous driving
Faster connection speeds	Transport and logistics	Drone delivery
Virtual reality applications	Environmental monitoring	Smart manufacturing
Augmented reality applications	Smart energy networks	
	Smart agriculture/retail	

Source: Edison investment Research

According to the Global mobile Suppliers Association's (GSA) '5G Market Snapshot' published in November 2020, 122 commercial 5G networks have launched worldwide. 407 operators in 129 countries/territories were investing in 5G, including trials, acquisition of licences, planning, network deployment and launches. GSA states that by the end of October 2020, 492 5G devices had been announced, of which 249 were understood to be commercially available, ie at least half of all announced 5G devices were actually commercially available. The number of announced 5G devices had almost doubled since end-March 2020, while there had been a 54% increase in the number of commercially available 5G devices in the preceding three months.

We note that not all of the functionality promised for 5G will be available at the start of the 5G roll-out, because in the first couple of years 5G will be transmitted at frequencies similar to 4G, ie 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 and handset demand

IQE has been supplying GaAs wafers to manufacturers of the power amplifier chips used in handsets for over two decades. In November International Data Corporation (IDC) predicted that, following a weak H120 and stronger than expected calendar Q320, global smartphone shipments would grow 2.4% y-o-y in Q420, giving a 7.5% drop for FY20 as a whole, followed by 4.4% y-o-y growth in 2021. IDC notes that the market rebound will be driven by rapid supply chain recovery as well as significant incentives from both OEMs and channels for new 5G products. The report observes that consumers in many markets around the world have shifted their normal spending from travel, dining out and general leisure, much of which has been curtailed by lockdowns, to items like consumer electronics that potentially ameliorate the lockdown experience. In our opinion, consumers, many of who will suffer a reduction in disposable income as a result of the coronavirus pandemic, will need to be persuaded by the emergence of 'must-have' apps as well as financial incentives to upgrade to 5G.

5G and infrastructure demand

IQE has been supplying GaN-on-SiC for low-volume, price-insensitive applications, primarily military communications and radar, and high-end base stations for several years. According to a report published in May 2020 by Yole Développement, the global GaN RF market is expected to

increase from US$740m in 2019 to more than US$2bn by 2025 (a CAGR of 12%), with growth driven by military applications, particularly light-weight radar, and 5G telecom infrastructure. The report observed that the coronavirus pandemic was likely to have only 'minor' consequences for GaN deployment in 2020 since leading Chinese telecom operators' 5G construction goals remained unchanged. As well as GaN-on-SiC, IQE offers a newer, less expensive gallium nitride on silicon (GaN-on-Si) technology. This potentially opens up various more price-sensitive applications in the wireless infrastructure market in the medium term, displacing the incumbent silicon technology. The availability of GaN-on-Si becomes particularly significant as the wireless market shifts to 5G applications because 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.

5G and penetration of switch and filter market

IQE's newer technologies give scope for growing wireless revenues substantially more quickly than the handset market. Customer engagement on projects using IQE's patented cREO technology to develop filters for higher frequency 5G handsets is progressing well, potentially moving to volume sales in the medium term and driving substantial growth in demand for IQE's epitaxy. In November IQE announced the successful development of its IQepiMo technology, which is based on the cREO platform, for applications requiring low-resistance buried electrodes, particularly higher-frequency RF filters required for true 5G networks. In the longer term, 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 5 shows the potential presented by expansion into the filter and switch markets.

Exhibit 5: Size of front-end market

Component	2017 market size	2023e 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 performance and outlook

IQE's wireless revenues jumped by 51% y-o-y in H120 to £45.5m. During H119 wireless revenues were adversely affected by customers destocking in response to the uncertainty caused by lengthening smartphone replacement cycles and by the disruption to global semiconductor supply chains caused by Huawei's addition to the US Bureau of Industry and Security's Entity List. In contrast, during H120 IQE's long-standing wireless customers benefited from major design wins and investment in 5G infrastructure. In addition, we believe that IQE took market share in Asia.

