

THE UK'S CONSTRUCTION EQUIPMENT SECTOR REPORT 2019

2018 FACTS AND FIGURES



TOTAL REVENUE

>£13bn 2018
>£11bn 2013
>£8.5bn 2004



GVA

>£2.3bn



TOTAL EMPLOYMENT

>42,000



EXPORT SHARE OF PRODUCTION

>60%



INVESTMENT IN R&D

>£220m pa



NUMBER OF COMPANIES

>1,550



UK MACHINE PRODUCTION

>60,000 units



WORLD RANKING (MACHINES)

5th Globally
1st Europe

THE UK'S CONSTRUCTION EQUIPMENT SECTOR REPORT 2019

Welcome to this extract of data from the 3rd Sector Report on the UK construction equipment industry. It comes five years since the last one in 2014. At that time our industry and the world economy was still recovering from the financial crisis triggered in 2008 – and at the same time investing heavily in Stage IV emissions compliant products. We can proudly report that the latest figures show record revenue for the sector.

Today the challenges facing our industry are considerably more diverse and disruptive to the established ways of doing things. Yet they also represent significant opportunities, following on from the further environmental improvements represented by the introduction of Stage V. What the full Report concludes is that the UK remains a good place to both manufacture and supply construction equipment. The objective is to continue to adapt and evolve to maintain our position in the world.

Rob Oliver
Chief Executive
Construction Equipment Association
The Construction Equipment



Association (CEA) is the trade association that represents the UK construction equipment sector – and is recognised by HM Government as the voice of our industry.

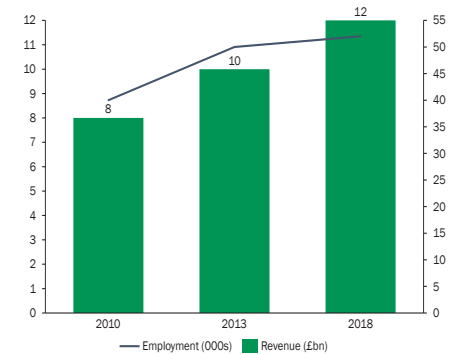
Categories of membership include:

- > Original Equipment Manufacturers (OEMs) with UK production facilities.
- > Overseas OEMs with UK offices.
- > Component and accessory suppliers.
- > Trade publishers.
- > Specialist service providers.
- > Equipment distributors.
- > International companies (non-UK based).

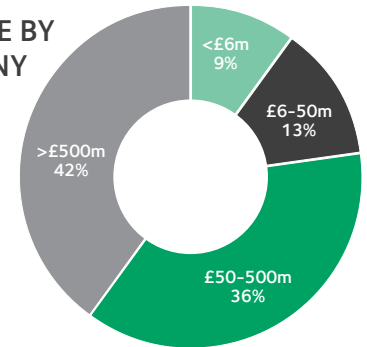
My thanks again to our friends at the Department for Business, Energy and Industrial Strategy for co-sponsoring this Report – and providing a updated piece of work that will help enormously in informing our forward agenda.



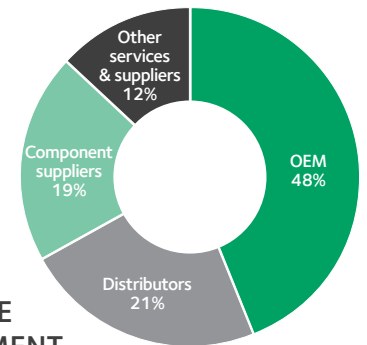
REVENUE AND EMPLOYMENT



REVENUE BY COMPANY SIZE



REVENUE BY SEGMENT





Rob Oliver, Chief Executive
The Construction Equipment Association

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THE CONSTRUCTION EQUIPMENT ASSOCIATION

CEA Membership

Construction Equipment Association

The Construction Equipment Association (CEA) is the trade association that represents the UK construction equipment sector – and is recognised by HM Government as the voice of our industry.

We are represented in Brussels – as active members of the Committee for European Construction Equipment (CECE) – and our influence is felt worldwide through our technical, regulatory and international trade work.

Categories of membership include:

- Original Equipment Manufacturers (OEMs) with UK production facilities.
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CEA Contact

Construction Equipment Association

Tel: +44 (0)20 8253 4502

E-mail: cea@admin.co.uk Website: <https://www.thecea.org.uk/>

Postal address/Registered Office: Unit 19, Omega Business Village, Thurston Road, Northallerton, North Yorkshire, DL6 2NJ, United Kingdom

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Construction Equipment Association

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KEY FINDINGS 2019

Three megatrends to drive industry forward, but all drivers are accelerating. 12 themes have and will transform the industry through the next decade...



Sustainability

Equipment must be considered as part of a productive, sustainable system. Near zero and zero tailpipe emissions equipment and alternative fuels will broaden product ranges further. De-carbonisation will be a driver in some segments, to meet CSR and LEZ requirements.



Productivity

Productivity improvements will require collaboration between OEMs, customers and government. Digitalisation will be a foundation, but competitiveness of the construction sector will also be critical.



Skills

Skills development will need to focus on a wider range of skills, with digitalisation, servification*, autonomy and electrical machines requiring IT skills over and above mechanical skills.

*Servicification (sometimes referred to as servitisation), is the shift away from product centred sales to product-centric services - which deliver 'value in use'.

ACCELERATING DRIVERS

Key drivers have intensified significantly since the 2nd report in 2014

Back in 2014 the UK Construction Equipment industry was recovering from the 2009/2010 economic crisis and the cost and complexity of implementation Stage IV emissions legislation. Five years on various global drivers, including weakness in the construction sector i.e. housing shortages, concerns over the continued health implication of noxious emissions, de-carbonisation trends to address climate change, on top of Brexit have all intensified pressure on OEMs to further develop and innovate products, services and business footprint. Over the five years since the last report KGP sees 12 themes being addressed through the industry globally:

01 PRODUCTIVITY

07 SKILLS

02 SUSTAINABILITY

08 DECARBONISATION

03 COMPETITIVENESS

09 GLOBALISATION

04 HEALTH & SAFETY

10 EMPLOYMENT

05 AUTONOMY

11 BREXIT

06 AUTOMATION

12 EMISSIONS

COLLABORATION TO INTENSIFY

Collaboration will be essential to ensure targets are met

SUSTAINABILITY

Sustainability will need to be embedded in future production methods and as a result machines will need to improve efficiency and productivity.

Sustainability is a considerable UK opportunity for machine technologies, and renewable energy technologies to deliver the benefits to work sites.

Globally, savings to industry from fuel savings from current machines are worth in excess of £1bn annually.



PRODUCTIVITY

Improving productivity throughout the construction sector is increasingly important, as machines become more expensive, the ability of the operator is in apparent decline, and the drive for quicker greener construction is increasing. A 10% productivity gain would be worth in excess of £5bn annually to the UK economy.

SKILLS

A shift to digital skills will require a significant increase in new grades of engineers and technicians to design and operate digital sites and digital machines. Skills shortages at all levels will present a problem for both the construction and the equipment sectors. Investment is therefore required in apprentices, undergraduate and post-graduate education to enable productivity and sustainability benefits. Additional investment over £250m annually will be needed in education for new skills.

INDUSTRY SWOT ANALYSIS

The UK sector has many strengths that will need to be built upon to meet the challenges of competitiveness and sustainability over the next decade. Collaboration across Europe is likely to have to continue for it to retain its relatively strong position.

FIGURE 1 - UK INDUSTRY SWOT ANALYSIS

Strengths	Weaknesses
<ul style="list-style-type: none"> • Flexible, skilled workforce. • Strong component supply chain. • Leading European production location. • Advanced product development and R&D capability • Recognised globally for expertise in R&D, especially for high-value speciality products. • Significant export volumes. 	<ul style="list-style-type: none"> • UK Industry includes various OEMs, of which only JCB is UK owned. This leaves the UK open to influence from overseas decision makers. • Limited availability of some skill sets, including engineering graduates and electronic specialists. • Companies report having difficulty retaining trained apprentices. • Production of lower stage machines for Middle East & Africa area. • Fragmented supply chain. • High energy consumption requirements.
Opportunities	Threats
<ul style="list-style-type: none"> • Development of niche product for global markets – especially screens, crushers and dump trucks. • Return to growth in UK and EU Markets • Increased UK infrastructure investment • Future CO₂ related emissions technologies. • Increasing strength of UK advanced automotive R&D. • Co-operative research and collaboration are in infancy, and key stakeholders appear willing to participate. • Taking advantage of the increasing need for additional CO₂ abatement technologies and project drives. This will be a major factor in competitiveness the next 15-20 years. 	<ul style="list-style-type: none"> • BREXIT • Continued growth in emerging market may see them become more attractive as production locations for advanced products. • CO₂ legislation could become a major threat if companies do not continue to improve the efficiency of their machines. • Other regulatory uncertainty. • Strength of UK automotive industry and motor-sport, seen as more glamorous and offering better opportunities. • Volatile currency fluctuations resulting in low UK exchange rates. • Aging infrastructure and asset base to support advanced technologies. • Lower investment opportunities in the UK due to less attractive returns than developing markets.

KEY ISSUES - THE UK SECTOR

The UK Sector has continued to strengthen since the 2014 report with record revenues, production volumes and employment



01 The Industry in Numbers

The UK industry is globally ranked 5th, and 1st in Europe, for the machines covered in this report, by unit sales. Over 1500 companies make up the sector from OEMs, suppliers, dealers, and other stakeholders.



02 Major OEMs & Plant Locations

14 major OEMs plants are spread across the UK, with clusters in the Midlands, North East and Northern Ireland.



03 Revenue, Employment and GVA

Total revenue has increased to over £13bn in 2018, employment over 42,000 and GVA £2.3bn.



04 2018 Production

Unit production in 2018 increased to over 60,000 machines.

THE INDUSTRY IN NUMBERS

Despite a number of pressures the UK industry has continued to grow and develop since 2014. On the back of strong global demand the industry retained its strong position and continues to invest in new products, for global markets. Estimated revenue increased to £13bn in 2018, with GVA up to £2.3bn, employing 42,000 and exporting over 60% of output globally.

FIGURE 2 - THE UK INDUSTRY IN NUMBERS



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2018 FACTS AND FIGURES



TOTAL REVENUE
>£13bn 2018
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GVA
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TOTAL EMPLOYMENT
>42,000



EXPORT SHARE OF PRODUCTION
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INVESTMENT IN R&D
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NUMBER OF COMPANIES
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UK MACHINE PRODUCTION
>60,000 units



WORLD RANKING (MACHINES)
5th Globally
1st Europe

MAJOR OEMS

OEM Revenues exceed £6bn, across 14 major equipment and engine plants and numerous smaller plants. Major OEMS include:



JCB

The UK's largest OEM producing around 40,000 machines in the UK in 2018. Head-quartered in Staffordshire, also has production facilities in Cheadle, Rocester and Foston. JCB employs around 10,000 people globally.

Caterpillar

The largest producer of construction machinery in the world, Caterpillar producing ADTs, backhoe loaders and wheeled loaders in Desford and Peterlee. Caterpillar also produces engines in Peterborough and Stafford and power generation products in Northern Ireland.



Komatsu

Japan's leading OEM and second largest global OEM produces crawler excavators at its plant in Birtley, Chester-Le-Street.

Mecalac

Mecalac recently entered the UK with the acquisition of Terex Ferrec in Coventry. It produces backhoe loaders, site dumpers and compact rollers.



MAJOR OEMS

Terex's divestment has seen Volvo CE and Mecalac take over UK plants, but retained its Finlay and Powerscreen crushing and screen machine businesses. McCloskey and Sandvik also produce in Northern Ireland.



Thwaites

The UK's largest producer of site dumpers, Thwaites, has invested in new products including cabbed site dumpers. All are built at the company's Leamington Spa plant.



McCloskey
INTERNATIONAL

Volvo

Volvo purchased Terex's dump truck production facility in Motherwell, Scotland in 2014. VCE produces the world's largest ADT at the site, and has invested in a new Volvo RDT for global sale.

 **TEREX** | FINLAY

Terex

Terex sold much of their construction equipment production in the UK to Mecalac and Volvo - in Coventry and Motherwell respectively. They still produce screens and crushers in Northern Ireland and Coalville, through the Finlay and Powerscreen brands.

Thwaites



McCloskey

A global leader for crushing, screening and conveying machinery. Global headquarters in Canada, but a production facility in Northern Ireland.

VOLVO

Construction Equipment



UK PLANT LOCATIONS

OEM production by nine major OEMs is concentrated in the West Midlands, North East and Northern Ireland. Mecalac and Volvo acquired Terex plants in the UK since the 2014 report. Six smaller OEMs identified here produce across the country.