In the short term, the prospects for the two companies we believe are IQE's major wireless customers appear positive. In November Skyworks stated that it expected double-digit sequential revenue and earnings growth in the December quarter, driven by content gains and product ramps across multiple 5G-enabled smartphone platforms. Qorvo reported expanded module shipments across multiple tier-one smartphone OEMs and projected the robust end-market demand would continue into the December quarter. Considering the handset market as a whole, as noted above,

global shipment of handsets are expected to grow by 4.4% y-o-y in 2021. We model 23% segmental growth during FY20 followed by 4% in FY21.

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 that may be used to either emit or detect visible light and light in the IR part of the spectrum. Photonics devices are used in many different markets, which should reduce IQE's reliance on the health of the handset market in the longer term. Market segments include data communications, consumer devices, medical diagnostics, environmental monitoring and autonomous driving. Wafer prices for photonic applications are at least twice that for wireless applications and typically command higher margins even though there are many more processing steps required than for wireless epitaxy. We note that a report from Mordor Intelligence stated the global photonics market was valued at US$686.9m in 2019 and predicted it would grow with a CAGR of 7.9% between 2020 and 2025.

VCSELs: Enabling new 'must-have' AR apps

IQE's segmental growth from FY17 onwards has been driven by demand for a specific type of photonics emitter, the VCSEL. We expect VCSELs to continue to have a major influence on segmental performance in future. Until 2017, the VCSEL market was driven by datacom applications, with photonics devices being used in links of up to 500m in data centres, enterprise and campus networks. Since 2017, 3D sensing has become the dominant driver, especially since Apple began to use Face ID in the iPhone X. It was initially expected that Android smartphone manufacturers would emulate Apple and also deploy 3D sensing modules in the front sides of their smart phones for facial recognition, but uptake has been modest and limited to a small number of top-of-the range devices because of cost. Despite uptake in Android phones being limited so far, Yole Développement's report on the VCSEL market published in October 2020 noted that mobile 3D sensing will represent around 75% of overall VCSEL revenues in 2020, of which Lumentum, as the main supplier of Apple's VCSEL's, has 68% of the market. Fixed telecommunications and infrastructure represent most of the remaining 25%.

Yole Développement's report predicts that the global VCSEL market will grow from more than US$1bn in 2020 to US$2.7bn in 2025, ie a CAGR of 18.3%. It observes that other applications such as driver monitoring systems and LiDAR-based pedestrian detection, collision avoidance and parking assistance in cars could emerge in the medium to long term. Other potential applications are proximity sensing, hand and body tracking and gesture recognition in gaming handsets, smartphones and tablets. In addition, two-dimensional arrays consisting of hundreds of individual VCSELs 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.

IQE was the first company to have a process for producing 150mm 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 that IQE has become the preferred outsourcing supplier for VCSEL epitaxy with around 90% of the market (management estimates). As noted above, we have previously inferred that IQE is engaged in the Apple VCSEL supply chain. IQE has also qualified VCSEL epitaxy for use in Android devices, though uptake so far has been modest.

Competition is intensifying. US-based Finisar, which is part of optical communications manufacturer II-VI, was awarded US$390m in 2017 from Apple's Advanced Manufacturing Fund to start VCSEL production at a mothballed facility in Texas. Finisar started volume production of VCSELs on 150mm wafers earlier this year. Taiwan-based Visual Photonics has also introduced 150mm

diameter VCSEL wafer capability. So far, IQE's dominant position in the segment appears undented since production for its major VCSEL programme has been consistently strong throughout FY20.

One reason we believe that IQE's VCSEL production is not being adversely affected by Finisar taking market share is that demand for VCSELs is being boosted by the introduction of a world-facing ToF device to improve AR experiences in the new iPhone 12 Pro. This increases the VCSEL content per phone by 1.5 times. The ability to integrate more accurate information about a handset user's physical environment into the AR world will potentially catalyse the launch of 'must-have' AR apps. This would be beneficial for iPhone 12 Pro sales. It would also encourage Android handset manufacturers, several of which already use modest amounts of IQE's VCSEL epitaxy to support facial recognition functionality, to deploy ToF devices too.