FIGURE 3 - UK OEM LOCATIONS

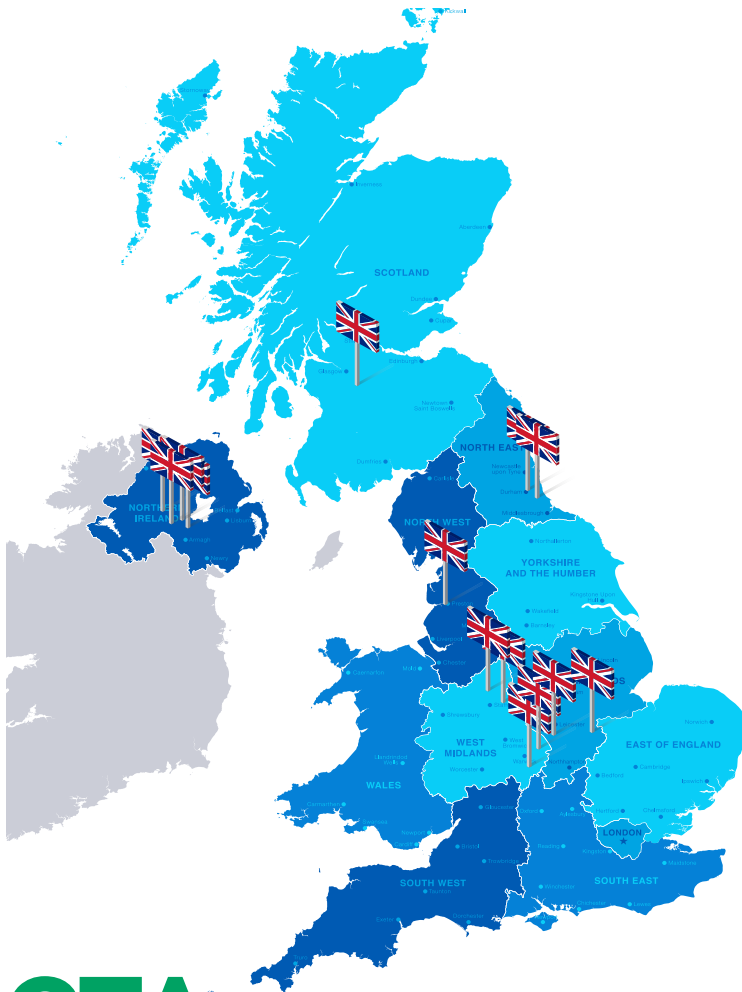


FIGURE 4 - UK OEM LOCATIONS AND PRODUCTS

Company	Main Locations	Products
BG Pavers	Preston	Asphalt Finishers
Caterpillar	Desford, Peterborough, Peterlee	Articulated Dump Trucks, Backhoe Loaders, Engines, Compact Wheel Loaders
Hewitt Robins	Swadlincote	Crushers, Screens
JCB	Cheadle, Foston, Rocester	Articulated Dump Trucks, Backhoe Loaders, Crawler Excavators, Engines, Mini Excavators, Telehandlers, Wheeled Excavators, Wheeled Loaders
Komatsu	Chester-le-Street	Crawler Excavators, Wheeled Excavators
McCloskey	Dungannon	Crushers, Screens
Mecalac	Coventry	Backhoe Loaders, Site Dumpers
NC Engineering	Richill (Armagh)	Site Dumpers, Telehandlers
Phoenix Engineering	Chard	Asphalt Finishers, Spreaders
Red Rhino Crushers	Grantham	Mini Crushers, Screens
Sandvik	Ballygawley	Crushers, Screens
Telestack	Omagh	Screens, Feeders and Conveyors
Terex	Dungannon, Omagh	Crushers, Screens
Thwaites	Leamington Spa	Site Dumpers
Volvo	Motherwell	Articulated Dump Trucks, Rigid Dump Trucks

Notes: Terex's Motherwell plant was sold to Volvo Construction Equipment and its Coventry plant sold to Mecalac. Sandvik closed its Swadlincote plant since 2014. JLG also closed its Bruntingthorpe development centre.

NEXT PAGE

REVENUE AND EMPLOYMENT

Revenue is spread across companies of all sizes, but dominated by the OEMs

FIGURE 5 - UK CE STAKEHOLDERS SPLIT BY TYPE OF BUSINESS - 2017

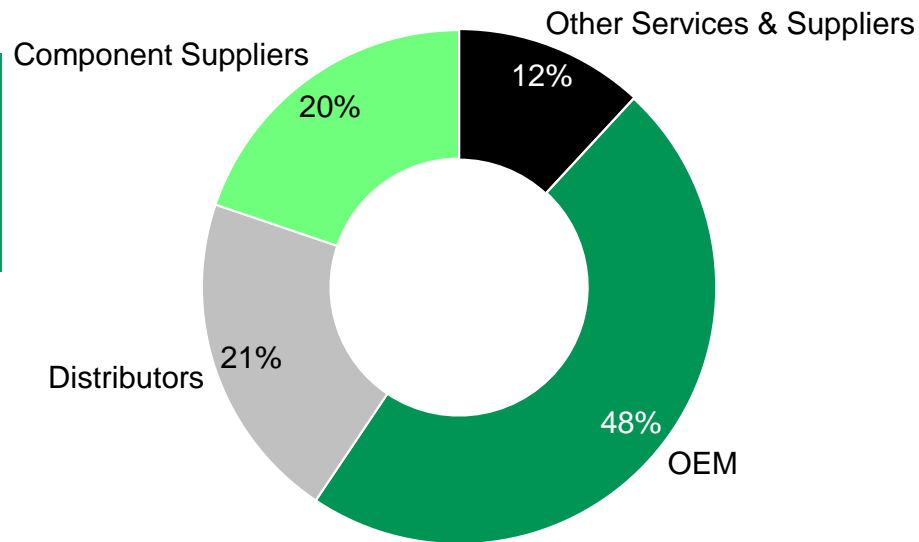
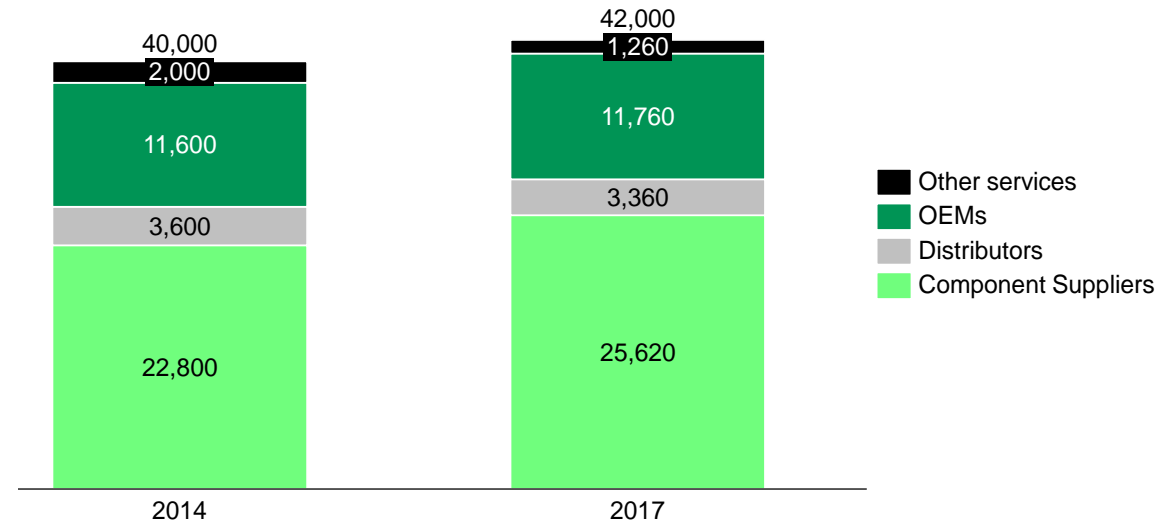


FIGURE 6 - UK EMPLOYMENT ESTIMATES 2014 VS 2017 BY TYPE OF BUSINESS



KGP analysis

Revenues are spread broadly across company sizes. Due to reporting requirements not all companies below £6m and some subsidiaries of larger companies report turnover in their returns to Companies House.

In the assessment companies revenue's were adjusted based on their estimated share in the construction equipment segment.

The size of the largest 10 companies is dominant however and the majority are OEMs. The share has only increased modestly since 2012 revenues included in the 2014 report. 2017 has been set as the base line, as 2018 annual figures are not published until later in 2019. Based on 2018's unit production growth we expect revenues will be higher still.

REVENUES BY COMPANY

UK industry revenues have grown modestly since 2014's report, but are expected to show stronger growth in 2018/2019

The second edition of this report was focused on two key issues - 1) how the construction equipment sector had recovered following the 2009 economic crisis and 2) what key stakeholders saw as future opportunities.

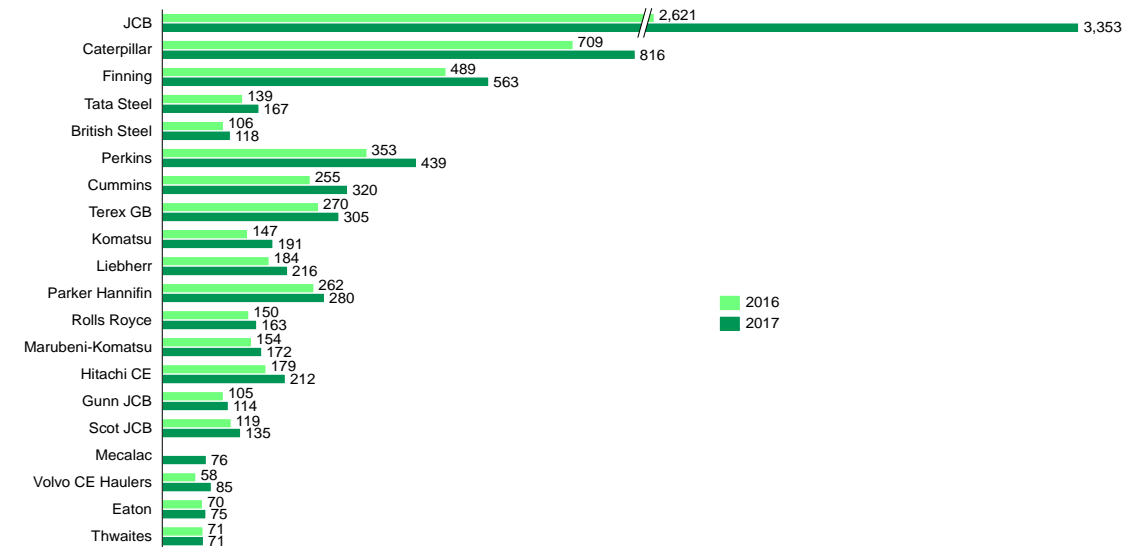
The third edition of this report examines in more detail many of the key topics identified as opportunities in 2014. How is the UK sector placed and how could the sector make most of the opportunities?

The UK market grew around 5-6% in 2017 and 8-11% in 2018. As a result the largest 20 companies in the UK performed well in 2017, compared to 2016, and are expected to have grown further in 2018.

Many companies interviewed for this report remain optimistic about future growth and the sentiment is very positive. Most reported that they are in a stronger competitive position since the last report.

Looking forward to the rest of 2019, and through to 2020, recovery is all but complete, economic growth appears stable in the Eurozone and North America, and key developing markets are promising long-term growth. In addition, with additional legislation in China and India coming into force in this period, they are turning to Eurozone companies to bridge the technology gap.

FIGURE 7 - 2016 VS 2017 REVENUE - KEY OEMS/SUPPLIERS (£M)



Source: ¹www.companieshouse.gov.uk, KGP analysis

GVA - GROSS VALUE ADDED

GVA improved across the UK sector, as profitability and employment have increased at the majority of the OEMs and supply chain companies.

FIGURE 8 - GVA (£BN) 2014 - 2018

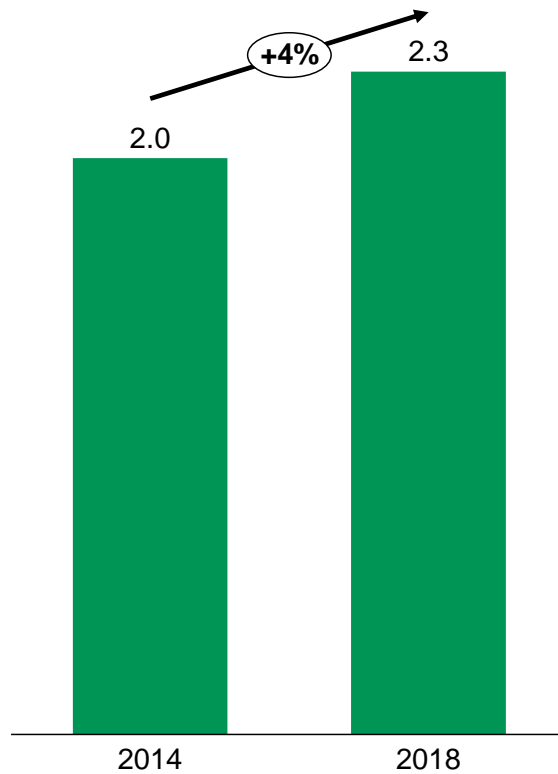
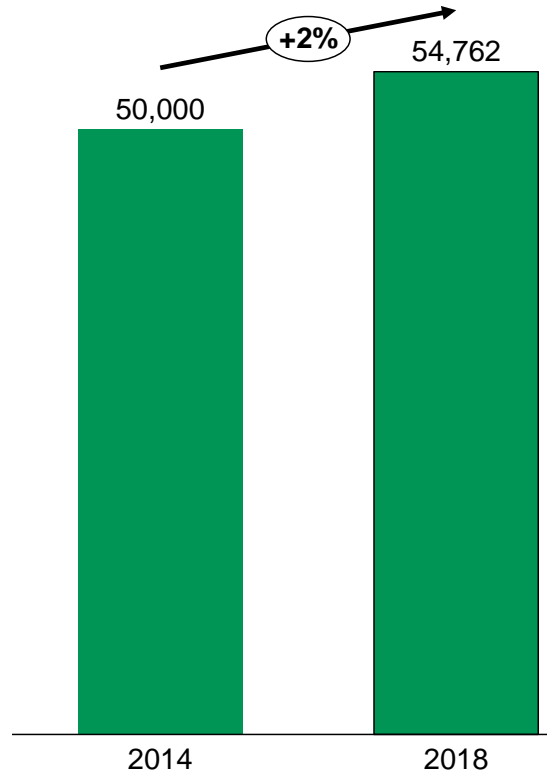


FIGURE 9 - GVA (£) PER CAPITA 2014 - 2018



GVA from the construction equipment sector is estimated to have risen around 4% compared with figures from the last report, to a total of £2.3bn.

However, employment has risen also, meaning the per capita GVA in the construction equipment sector has only grown around 2%. We have seen some consolidation of employment at large enterprises, in order to cut costs following the 2009 recession and the 2015 Chinese market crash which depressed the global market. This has been somewhat offset by increasing investment in expertise from the supply chain and niche product suppliers taking advantage of the demand for better and more readily available technology solutions.

Source: KGP analysis

R&D EXPENDITURE

The industry has continued to innovate, invest and develop new products and services to meet customer demand since 2014, despite investment in the Stage V products.

Historically OEMs and suppliers have had their hands tied financially by government-imposed emissions legislation - Approximately 70-80% of OEMs R&D budget over the past 10 years has been spent meeting progressive emissions legislation and technological challenges that go with it. As we enter into Q2 2019 however, OEMs have their strategy in place for Stage V and these engines are over 95% cleaner than equivalent Stage II engines in terms of NO_x and PM emissions.

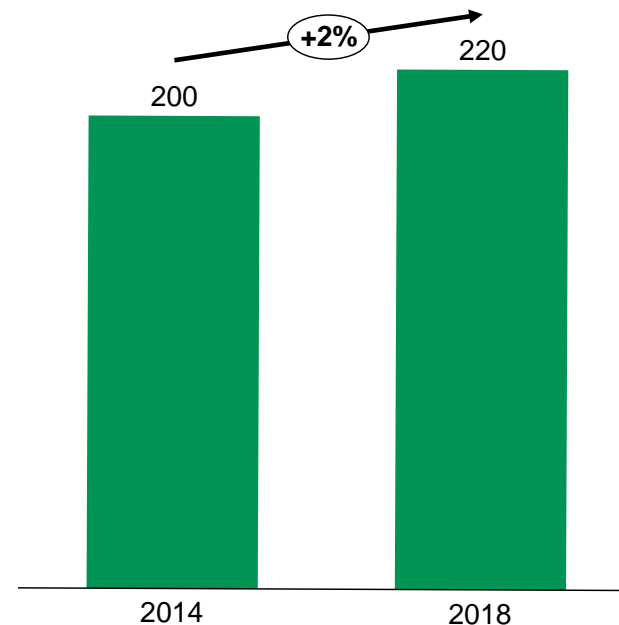
It appears as if companies may have some spare budget to play with in the next few years - although most will have an eye on Stage VI equivalent legislation and if this will entail ultra low NO_x limits and CO₂ reductions.

One key area that is expected to impact the market in the future is the drive for efficiency. Customers are demanding improved efficiency, and not just from an engine/fuel consumption point of view - the operational efficiency of the machine and technology to aid the process efficiency of the job which the machine is performing are all subject to huge interest.

JCB, Caterpillar, Komatsu, Terex Finlay, Bomag are all installing advanced telematics software on their machines (albeit for an additional cost in most cases) - this is the start of an upward curve of investment in digitalisation technology that allows the OEM, key suppliers, the purchaser and the operator to view and analyse data that will help improve machine efficiency, process efficiency and operational efficiency within a construction site.

Most recently reported R&D spend reached 2.2% for Hitachi, 3.0% for JCB and Komatsu and 4.5% for Caterpillar.

FIGURE 10 - TOTAL R&D INVESTMENT 2014 VS 2018 (£M)



Source: KGP analysis

NEW PRODUCTS 2014-2019

Investment in new products across segments continues, a few examples are shown here:

Mecalac cabbed site dumper



Perkins Synchro engine



JCB Hydradig



Volvo Rigid Hauler

Investment in plants to produce new models has been significant, with JCB investing in a new cab plant, Volvo upgrading its plant to reduce carbon emissions as examples. Terex is also expanding in Northern Ireland.

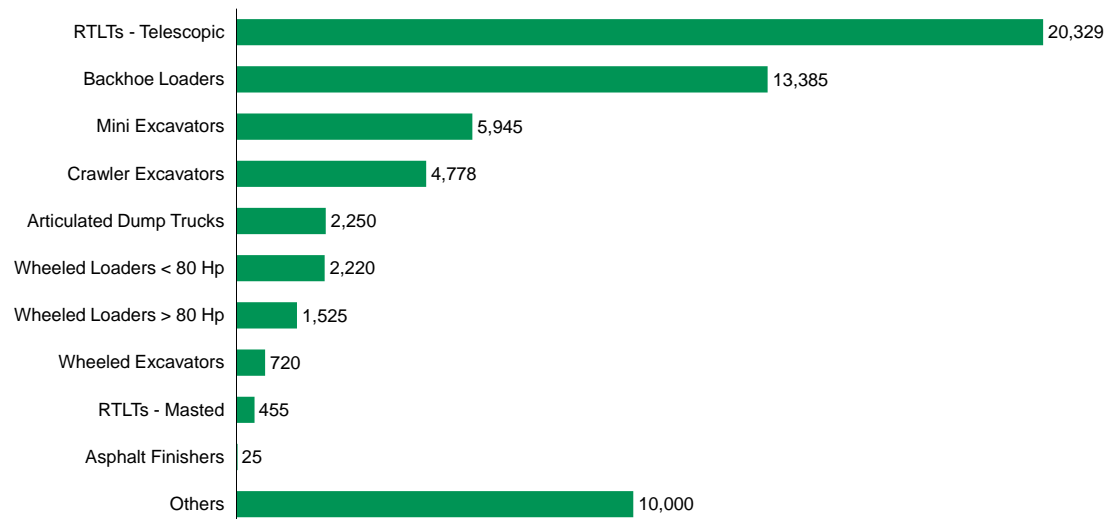
2018 SALES AND PRODUCTION

In production units the UK was the largest producer of construction equipment in Europe in 2018, and the 5th largest in the world, after – China, Japan, US, India.

Including niche equipment total production in 2018 exceeded 60,000 units, up from 50,000 in 2013 when this report was last published. JCB is the largest producer by some distance, followed by Caterpillar, Thwaites and Komatsu in unit terms.

The telehandler, or Telescopic Rough Terrain Lift Truck (RTLs - Telescopic) has grown to be the largest product. Backhoe loaders, despite a declining market remain significant, with mini and crawler excavators also having higher production than local demand. Site dumpers, not split out are also near 10,000 units. In value terms some niche equipment, particularly for crushing and screening are high value items, so represent a higher share in value than units accordingly.

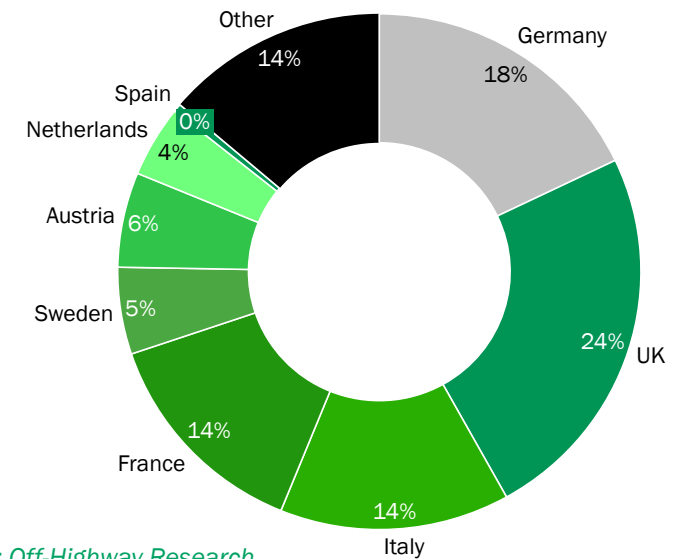
FIGURE 11 - UK PRODUCTION BY EQUIPMENT TYPE 2018



Source: Off-Highway Research²

Others: Site dumpers, crushers, screeners etc.

FIGURE 12 - EUROPEAN PRODUCTION BY COUNTRY 2018



Source: Off-Highway Research

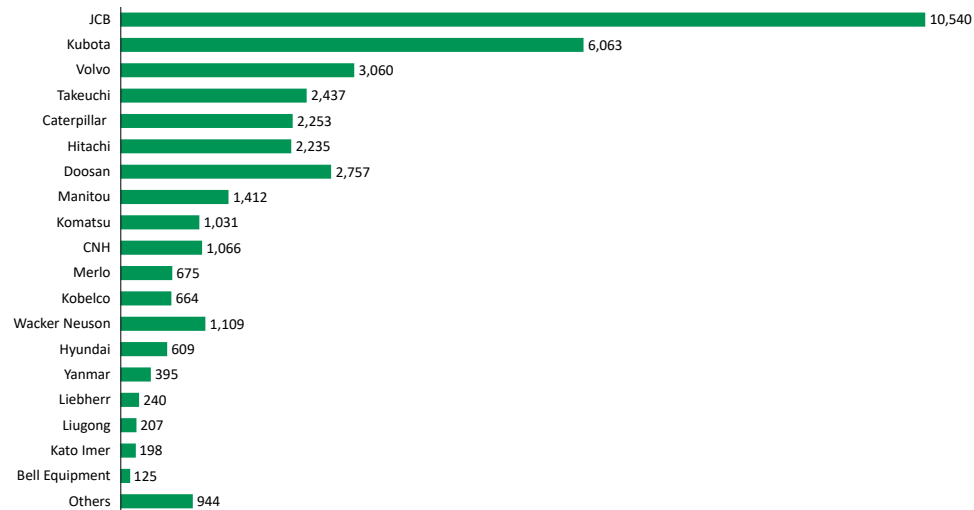
2018 SALES AND PRODUCTION

2018 was an exceptional year for construction equipment suppliers in the UK, as the level of demand in 2018 had only been exceeded once before, at the height of last decade's boom in 2007, just prior to the financial crash. This has naturally raised concerns that another bubble is forming and that a major correction is due.

Early indicators from Off Highway Research and Systematics show a 4% decline in Q1 2019 compared to the same period in 2018. For full year 2019 we are expecting a moderate, single figure, decline partially due to incoming Stage V legislation negatively impacting the buying incentive of the customer, and a natural correction due to very high sales in 2018.

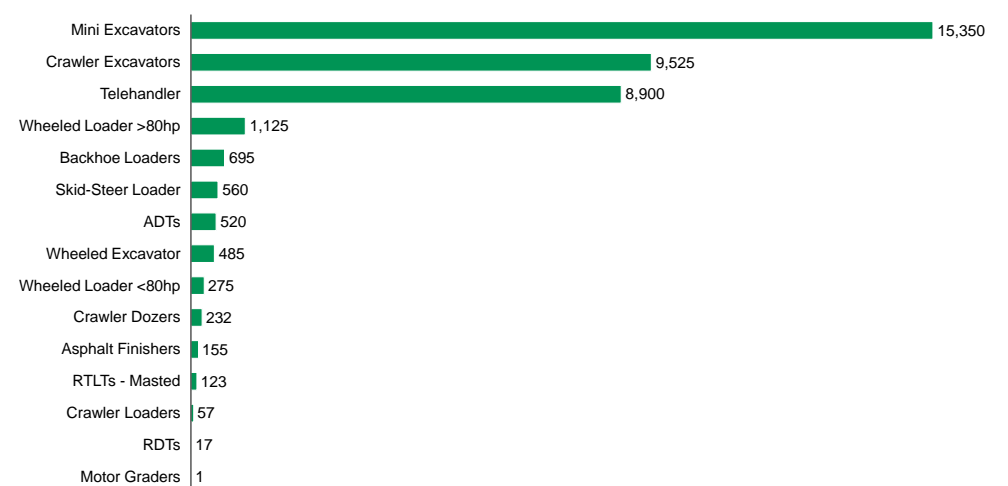
Specific sales outlook for the UK construction equipment sector, beyond March of this year (2019) is clouded by BREXIT. The Government is committed to significant infrastructure investment and wants to expand the current housebuilding programme by another 30% to 300,000 new homes a year. According to the office for national statistics, five years ago, the UK was building fewer than 100,000 new homes a year. This increase in investment, led by government policy, should help alleviate some of the potential negative aspects of Brexit in the short term. The relative boom in housebuilding is helping to fuel the growth in mini excavators and telehandlers, and the recovery in the agricultural sector in 2017 also helped telehandler sales. Last year just over 3,000 telehandlers were sold into the British agricultural sector. Looking ahead, construction of the HS2 high speed rail link has begun and this will call for large numbers of articulated dump trucks, crawler dozers and crawler excavators to be bought over the next five years.