Exhibit 6: Video of LiDAR scanner on iPhone 12 Pro

Source: Apple Inc

With regards to maintaining its competitive advantage, IQE has substantially more experience of manufacture on 150mm wafers than its competitors, which should, in our opinion, manifest in higher yields. Moreover, it is already making progress on transitioning to 200mm diameter wafers (see below), which would confer further cost advantages. It also has a route for manufacturing longer wavelength VCSELs (see below), which Finisar does not have.

InP: Enabling high data rate fibre-optic communications

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. Until FY19, around half of IQE's photonics revenues were derived from indium phosphide (InP) sales related to this segment, but during FY19 its major InP customer experienced internal issues unrelated to IQE's epitaxy.

IQE is looking to its nanoimprint lithography (NIL) technology to drive growth in this segment. NIL technology may be used to manufacture distributed feedback (DFB) lasers. These are currently used in short- (up to 20km) and long-haul networks and may also be deployed in a wide range of emerging sensing applications such as monitoring environmental emissions and air quality, detecting chemical weapons and explosives, and monitoring breath and blood vessels to aid disease diagnosis. Using nanoimprint lithography reduces the cost of DFB lasers and improves their data throughput. 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, but while the

company has generated some revenues from the technology, these have not been material so far. Customers are currently testing samples of devices based on IQE's epitaxy for 10G and 25G networks and optical detectors. Management expects this to result in some volume sales in FY21.

Turning to medium-term opportunities, NIL technology is also the foundation for manufacturing quasi-phonic crystals. These will potentially enable IQE to manufacture VCSELs with further epitaxial layers on top that form diffraction gratings, thus creating an integrated optical front-end for smartphones.

Extending IR epitaxy offer to blood and environmental monitoring

Compound semiconductor materials tuned to IR frequencies have revolutionised image sensing, providing images that are eight times sharper and can be generated four times 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 and represents around 30% of the group's photonics activity. Defence applications continue to be an important segment for IQE's IR epitaxy, as evidenced by a recent order from a major US customer with a combined value of more than US$10m for delivery over nine months for both IR and high-performance RF applications. This is IQE's largest defence sector purchase order to date.

In addition, as the economics of production of indium antimonide wafers improves, which is a medium-term goal, IQE will be able to offer these IR substrates for sensors for a wide range of high-volume applications such as non-invasive blood monitoring and environmental monitoring, eg of carbon dioxide levels. We expect that the capacity provided by 5G networks will support a proliferation of sensors used in remote monitoring applications. As IQE currently has over 80% share (management estimates) of the global IR substrate market, being able to offer the product to a much larger market represents a significant growth opportunity. We note that, at least to start with, this market could be supplied using relatively under-utilised MBE equipment located in IQE's North Carolina facility.

Segmental performance and outlook

Photonics revenues rose by 22% y-o-y during H120 to £43.4m. As noted previously, production for IQE's major VCSEL programme has been consistently strong throughout the year so far, supporting our assumption of 21% segmental revenue growth for FY20 as a whole. We assume that IQE will continue to be the major supplier of epitaxy for the Apple supply chain, with content gains offsetting any erosion of share. Assuming that the next-generation Apple phones also have world-facing ToF devices, the proportion of Apple phones shipped with scanners will increase during 2021, requiring additional VCSEL production. The associated content gain, together with commencement of meaningful volumes of NIL related epitaxy for DFB lasers and IR epitaxy for the recently announced US contract in the defence sector underpins our estimate of 11% segmental revenue growth in FY21.

Strategy

Investing in the future of compound semiconductors

IQE is continually refining its advanced epitaxy skills to create innovative, value-added, materials-based solutions that are applicable across multiple market sectors for its customers. In our opinion, it would be difficult and time consuming for a competitor to replicate the breadth of the product portfolio.