FIGURE 13 - UK SALES BY COMPANY 2018 (UNITS)



Source: Off-Highway Research

FIGURE 14 - UK SALES BY EQUIPMENT TYPE 2018 (UNITS)

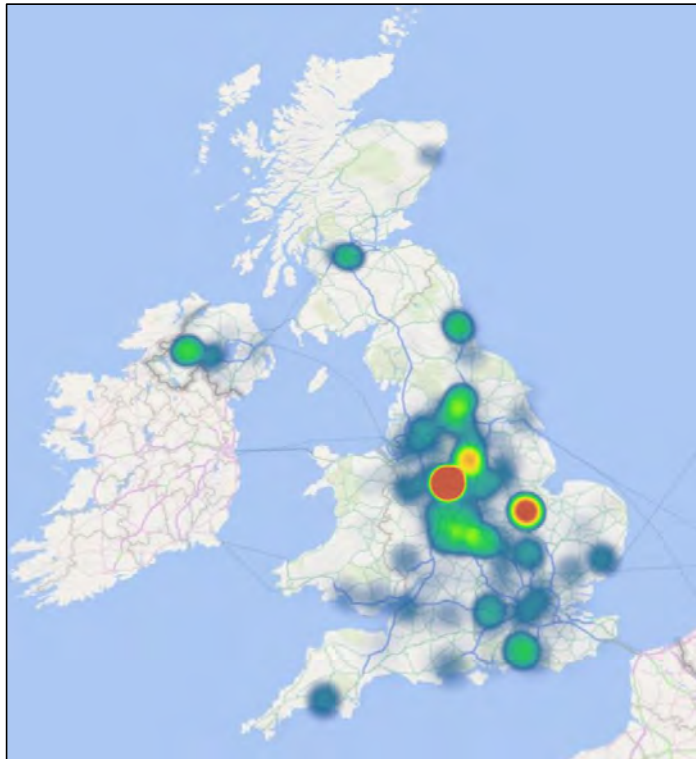


Source: Off-Highway Research

UK CLUSTER MAPPING

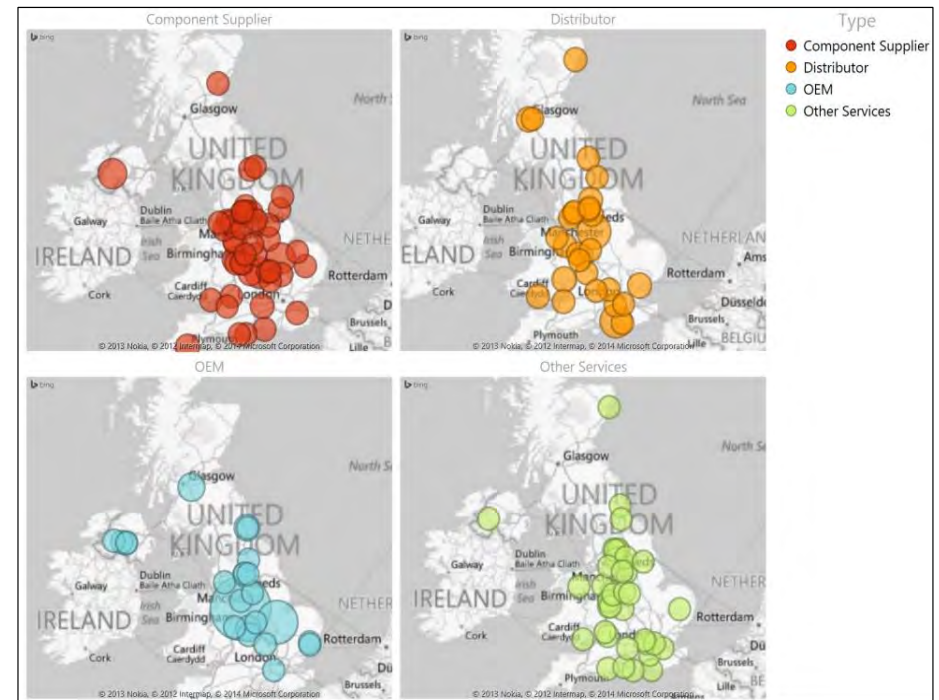
The UK industry is fragmented but has clusters in the West and East Midlands, North East of England and Northern Ireland

FIGURE 15 - UK CLUSTER MAP BY COMPANY TYPE



Source: KGP analysis

FIGURE 16 - UK CLUSTER MAP BY COMPANY TYPE



Geographically, the UK companies supporting the construction equipment association have not changed much, there is still a stronghold in the Midlands with JCB, Caterpillar, Mecalac, Cummins and numerous tier ones and other suppliers all operating there. Additionally the North East and Northern Ireland have significant investment with key OEMs and suppliers in the respective regions.

KEY ISSUES - ECONOMICS

The underlying economy is the key driver of equipment demand.

In the current period of global political and economic uncertainty the UK appears relatively robust, despite a decade of post economic crisis austerity. GDP growth remains positive, investment in infrastructure and housing, the main economics factors are positive.



01

UK vs Global Economy

The global economy was buoyant in 2018. Strong growth in India and China was supported by lesser but sustained growth in Northern Europe and North America. The outlook is good for the UK economy, despite some uncertainty surrounding Brexit, the UK is performing admirably against strong growth from Germany and France on the continent. Southern Europe and Ireland still has some growing to reach their market peaks, but signs are optimistic for continued growth in 2019.



02

Infrastructure & Housing

Infrastructure and housing investment in the UK is at the highest level since pre-recession. HS2, other rail and road improvements are investing over £60bn into the economy, and housing starts are over 160,000 per year, up from 144,000 from the previous report.



03

Government Investment

Government investment is paramount to stimulating construction sector growth, with over £300bn in planning from 2016 - 2021 the construction sector has a solid foundation to continue steady sustainable growth, even with the upset uncertainties presented by Brexit. Like most government led projects, there is a focus on environmental impact, which should improve the viability of digitalisation and efficiency improving technology on the machinery used.

UK ECONOMIC OVERVIEW

UK economic growth of c.1.5% is expected, supporting the market

At the time of writing (May 2019), the UK missed its first deadline for leaving the European Union. Since the Brexit vote the UK has been negatively impacted by the uncertainty following the vote. Key construction equipment customers and investors in infrastructure projects and housing all require confidence and clarity as to what the future holds in order to effectively drive the construction equipment sector in the UK.

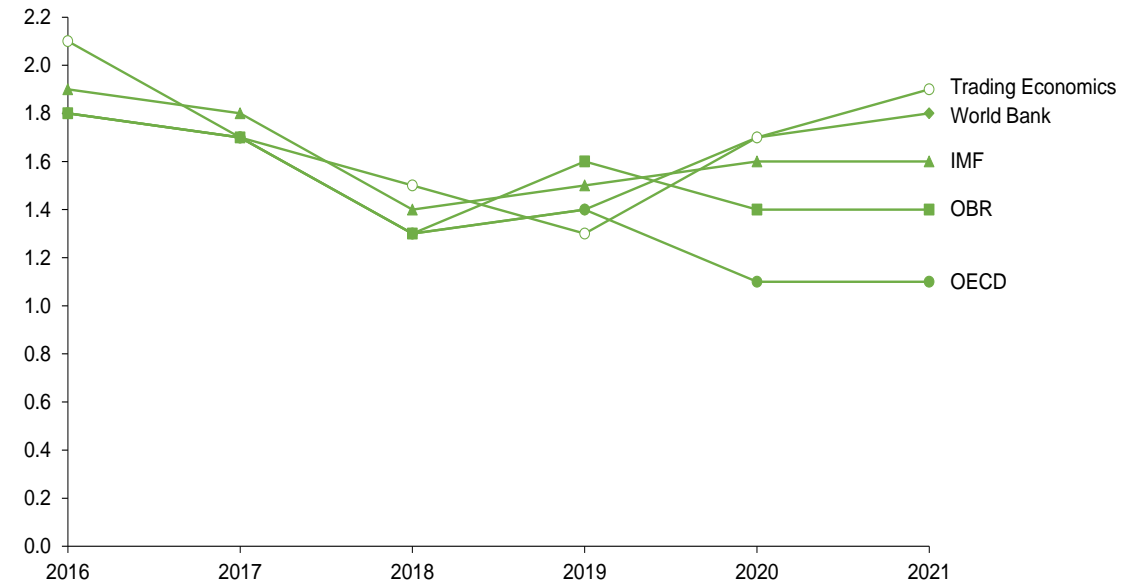
There are several key indicators that will instil confidence in the UK construction equipment sector's outlook. New approvals for infrastructure and housing are most important. 2017 was a record year for new approvals, with a value of around £106.5 billion. In 2018 the total grew slightly to £107Bn despite BREXIT uncertainty. This was primarily due to poor weather at the start of 2018 causing many projects to be delayed, which resulted in construction output falling for three months from March to May, however the remainder of the year saw growth and eventually a peak total value for new housing and infrastructure projects.

According to the World Bank, UK GDP has been falling since 2015 from \$3.02 trillion to around \$2.62 trillion in 2017, rising again to around \$2.8 trillion in 2018. Industrial output, including construction accounted for around 18% of total GDP in the UK.

In 2019, the UK economy is expected to grow by about 1.5%, whilst this is inclusive of the uncertainty surrounding Brexit, higher spending and favourable short-term tax cuts for 2019 are expected to boost spending.

Construction spending is expected to fall back somewhat soon, as Brexit magnifies uncertainty, but in either deal or no-deal situation a resolution will bring back some stability. However, a no-deal has far reaching negative implications that will see construction spending grow much more slowly in the short term.

FIGURE 17 - UK GDP GROWTH FORECASTS - 2021 (%)



Source: Trading Economics, World Bank, IMF, OBR, OECD

GLOBAL ECONOMIC OVERVIEW

Globally the economy is growing c.3.5% annually

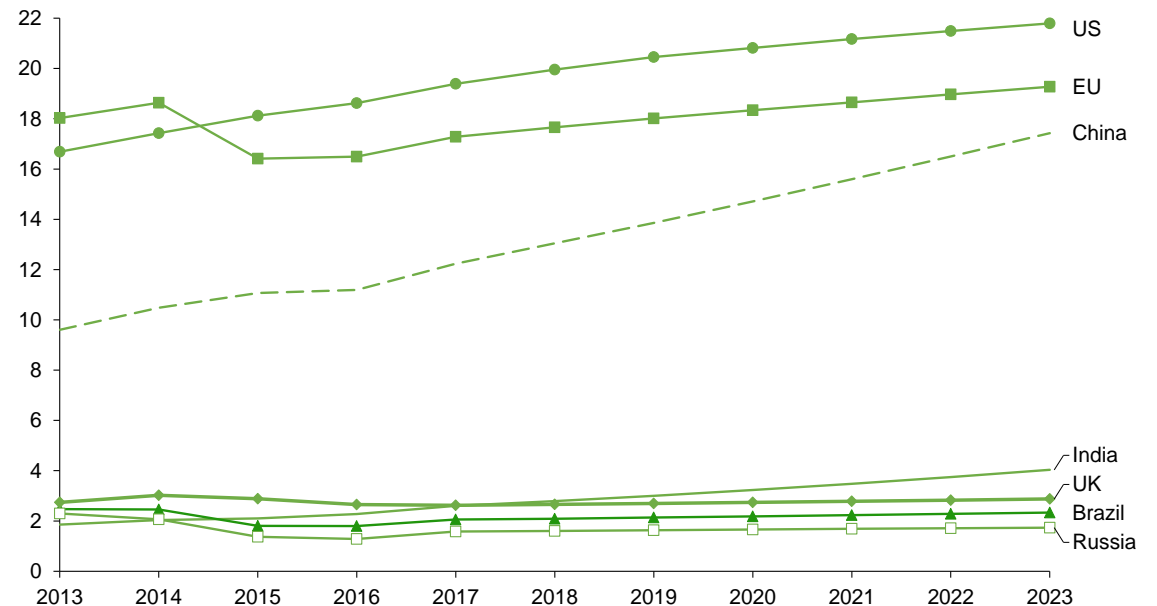
Following the financial crisis the global economy shrunk significantly in 2008 and 2009. 2010 and 2011 saw a temporary spike in growth, but since then real GDP growth has sustained stable levels of around 3.5% annually. Despite various headwinds the global economy is forecast to continue to grow around the same rate over the next five years.

Emerging markets and developing economies have been the main driver of global economic growth. China and India have recorded consistently high levels of GDP growth. China's growth is expected to fall over the next five years and along with trade restrictions with the U.S. could negatively impact parts of the global construction market. Having said that, any negative impact should be outweighed by the bounce back from Brazilian and Russian economy and continued growth of developed economies in the West.

The EU and USA are the two largest export markets for UK construction equipment. Economic growth in both markets is expected to be modest through 2023. From 2013-2015, the UK's real GDP growth was the highest in the G7. Since the Brexit referendum of 2016, however, growth has weakened, and this has had a knock-on effect to the EU GDP.

Although the referendum has caused some uncertainty and significant depreciation of the pound both the UK economy has remained stable despite concerns. This is evident in continued sector confidence for both manufacturing and construction industries.

FIGURE 18 - GDP FORECAST - KEY MARKETS (\$TN)



Source: World Bank³

CONSTRUCTION - MAJOR PROJECTS

Government accounts for c.16% of all investment (Gross Fixed Capital Formation), and its volume has continued to grow despite austerity. However as a share of GDP the UK lags most OECD countries. Major areas of infrastructure investment include:



HS2

Over £55bn in two phases to 2033



Housing

162,000 new starts in 2017 valued at £45bn



Roads

Road receives only a small share of the *NICP* at £8.2bn



COMPETITIVENESS - SECTOR DEAL

The UK's *Construction Sector Deal*⁴ was published in July 2018. The £170m Transforming Construction Programme aims to support the development and commercialisation of digital and off-site manufacturing technologies, to drive productivity improvements in the industry. Changes to business models and practices are the key to improving sector competitiveness and the sustainability of construction firms. A report by Ernst Young - *UK Construction Margin Pressure*⁵ highlighted the weakness of the sector financially, with company profits at low levels similar to retail, where failures have been commonplace in recent years.



01 PEOPLE

An industry that is known for its talented and diverse workforce



02 SMART

An industry that is efficient and technologically advanced



03 SUSTAINABLE

An industry that leads the world in low-carbon and green construction exports



04 GROWTH

An industry that drives growth across the entire economy



05 LEADERSHIP

An industry with clear leadership



GOVERNMENT POLICY

Industrial Strategy - The modern Industrial Strategy⁶ is a long-term plan to boost productivity and earning power for people throughout the UK. The aim is to build a Britain fit for the future – helping businesses to create better, high-paying jobs across sectors in every part of the UK. The Five Foundations - The fundamentals of productivity:

Business Environment

- Launch and roll out Sector Deals -partnerships between government and industry to improve productivity
- Drive over £20bn of investment in innovative and high potential businesses, including a new £2.5bn investment programme
- Review the most effective actions in improving the productivity and growth of small and medium sized businesses

Ideas

- Raise total R&D investment to 2.4% of GDP by 2027
- Increase R&D tax credit to 12%
- Invest £725m in new Industrial Strategy Challenge Fund programmes

Places

- Agree Local Industrial Strategies
- Create a new Transforming Cities fund which will provide £17.7bn for intra-city transport
- Provide £42m to pilot a Teacher Development Premium to test the impact of a £1000 budget for high-quality professional development for teachers working in areas that have fallen behind

People

- Establish a world-leading technical education system
- Invest an additional £406m to address shortage of science, technology, engineering and maths (STEM) skills
- Create new National Retraining Scheme with £64m investment for digital and construction training

Infrastructure

- Increase investment of National Productivity Investment Programme to £31bn
- Support EV through £400m charging infrastructure investment and £100m to extend plug-in car grant
- £1bn of public investment for digital infrastructure, including £176m for 5G and £200m for local areas for full-fibre networks

Underlying the the strategy are the Grand Challenges - the big social challenges for the future:



AI & Data - AI and machine learning are starting to transform the global economy. Embedding AI throughout UK Industry will help create jobs and improve productivity.



Clean Growth - Low carbon technologies and the efficient use of resource for UK industry will maximise advantage in the global marketplace. The UK is well placed to take advantage with low carbon technologies, systems and services.



Ageing Society - Longer lives means new technologies to support an aging population, and career changes, skills and retirement planning will all be impacted.



Future of Mobility - The way in which people, products and services are transported around the world is on the cusp of radical change. Driven by innovation, engineering, technology improvements and adopting and challenging new business models, the UK is poised to take advantage.

Source: HMG Industrial Strategy

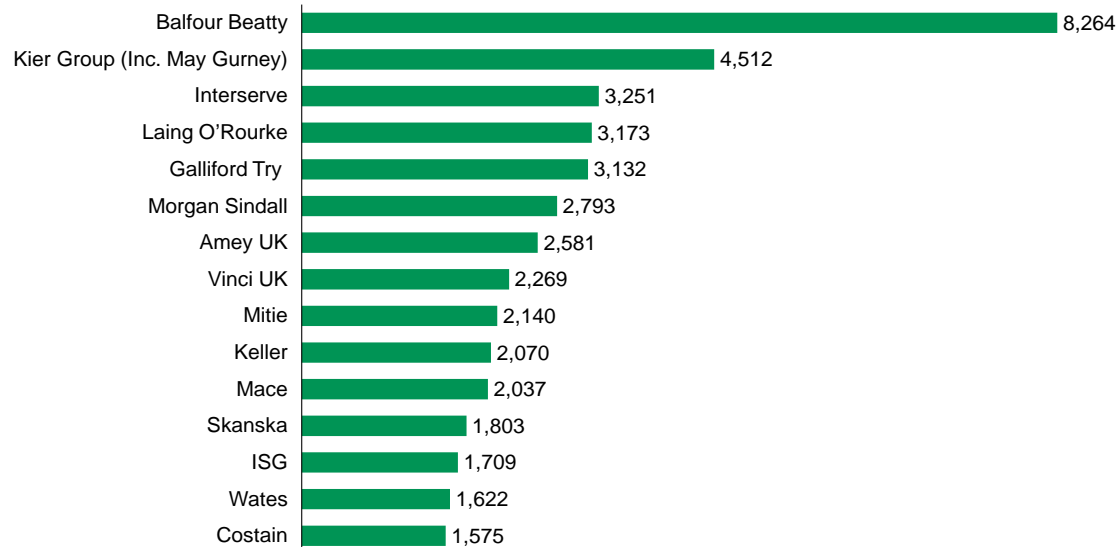
MAJOR CONSTRUCTION COMPANIES

Construction revenues have grown, despite weakness in the sector

The weaknesses of the construction sector has been highlighted in the *Industrial Strategy Construction Sector Deal*. As it stands the construction sector is performing suitably well for most shareholders. However there are challenges ahead. Digitalisation of the sector is an important concern for government, compared with other key industries in the UK, construction is far behind in terms of wide-scale adoption of advanced digitalisation technology. This drive for increased digitalisation goes hand in hand with an increased focus on efficiency of operation within the construction sector. The machines are much cleaner than they have been in the past, and with low emission zones and better monitoring of workplace harmful emissions, focus has shifted recently towards improved efficiency and CO₂ output from construction. Digitalisation, data management, analysis and telematics and are key to improving overall efficiency of construction sites moving forwards.

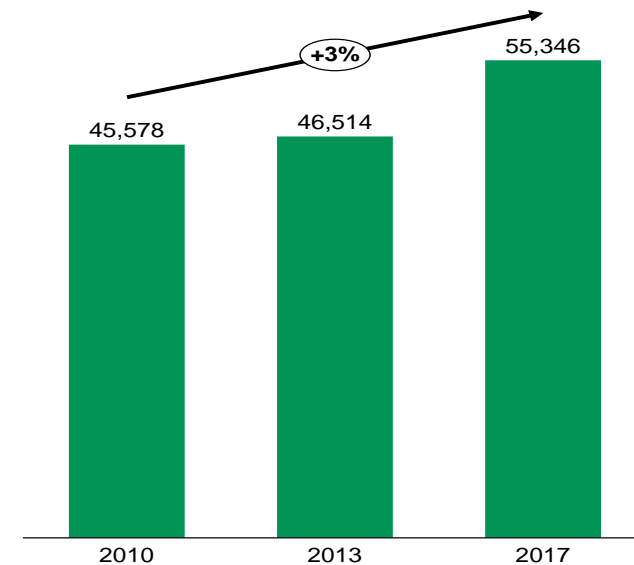
The collapse of Carillion led to contracts being absorbed by other companies, with limited overall impact on the sector. The difficulties at Interserve however show the continued fragility of the sector.

FIGURE 19 - TOP 15 CONSTRUCTION COMPANIES REVENUES 2017 (£M)



Source: Construction Index

FIGURE 20 - TOP 35 CONSTRUCTION COMPANIES TOTAL REVENUES (£M)



UK HOUSING STARTS

Housing starts recovered with support of government incentives, but fell slightly in 2017/2018

Statistics from the UK Department for Communities & Local Government provides data covering all residential dwellings built for private, local authority and housing association requirements, as recorded by regional UK authorities. There are certain notes to this data not chiefly. A record is only made when the building work has actually begun. Groundwork and other preparation is not counted a part of the start phase.

The 2007/08 financial crisis caused a significant drop in housing starts in the UK, new starts began to pick up and took a large jump in 2013/14 due to the introduction of various government incentives to provide affordable homes. Housing starts continued to rise through 2014-2017 but are set to take a decline with provisional figures for 2017/18 down 1% from the prior period.

FIGURE 21 - VALUE OF NEW WORK STARTED 1997 - 2018 (£M)

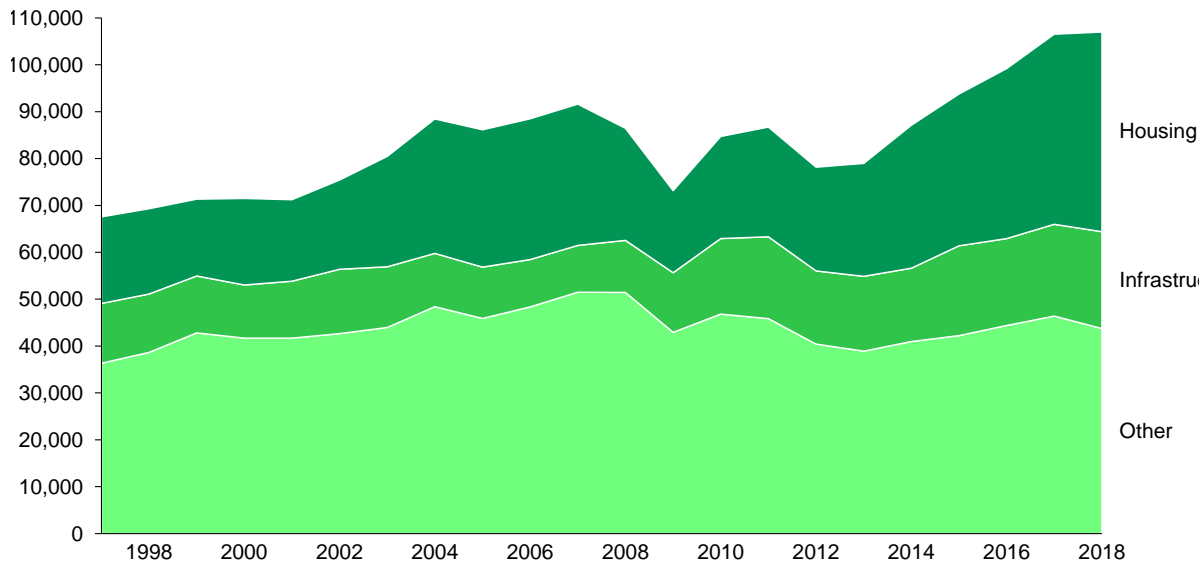
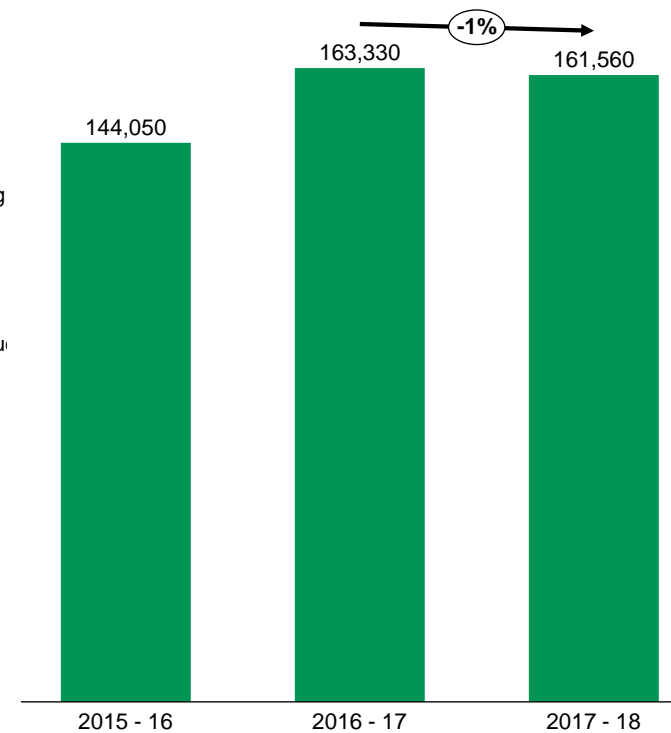