For example, in November IQE announced that it had successfully developed a new, patent pending technology, IQGeVCSEL 150, which uses germanium substrates for VCSELs rather than

GaAs as at present. This is a key step on the way to manufacturing VCSELs on 200mm diameter wafers because the wafer buckling that occurs when attempting to process VCSELs on a 200mm GaAs wafer compromises yield. Germanium wafers stay flatter during VCSEL fabrication, so the yield is better. In addition, it is easier to process the germanium wafers downstream and it is possible to fabricate the thicker device architectures required for longer wavelength VCSELs. A longer wavelength would mean that the VCSEL array used for facial recognition in a handset could be located behind the OLED screen, eliminating the cut-out at the top of the screen and increasing the display area. Longer-wavelength VCSELs are manufactured using molecular beam epitaxy (MBE) equipment, which VCSEL competitor Finisar does not have. In addition, since IQE also has a technology for creating a germanium layer on top of a silicon wafer, the development potentially provides a route for manufacturing VCSELs on 300mm diameter silicon wafers. Manufacturing VCSELs on higher-diameter wafers would result in significantly lower-cost devices and higher-volume production volumes.

Scaling the business for growth

IQE completed a major programme of investment during FY19. The programme included construction and fit-out of the new foundry in Newport, UK, which has 10 tools installed, six of which are currently in production, 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 as reactor conversions had previously cost c £3m over an 18-month period. Availability of the additional capacity was very timely as it coincided with a shift in wireless chip production to Asia in response to the US-China trade issues. There was also investment in capacity during FY19 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. 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. Production at a 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. Over the next three years MBE production in the US will be consolidated on the North Carolina site and the facility in Pennsylvania closed.

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 November 2020 Dr Drew Nelson, founder and CEO, announced his intention to step aside from his current role once a successor had been found. At that point, he will become a board member with the title of president and will act in an advisory and ambassadorial role for the business. He will also devote more of his time to the further development of the Compound Semiconductor Cluster in South Wales.

Sensitivities

- **Handset exposure:** with 51% of H120 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 VCSEL programmes for applications such as autonomous vehicles move to volume production and IR epitaxy is used in high-volume applications such as blood monitoring. In the short term, however, the ramp-up in VCSEL production for programmes connected to AR applications 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 (30.0% and 29.6% of FY19 wireless revenues respectively), the major VCSEL customer (26.0% of FY19 photonic revenues) and the major InP customer. We believe the main problems with this customer concentration is the big impact that changes in demand for phones for an individual smartphone vendor 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. For example, it purchased 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, it has extended its current contract until the end of 2021. While Finisar has started manufacturing VSELs for the Apple supply chain, this does not appear to have materially affected IQE's VCSEL output so far, possibly because the reduction in share has been offset by content gains. We note that if IQE's major VCSEL customer switches epitaxy provider at the end of the current contract, or Finisar makes material share gains, the completion of multiple VCSEL product qualifications for Android supply chains provides alternative revenue sources, potentially reducing the impact of these changes.
- **Uncertainties in markets that are still not yet developed:** IQE has opportunities in many end markets including gesture recognition, environmental monitoring and non-invasive blood monitoring. The timing and rate at which revenues from these applications could grow is difficult to gauge.
- **US-China trade war:** During FY19 IQE was adversely affected by the change to supply chains in response to Huawei's addition to the US Bureau of Industry and Security's Entity List. Because IQE has fabrication facilities in the US, Europe and Asia it has been able gain 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

Record first-half revenues return group to profit

In line with June guidance, group revenues grew by 35% year-on-year during H120 to a record £89.9m. While this result was flattered by £2.5m of forex tailwind, the Q120 performance was slightly ahead of internal expectations and trading in Q2 was strong, with no disruption to production from coronavirus related lockdowns or any significant impact on the supply of materials.

As discussed earlier in the note, wireless revenues jumped by 51% to £45.5m and photonics revenues rose by 22% to £43.4m. Production for IQE's major VCSEL programme was consistently strong throughout the period.