FIGURE 22 - NO OF UK HOUSING STARTS BY YEAR

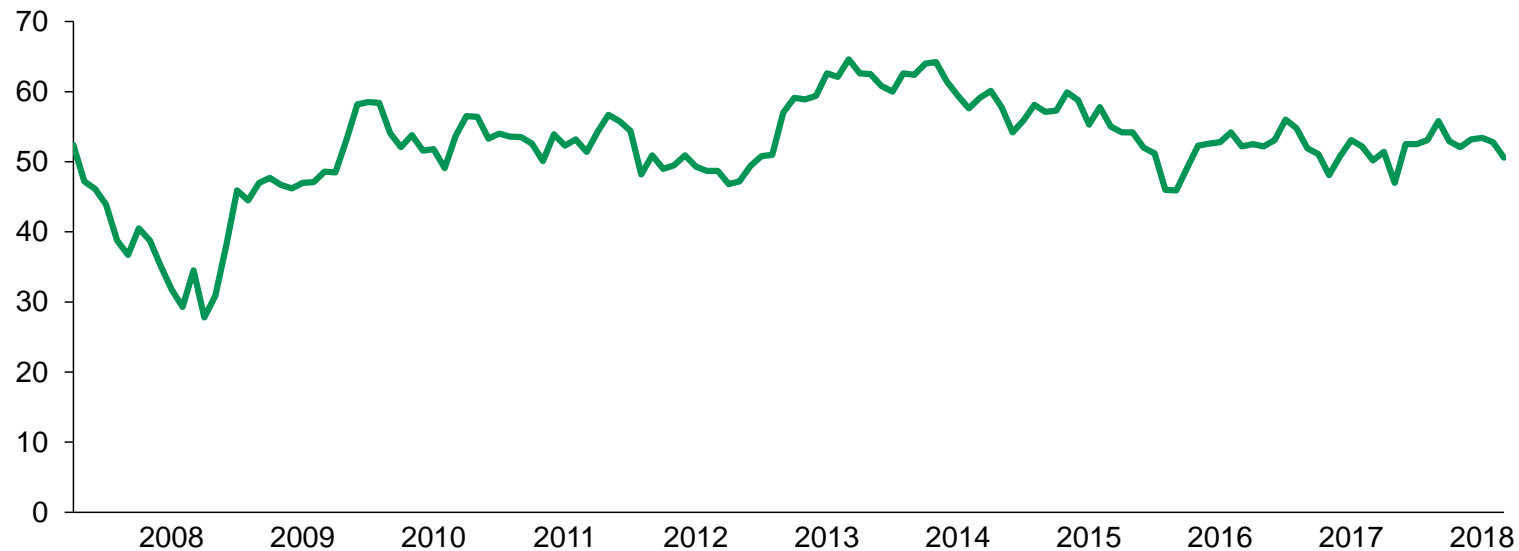


UK CONSTRUCTION PMI

Construction PMI weakened towards the end of 2018, but the outlook is positive into 2019

UK construction firms indicated a disappointing end to 2018 as business activity growth eased to a three-month low and new orders expanded at a relatively subdued pace. The main bright spot was a sustained rebound in civil engineering activity, which rose at the fastest pace since May 2017. Business optimism looking through to 2020 looks positive, and has been boosted by construction output peaking in December 2018. The degree of confidence was the highest since April 2018 and well above the near six-year low seen in October 2017. Survey respondents cited hopes of a boost to growth from work on big-ticket transport and energy infrastructure projects in 2019.

FIGURE 23 - UK CONSTRUCTION PURCHASING MANAGERS INDEX 2007 - 2018



Source: The Chartered Institute of Purchasing and Supply (CIPS) Construction Purchasing Managers Index

NATIONAL INFRASTRUCTURE PLAN

Since 2016 the National Infrastructure Delivery Plan 2016-2021 has set out investment plans for government spending on transport, energy and other infrastructure.

The National Infrastructure Delivery Plan (NIDP) 2016-2021⁷, for the first time sets out the government's 5-year plan for infrastructure in particular to support delivery of infrastructure for housing and social uses. The NIDP is based on the National Infrastructure Pipeline (NIP) published in 2016 announcing planned investment from the government of over £100 billion, combined with private sector investment, generating total investment of just under £300 billion over the five years.

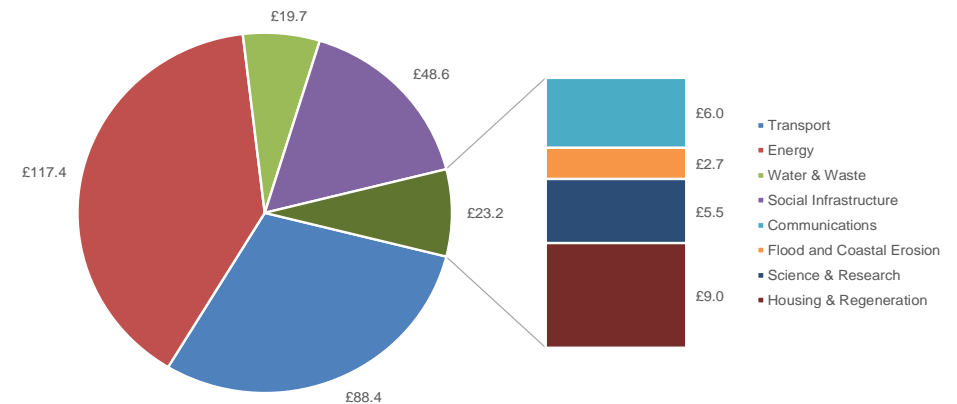
Key infrastructure projects progress by the end of 2020-21:

- Over 100 major road projects to be completed or in construction
- Major improvements in rail across the country
- Electrification of the Great Western Mainline to Cardiff
- HS2 Phase 1 in construction
- Crossrail in service

The National Infrastructure and Construction Pipeline was first published in 2010, and sets out private and public planned investment for new projects, current programmes and other expenditure commitments. The 2018 issue builds on the work laid out by NIDP 2016-2021, with £190 billion by 2020/21 contributing to a total of £400 billion planned investment and forecast investment of over £600 billion in the next decade.

Transport will receive the largest amount of investment for the period 2018/19 to 2020/21, accounting for £54.9 billion of the £190 billion of planned investment. The 2018 Pipeline includes 256 projects for transport with the highest share for rail. High Speed Rail (HS2), although a single project, generates the largest amount of investment across the transport sector.

FIGURE 24 - NIDP INFRASTRUCTURE INVESTMENT 2016 - 2021 (£BN)



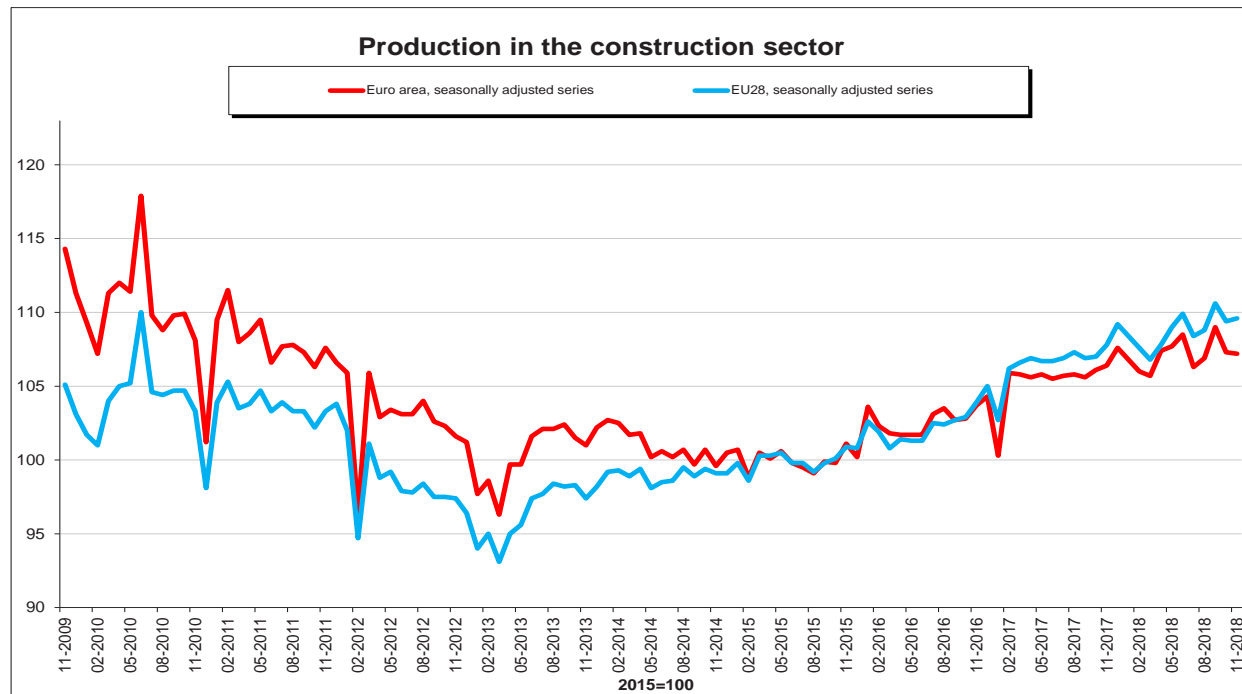
Source: NIDP 2016 - 2021

EUROZONE CONSTRUCTION

EU construction indices show weak growth since 2014, with overall seasonally adjusted levels still not recovering to the pre-economic crisis levels across the Eurozone.

Across the EU28 as a whole the indices reached the 2009 levels by the end of 2018. Of the major economies in the EU28 the UK was by far the strongest, but the central European economies were stronger still.

FIGURE 25 - EU CONSTRUCTION INDEX (2015 BASELINE)



Source: Eurostat

KEY ISSUES - MARKET

Understanding the market and responding to customer requirements is a key challenge to OEMs in today's environment. Not only must they produce machines to different environmental and design standards they need to meet challenges of a diverse customer base. Unlike the automotive and commercial vehicle industries construction equipment OEMs are often producing a wide variety of machines for global markets from single plant.



01 Exports

The CE industry supplies into a global market, approximately 60% of UK CE production is exported - mainly to the US and Europe.



02 Segment Changes

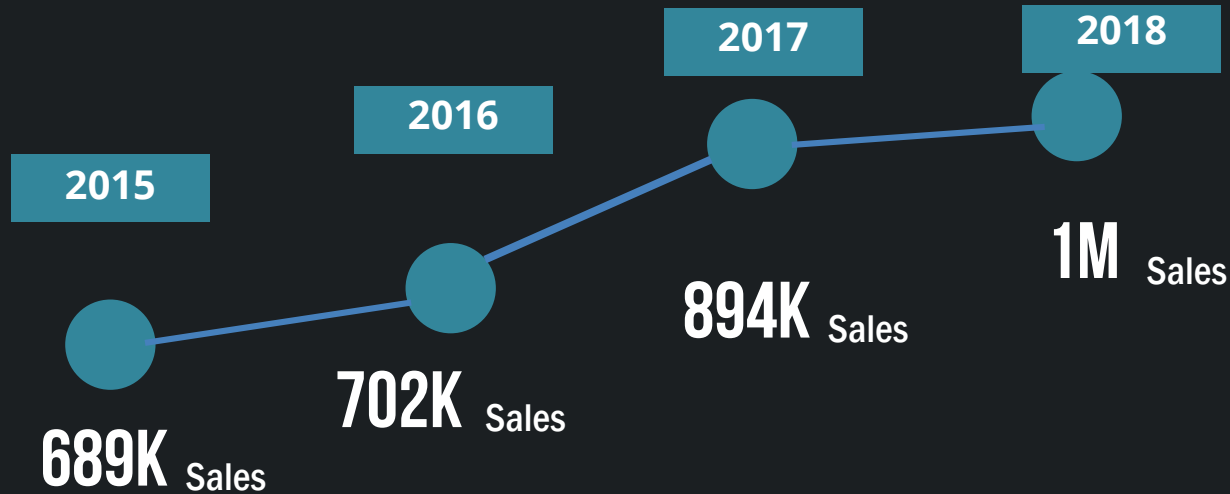
Machinery is becoming more versatile, whilst adding functionality. The increasing popularity of mini-excavators and telehandlers is evidence of cross segment machinery becoming more important, especially for rental companies.



03 End Users

End use can vary considerably depending on several factors - machine type, power, location and operational requirements - in addition, the same machine can have different operational requirements depending on what the end use application is - construction, repair and maintenance, landscaping, agriculture, materials and waste handling. The majority of machines are rented or leased into these segments rather than owned directly.

Global Construction Equipment Sales



Global Sales 2015-2018

Off-Highway Research's global volume service shows 1m units of core equipment were sold in 2018, with the UK having around a 5% share of production. Major EU & EFTA sales totalled 170,000 units, North America 195,000 but China reached 297,000 units. The total market was up from 894,000 units in 2017 and 689,000 in 2015.



Global Sales Outlook

Off-Highway's forecasts suggest continued global growth has peaked. Headwinds including the US-China trade issues, weak oil prices and slow economic growth will limit the global market, seeing a forecast 4% fall by 2023. China will fall the most, back to replacement levels, Europe and the rest of the world will also fall, but the US, Japan and India will continue to grow.

UK IMPORTS VS EXPORTS

The UK construction equipment sector is a significant net exporter

Import and export data allows key insights into the UK sector's position globally. Within the EU the data helps understand how the UK's position can be protected under any future BREXIT deal. The top five export destinations for UK construction equipment account for around 48% of total export value. These being the USA, Irish Republic, Germany, Poland and France.

The US is the most valuable export destination for UK machines, accounting for around 24.9% of total export value in 2018. Positively, we expect this trend to continue and be largely un-impacted by the eventual outcome for Brexit.

However, of the other top 5 destinations for UK equipment, all four are in the EU – Irish Republic (5.6%), Germany (8%), Poland (5.3%) and France (6.3% - total value). The value of these export destinations is important to sustainable growth for the UK sector.