Given the high proportion of fixed costs, the strong revenue growth took the group from a £1.9m adjusted operating loss in H119 to a £4.3m adjusted operating profit. The adjusted cost of sales increased by £14.3m to £70.4m and adjusted indirect costs rose by £2.5m to £15.0m. £2.3m of the cost increases related to an increase in amortisation, the remainder primarily to ramping up production in the Newport facility and taking on all of the costs of Singapore JV when the group increased its ownership of the JV to 100% in October 2019. The group incurred £9.3m exceptional costs, which are described in Exhibit 7. £1.1m of these exceptional costs were cash items.

Exhibit 7: H120 P&L breakdown of exceptional items

Category	Value* (£m)	Details
Share-based payments	0.3	
Exceptional legal fees	0.7	Fees incurred defending a non-core patent. The arbitration hearing in September determined entirely in IQE's favour.
Impairment of intangible assets	6.5	Impairment of cREO patent and development costs that are not related to filters, following a decision to focus cREO activity on the filter market.
Onerous contract provision	1.8	Cost of minimum guaranteed future royalty payments to Translucent agreed when the cREO technology was acquired. These are still payable although the date when IQE will start to generate revenues from commercial exploitation of the technology has been delayed.

Source: IQE. Note: *Before adjustment for tax.

Strongly cash generative now expansion programme complete

Net debt reduced by £8.6m during H120 to £7.4m at the end of June (excluding £48.1m IFRS 16 lease liabilities). Cash generated from operations more than trebled year-on-year to £15.1m despite the £1.1m exceptional cash-cost related to legal fees. Capital expenditure dropped from £19.0m to £1.1m. This is because the programmes to build infrastructure at the Mega Foundry in Newport, South Wales, and expand capacity in Taiwan and Massachusetts all completed in FY19. Capitalised development expenditure fell from £4.8m in H119 to £2.6m reflecting a more disciplined, commercially oriented new product development process.

During H219 management agreed a £30m asset financing facility, increasing total available facilities to around £57m. This will provide support if the longer-term impact of the coronavirus is to reduce demand for new mobile phone handsets, though the signs so far suggest that this is not the case. During H120 management negotiated an agreement with HSBC to relax debt covenants in December 2020 and June 2021. This was a precautionary measure to ensure continued access to debt facilities in severe downside scenarios.

Outlook and estimates

Exhibit 8: Revenue analysis and top-line estimates

	2018	2019	2020e	2021e
Wireless (£m)	87.9	68.2	83.8	87.2
Photonics (£m)	66.8	69.8	84.7	94.0
CMOS++ (£m)	1.6	2.1	2.1	2.1
Total (£m)	156.3	140.0	170.6	183.3
Growth				
Wireless		-22%	23%	4%
Photonics		4%	21%	11%
CMOS++		29%	0%	0%
Total		-10%	22%	7%

Source: IQE data, Edison Investment Research estimates

Management introduced guidance for FY20 in September for revenues of at least £165m with an adjusted operating profit of at least mid-single digits. In November management raised FY20 revenue guidance to over £170m, with adjusted EBIT guidance remaining at the mid-single-digit million level. At the time, the company noted that the strong performance in H120 had continued into the second half. We upgraded our FY20 and FY21 estimates in our November note and have not changed them since. These estimates are based on the following assumptions:

- **Wireless segment demand:** as discussed earlier in the note, our growth assumptions are supported by bullish comments regarding Q420 from both Skyworks and Qorvo, as well IDC's prediction of a 4.4% y-o-y growth in global smartphone shipments during 2021.
- **Photonics segment demand**: as discussed earlier in the note, we assume that IQE will continue to be the major supplier of epitaxy to its major VCSEL programme with content gains compensating for any erosion of share. The associated content gain, together with potential adoption of world-facing ToF devices in Android handsets, commencement of meaningful volumes of NIL related epitaxy for DFB lasers and IR substrates for defence application such as the recently announced US contract in this sector underpin our segmental revenue estimate for FY21.
- **Cost of sales**: this includes a high proportion of fixed costs.
- **Cost base:** our estimates for indirect costs are in line with H120 levels.
- **Capital expenditure:** as the major infrastructure investment programmes completed in FY19, we model £7.0m capex in FY20 and £10.0m in FY21. The Newport Mega Foundry already has bays for an additional 10 reactors, so future investment will be primarily only in reactors rather than the supporting infrastructure and thus proportional to incremental revenue development.
- **Capitalised development costs**: we model FY20 and FY21 estimates at £6.0m each year in line with H120 levels.