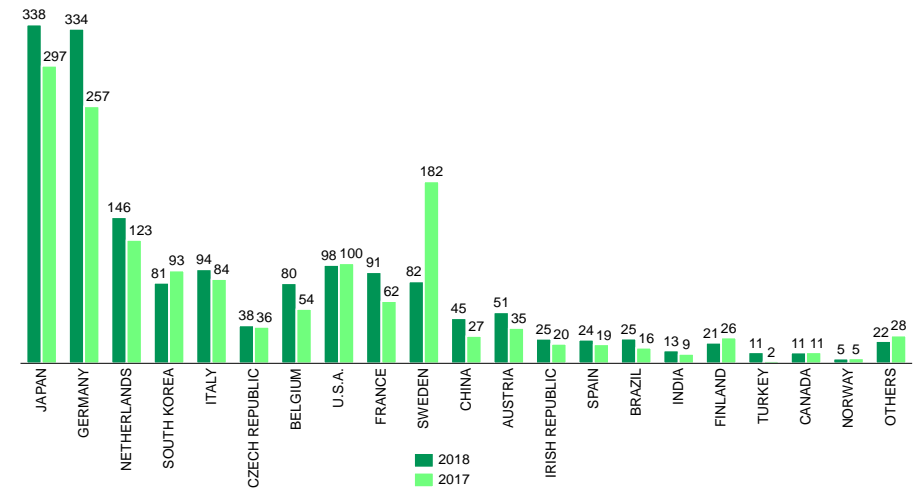
As the situation stands, the CEA and other key stakeholders can do the following to limit potential damage, considering that many markets are partially protected by tariff and non-tariff barriers:

- Look to developing economies and ensure the UK's technological expertise and services are represented effectively. As it stands, UK exports to key developing economies only account for 4% of total value but higher in unit share terms and present opportunities for improvement in higher value, service backed niches. In 2018 Brazil represented just 0.3% of exports, China – 0.29%, India – 0.14% and Russia – 2.18%.
- Effectively promote domestic product over EU produced machinery – spare parts and 24 hour maintenance contracts might not be available/sustainable under a No-Deal BREXIT.

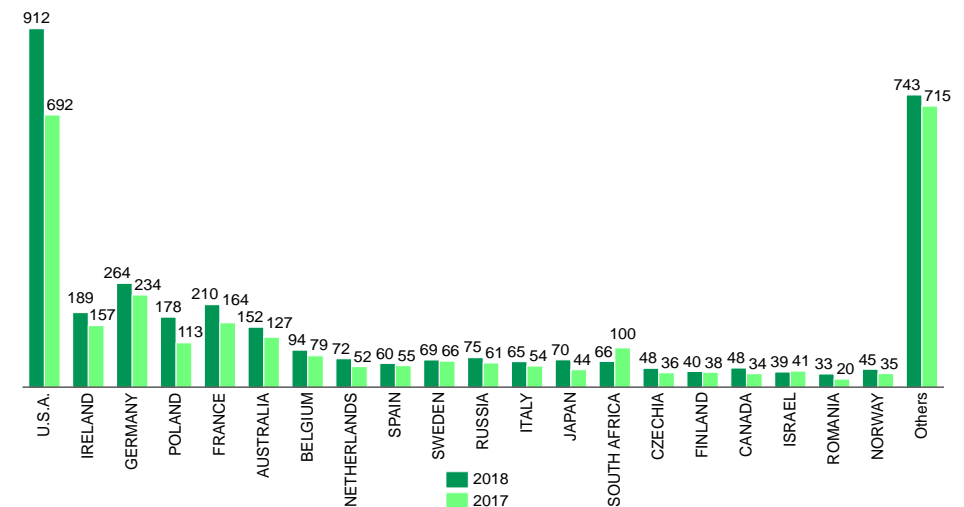
The UK is a very important market for the EU based stakeholders. The total value of imports to the UK from EU countries was £810m in 2018, and whilst the UK exported £1,137m worth of equipment into the EU, it is still a huge market for EU companies. Therefore, it would be mutually disruptive if the EU looked to build barriers for British machines entering the EU. A collaborative approach appears the best option for all parties, but in the event of a No-Deal BREXIT, UK stakeholders must be prepared.

FIGURE 26 - UK IMPORT VS EXPORT VALUE - TOP 20 COUNTRIES

Imports (£m)



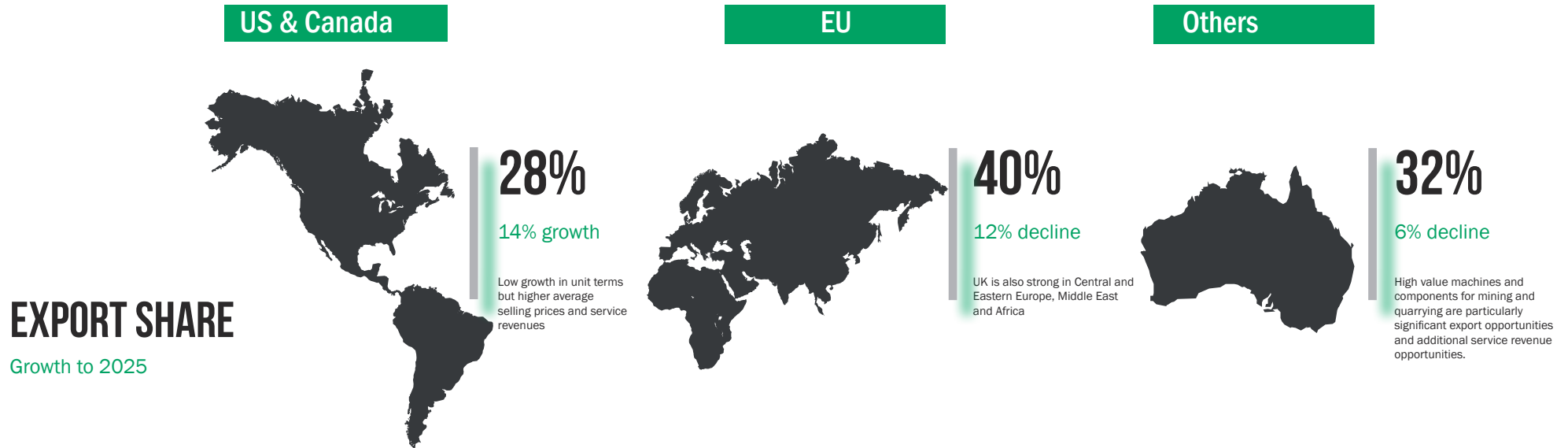
Exports (£m)



Source: CEA, Business & Trade Statistics, HMRC Customs Data

EXPORT MARKETS

Around 60% of UK machine exports are outside the EU, but component suppliers are more reliant on the EU. Growth potential appears stronger in developing markets, but competes against low cost products from China etc.



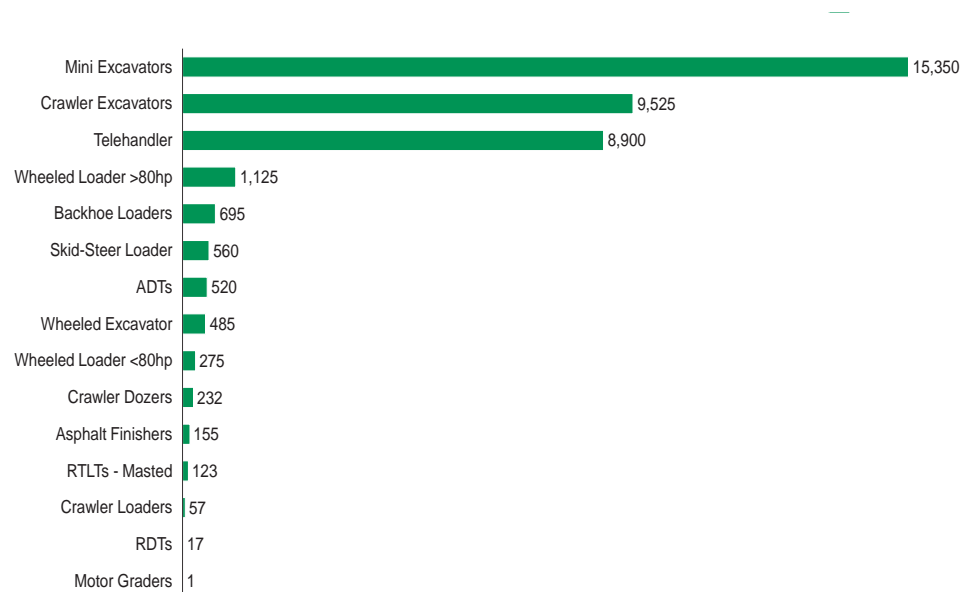
Source: Various

A majority of exports are outside the EU, with the US the largest single market. Australia, Japan, South Africa, Israel are other key markets. However figures cannot be relied upon for a truly accurate picture as used machines and re-export may distort statistical data.

PRODUCT MARKET TRENDS

Excavators are the dominant product in the UK market

FIGURE 27 - UK SALES BY EQUIPMENT TYPE



Source: Off-Highway Research

Excavators

Hydraulic excavators are the most produced piece of construction equipment in every major market in the world. Globally, over 480,000 crawler excavators (273,000 normal - 206,000 mini's) were produced in 2018.

Excavators are one of the most diverse applications in the CE product line. Machinery exists from 5kW to over 2,000kW. Price and end use are also as diverse as power requirements: The rental industry takes a large share (around 40%) of excavator volume between 4 and 30 tonne capacity. The remaining volume is typically split between; light construction, waste management, earth moving companies, civil engineering and a several other niche applications.

Mini-Excavators

Mini excavators are a high growth product, improving hydraulic functionality and efficiency means that smaller machinery can operate more effectively in a more diverse range of applications. Production is expected to rise from 178,000 units in 2015 to 236,000 units by 2020.

UK production is centred around JCB in Staffordshire and is for the domestic market. JCB are looking at increasing capacity, with 7,400 units expected to be produced by 2020, to meet growing domestic demand.

Telehandlers

Another growth product, not just in the UK but also in Europe. Telehandlers are widely used across construction, agriculture and materials handling applications, making them very versatile. Production in the UK is again dominated by JCB, with significant imports from Europe.

KEY PRODUCTS

Top 3 Products account for >70% of UK market volume

35%

Market Share 2018

35%

Mini-Excavator

UK Production:	6,000 (JCB)
Global Production:	206,000
2018 UK Sales:	15,350
Electrification potential:	High



20%

Excavator

UK Production:	2,700 (JCB, Komatsu)
Global Production:	273,000
2018 UK Sales:	9,525
Electrification potential:	Moderate



18%

Telehandler

UK Production:	15,300 (JCB)
Global Production:	53,000
2018 UK Sales:	8,900
Electrification potential:	Moderate



KEY PRODUCTS

Value is skewed towards niche products, with ADTs, crushers and screens a major UK export

35%

Market Share 2018

1%

Dump Trucks

UK Production:	2,326 (JCB, CAT, Volvo)
Global Production:	10,985
2018 UK Sales:	520
Electrification potential:	Moderate



3%

Wheeled Loaders

UK Production:	3,600 (JCB, CAT)
Global Production:	150,000
2018 UK Sales:	1,400
Electrification potential:	Low



<1%

Crushers and Screens

UK Production:	>2,000 (Terex, Sandvik, McCloskey)
Global Production:	>3,000
2018 UK Sales:	<150
Electrification potential:	Moderate



UK MARKET SEGMENTS

Major end users accounted for by four main segments. The structure of the end users impacts choices of technology development. Historically fuel consumption has been less critical to rental companies than up-front price and resale values

60% **Rental Companies**
Typically rental companies have been averse to adopting more efficient machines, seeking lower cost, to keep rentals low. In the future they will have to work with customers to provide a more end to end service.

10% **Contractors**
Contractors

9% **Agriculture**
A surprisingly large share of construction machines are sold into the agriculture sector. Typically lower than average hours they will however be used in a wider range of applications. Telehandlers in particular are sold into this segment.

6% **Waste Management**

15% **Others**

Source: KGP analysis, Off-Highway Research

KEY ISSUES - PRODUCTIVITY

A number of key issues are critical to the market, defining near term product trends and investment



01 Efficiency

Overall machine efficiency is a key issue for most OEMs and operators, but not necessarily the purchaser of the machine - because rental companies have such a high share of the market. In terms of total cost of ownership (TCO) contribution, fuel is often not a major concern for construction equipment (it is in certain end use applications, such as waste management) but machine efficiency is certainly a growing point of interest for government, the public, engineering firms and operators. We expect huge amounts of investment in efficiency improving technology in the next 10-15 years.



02 Digitalisation

Digitalisation is a hot topic right now for all industries, not just construction. The construction equipment industry is at a low level of digitalisation according to the McKinsey Report commissioned by CECE. However there is obvious strides towards increasing levels of adoption, Building Information Model (BIM), Smart Communication and telematics are all receiving large sums of investment. However, without proper collaboration, communication and willingness to share data, the touted benefits of digitalisation for the construction equipment sector.



03 Automation & Autonomy

Automation of operation - such as grade assist for excavators - is a tool that increases operational efficiency whilst simultaneously bridging a widening skills gap. The UK construction equipment sector must invest heavily in technology that helps improve the automation of machinery because it's likely to offer an important competitive advantage when combined with the increasing data mining uses of digitalisation and telematics. Progression from automation of operation to full autonomy, is where the machine can operate independently from single in-cab operator, or where one operator can remotely control multiple machines - i.e. Caterpillars CAT Command System.



04 Skills

The skills gap for UK construction equipment operators and manufacturers is widening, and has been for years. The technological advancements expected in the construction equipment sector in the next 10 - 15 years are going to broaden this gap even further if cultural changes are not made. The communication technology requirements and technology incorporated into machine's now require the brightest minds. Competition is increasing alongside globalisation and the government alongside industry needs to do what it can to promote construction equipment as a favourable, attractive career choice.

CONSTRUCTION PRODUCTIVITY

Construction productivity is the lowest for any key sector in the UK.