Valuation: Share price above pre-pandemic levels

Exhibit 9: Peer valuation

Name	Ytd performance (%)	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	(26.6)	164	2.4	2.3	N/A	N/A	(281.1)	(26.8)
IntelliEPI	(13.4)	72	2.8	2.4	20.5	14.5	135.9	32.7
LandMark Optoelectronics	(3.2)	969	11.4	8.8	22.9	16.9	49.5	31.9
Soitec	61.8	6,107	8.3	6.3	27.9	20.6	58.0	37.2
Visual Photonics Epitaxy	(15.8)	651	7.2	6.1	19.3	16.4	34.1	27.2
WIN Semiconductors	15.6	5,113	5.8	5.3	12.6	11.9	21.3	20.8
Opto-electronics								
II-VI	111.3	7,379	2.9	2.6	11.5	10.3	20.9	18.5
EMCORE	48.4	133	0.8	0.7	8.4	5.8	15.4	10.5
Lumentum Holdings	12.6	6,739	3.5	3.2	9.8	9.1	14.5	13.1
Mean – Epitaxy and Opto-electronics			**5.0**	**4.2**	**16.6**	**13.2**	**43.7**	**24.0**
VCSELs								
IntelliEPI	(13.4)	72	2.8	2.4	20.5	14.5	135.9	32.7
LandMark Optoelectronics	(3.2)	969	11.4	8.8	22.9	16.9	49.5	31.9
Visual Photonics Epitaxy	(15.8)	651	7.2	6.1	19.3	16.4	34.1	27.2
Mean – VCSELs			**7.1**	**5.8**	**20.9**	**15.9**	**73.2**	**30.6**
IQE Plc	49.9	$784m	3.5	3.2	19.9	15.7	190.9	63.4

Source: Refinitiv, Edison Investment Research. Note: Prices at 7 December 2020. Grey shading indicates exclusion from mean. IQE's EBITDA includes losses from JV.

We include a comparative valuation of IQE versus its broader (if imperfect) peer group above. IQE's share price has more than recovered the ground lost during the panic selling in March. At current levels, on an EV/EBITDA basis, IQE is trading at a premium to the mean of the larger sample and in

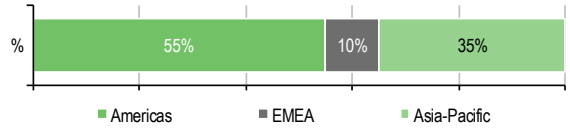
line with the mean of the sample of companies engaged in manufacturing VCSEL epitaxy. It is trading above the upper bound of the sample of VCSEL peers with regards to P/E multiples.

IQE has a broader product portfolio than its VCSEL peers. In addition, it can manufacture on multiple sites, which gives it better resilience to US-China trade disputes than its competitors. For these reasons, we believe it is reasonable for IQE to trade on EV/EBITDA and P/E multiples that are at the upper end of the VCSEL sample. However, we believe that further share price improvement will require greater visibility of how handset demand will be affected by any potential pandemic-related recession in FY21 and whether the switch to 5G and the availability of as yet unknown 'must-have' AR apps will be sufficient motivation for cash-strapped consumers to justify upgrading their handsets.

Exhibit 10: Financial summary

£'000s	2018	2019	2020e	2021e
Year end 31 December	IFRS	IFRS	IFRS	IFRS
PROFIT & LOSS	**restated**			
Revenue	156,291	140,015	170,621	183,307
Adjusted Cost of Sales	(119,536)	(119,145)	(134,000)	(138,427)
Adjusted Gross Profit	36,755	20,870	36,621	44,880
EBITDA	26,404	16,246	30,281	38,209
Depreciation and Amortisation	(12,882)	(22,289)	(24,468)	(25,418)
Operating Profit (before amort. and except.)	16,040	(4,676)	6,113	13,091
Acquired Intangible Amortisation	0	0	0	0
Exceptionals	(8,424)	(14,897)	(9,346)	0
Share based payments	1,044	771	(550)	(550)
Operating Profit	8,660	(18,802)	(3,783)	12,541
Underlying interest	(66)	(1,606)	(1,600)	(800)
Exceptionals and losses from JVs	(1,847)	(4,540)	(300)	(300)
Profit Before Tax (norm)	13,974	(7,019)	4,213	11,991
Profit Before Tax (FRS 3)	6,747	(24,948)	(5,683)	11,441
Reported tax	(5,558)	(10,180)	1,826	(2,278)
Profit After Tax (norm)	11,229	(19,010)	3,413	9,713
Profit After Tax (FRS 3)	1,189	(35,128)	(3,857)	9,163
Average Number of Shares Outstanding (m)	761.8	787.2	797.2	800.2
EPS - normalised (p)	1.38	(2.46)	0.38	1.16
EPS - (IFRS) (p)	0.13	(4.51)	(0.53)	1.10
Dividend per share (p)	0.0	0.0	0.0	0.0
BALANCE SHEET				
Fixed Assets	267,476	300,047	288,579	279,161
Intangible Assets	121,775	118,456	116,648	114,240
Tangible Assets	124,520	136,557	126,897	119,887
Other	21,181	45,034	45,034	45,034
Current Assets	94,531	72,533	93,469	116,809
Stocks	35,709	30,668	33,189	40,177
Debtors	38,015	33,065	39,734	44,697
Cash	20,807	8,800	20,546	31,935
Other	0	0	0	0
Current Liabilities	(48,893)	(32,646)	(39,001)	(40,932)
Creditors	(48,893)	(27,529)	(33,884)	(35,815)
Short term borrowings*	0	(5,117)	(5,117)	(5,117)
Long Term Liabilities	(3,836)	(69,491)	(69,491)	(69,491)
Long term borrowings*	0	(67,631)	(67,631)	(67,631)
Other long term liabilities	(3,836)	(1,860)	(1,860)	(1,860)
Net Assets	309,278	270,443	273,556	285,547
CASH FLOW				
Operating Cash Flow	16,988	8,948	26,346	28,189
Net Interest	(66)	(671)	(1,600)	(800)
Tax	(665)	(151)	0	0
Capital expenditure and capitalised R&D	(42,362)	(41,834)	(13,000)	(16,000)
Acquisitions/disposals	0	10	0	0
Financing	813	712	0	0
Dividends	0	0	0	0
Net Cash Flow	(25,292)	(32,986)	11,746	11,389
Opening net debt/(cash)*	(45,612)	(20,807)	63,948	52,202
HP finance leases initiated	0	0	0	0
Other	487	(51,769)	0	0
Closing net debt/(cash)	(20,807)	63,948	52,202	40,813
Closing net debt/(cash) excluding finance leases		15,970	4,224	

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

Contact details	Revenue by geography (FY19)
IQE 22 Pascal Close St. Mellons Cardiff CF3 0LW +44 (0)2920 839 400 www.iqep.com	

Management team

CEO: Dr Andrew Nelson OBE

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 1999. He is a member of the high-level group appointed by the EC to oversee the implementation of key enabling technologies throughout Europe. In October 2020 he was awarded the Institute of Physics' Gold Medal and made a Fellow of the Institute of Physics.

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 37-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	(%)
Invesco (Oppenheimer Funds)	17.8
T Rowe Price Group	15.2
Hargreaves Lansdown Asset Management	6.0
Dr Andrew Nelson	4.4
Interactive Investor	4.4
Herald Investment Management	2.9
Barclays Wealth	2.8
Marlborough Fund Managers	2.8

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