However there is a slight upturn as engines became more efficient and operational efficiency improved with drive aid systems (such as grade assist on an excavator). In terms of the UK's position in the global marketplace, the UK's GDP added per hour worked for the entire economy places us a few points ahead of the EU and several behind the US, which is still a positive for the UK - maintaining productivity despite mass uncertainty for the economy and industry as a whole.

FIGURE 28 - CONSTRUCTION PRODUCTIVITY

GDP added per hour worked - total industry

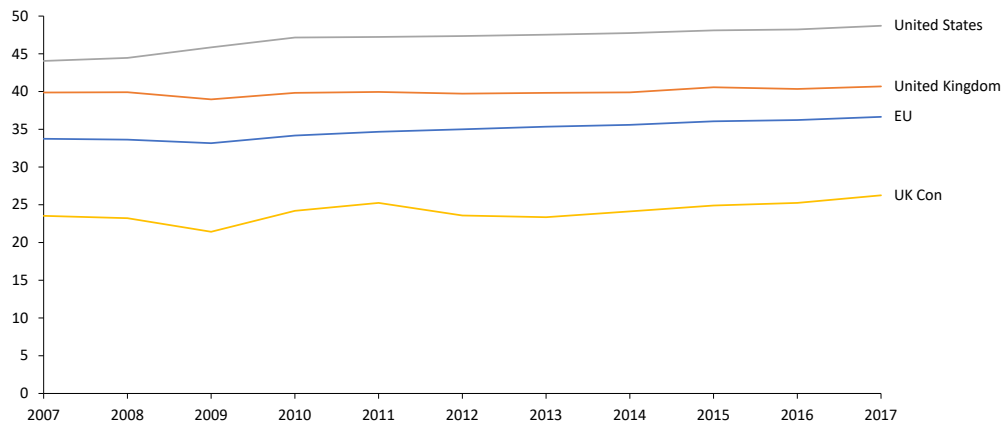
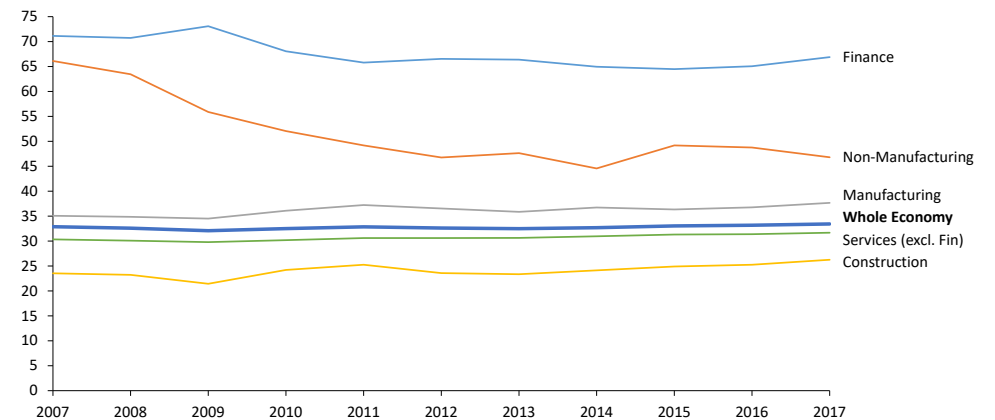


FIGURE 29 - CONSTRUCTION PRODUCTIVITY

GDP added per hour worked - UK Sector Analysis - Including Construction



Source: Various

PRODUCTIVITY - CECE FOUR PILLARS

Productivity improvement will require efficiency improvements across the whole of the sector, including sites, their machines and operations, as well as alternative fuels. In a joint paper published by CECE and CEMA - *Optimising our industry 2 reduce emissions*⁸ - the two industry associations identified the four pillars to meet customers, and other stakeholders efficiency targets.

MACHINE EFFICIENCY

- Machine Technology - load sensing hydraulics, advanced drivelines , electrification, aftertreatment, thermal management, advanced sensors and controls, Smart communications and autonomy

PROCESS EFFICIENCY

- Advanced monitoring - GPS, wireless network connections, automation, etc....

OPERATIONAL EFFICIENCY

- Site technologies – telematics, data analysis, digitalisation, automatic blade sharpening, automation of the jobsite
- Operator training

ALTERNATIVE ENERGY SOURCES

- Hybridisation
- Advanced Renewable Fuels and E-fuels



PRODUCTIVITY - CECE DIGITALISATION

CECE, the Committee for European Construction Equipment, has commissioned an extensive report on Digitalisation in the European sector. *Digitalising the Construction Sector*⁹ was published early in 2019. The report highlights in detail the benefits and challenges for the industry of the shift to a digital sector. It has also published a complementary manifesto on the topic¹⁰.



DIGITAL FUTURE

Digitalisation - key to productivity improvement?

Digitalisation is the process of collecting, analysing and actioning large amounts of data that is gathered using telematics software and other integrated technologies – using this information to improve efficiency within the construction industry as a whole.

Stage 1: Monitoring

Technology and software that monitors various operational and efficiency indicators, such as - fuel consumption, location and operator statistics – this sort of technology is not new and has been around in other manufacturing industries for a long time.

This stage of technology is equipped on most new equipment sold in the UK, although often at a cost premium on top of the machine cost. Additional capabilities of the software, such as predictive maintenance can be an additional cost yet again.

Stage 2: Fleet Management

The second stage of digitalisation, which KGP expects to begin around 2025, will take fleet management and coordination to new heights. Using operational and performance data from the equipment gathered by the telematics software, the construction schedule can be adjusted frequently – without disrupting construction whilst improving overall efficiency of the job. Key factors for schedule changes:

- Physical location of machinery

- Location of machinery needed for next phase of construction

- Suitability and process efficiency of each machine type for each job assigned to it

In order to effectively communicate and process this information, it is likely that construction companies and construction equipment OEMs will have to jointly create a set of standards that collaboratively collects, stores and facilitates the use of telematics data across various brands and applications to establish a measure of best practice from which to improve.

Stage 3: Complete Digitalisation of the Jobsite

The third stage of digitalisation is mass automation within the job-site – for example the Volvo X-Electric Project. The impact of this type of automation and BIM on the construction equipment sector is going to be profound. By 2020 and beyond BIM is expected to allow a virtual model of the entire construction process. This will include a digital model consisting of a complete breakdown of construction schedules and costs. This model will enable construction companies a version of lean-production, BIM will allow construction companies to see the most efficient route – in real time, taking into consideration previously unseen occurrences – to project completion. In order to achieve this, automation will most certainly be involved.

Some thought leaders are suggesting that just-in-time delivery could see the required construction equipment fleet being reduced, because as the machinery is delivered and used for the optimum amount of time and is already scheduled for just-in-time delivery to the next job-site where it is required. The less idle time and delivery downtime means the overall equipment requirements could reduce slightly.

BIM LEVELS

BIM - the Building Information Model will be adopted for all major projects. BIM will be used to manage all of the life-cycles of a building - design, manufacture, use and eventually end-of-life.

BIM is a shared knowledge resource – this is where it is going to have a vital role in the future of the construction equipment sector – it allows a comprehensive view of all aspects of any given project. Meaning the project manager, the machinery operators, the design team and the maintenance crews to all share and collaborate their information.

BIM information consists of everything that goes into constructing and maintaining a building through its lifetime – this includes construction programming, costing and facilities management. There are currently four BIM levels identified, three of which are fully defined, the fourth in development.

0

BIM Level 0

No collaboration. 2D CAD drafting only, mainly for production information. Distribution of this information is via paper or electronic prints. Most of the industry is well ahead of this stage.

I

BIM Level II

This is where most projects (over £5 million value) operate in accordance within the UK. Level 2 is distinguished by a collaborative working approach which requires an exchange of information process that is specific to that project and coordinated between several system as well as project participants. Any CAD software must be capable of exporting to one of the common file formats.



II

BIM Level I

Typically this comprises a mixture of 3D CAD for concept work, and 2D drafting for statutory approval. The sharing of information and data is carried out from a common data environment (CDE) – this is often managed by the contractor.

III

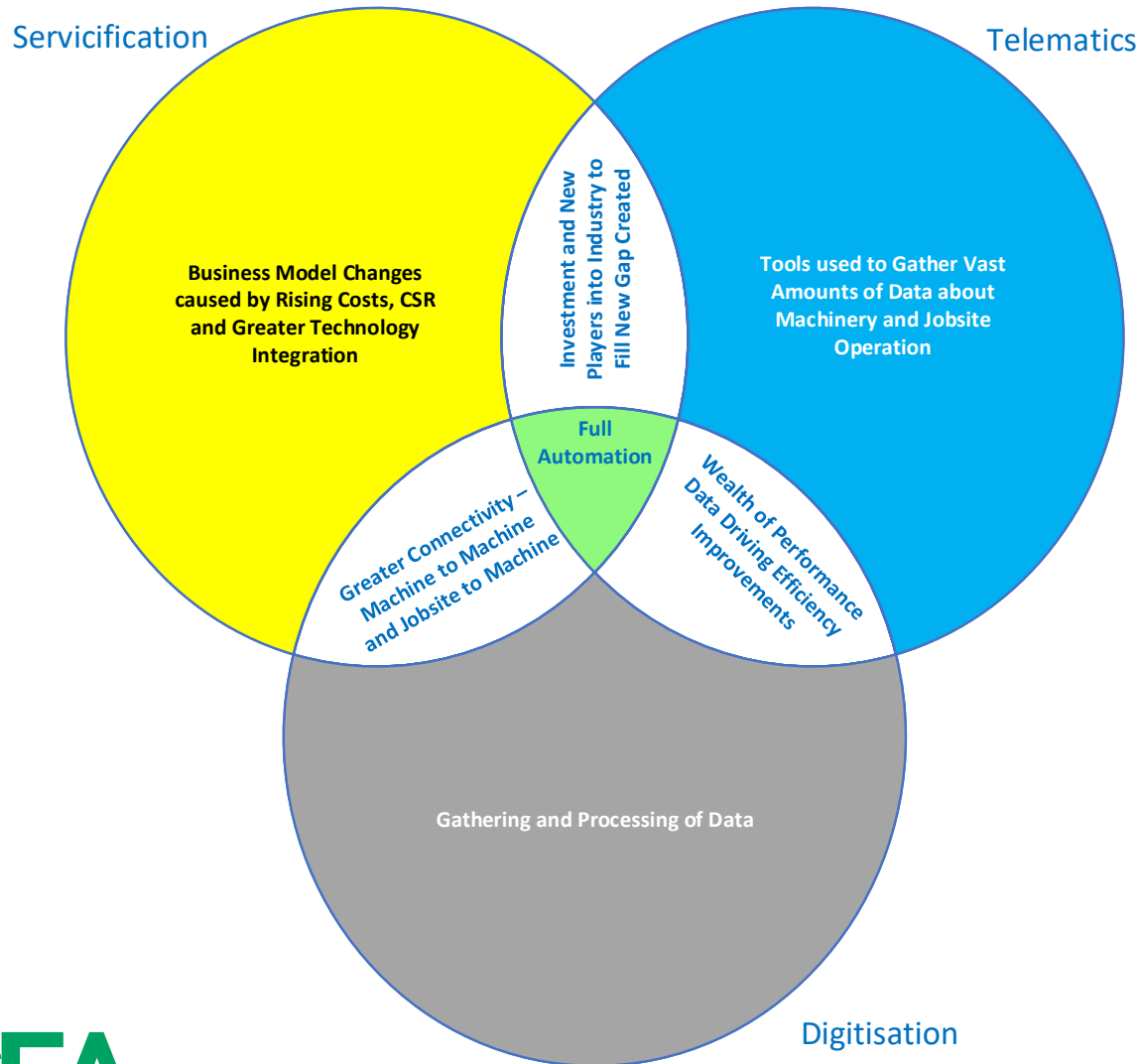
BIM Level III

Although not fully defined yet, the 'key measures' of level 3 BIM are:

- The creation of a set of new international 'open data' standards which would pave the way for easy sharing of data across the entire market.
- Establishment of a new contractual framework for projects with BIM as a contributing factor to ensure consistency, avoid confusion and encourage open, collaborative working.
- Creation of a cultural environment which is cooperative
- Training the public sector client in the use of BIM techniques
- Driving domestic and international growth and jobs in technology and construction

DIGITAL INTERACTION

Servicification, telematics and digitalisation are all inter-related, and most benefit will come from collaboration, bringing cost, productivity and sustainability improvements.



There is much more interaction and collaboration required to realise the full potential of efficiency improving technology. The market is already seeing individual change - but it is a cultural wholesale change that needs to be adopted if efficiency changes are going to reach their potential.

The amount of data being gathered by modern machinery is huge, but the value is in using this data to improve performance and efficiency - not just of the machinery - but the operational circumstance throughout the life-cycle.

This is where collaboration is vital. OEMs, suppliers, and customers have historically been some-what closed book about the data they are gathering, but a lot of value can be placed in big data analysis. Looking at data from:

- Many end-use applications
- Different operating environments
- Different load cycles
- Different operating hours

These can all contribute to efficiency improvements throughout UK job-sites just by allowing mass analysis of the data and best practice to thrive.

To enable this amount of collaboration, KGP realises that industry standards will need to be applied for things like:

- Data reporting format
- Data ownership
- EU vs. UK vs. Global relationships

There is an opportunity for the UK to set the standard for collaboration and efficiency improvements by laying the path of best practice for other countries and stakeholders to follow - the UK has the information communication technology skills and industry to take advantage of this opportunity but we must act quickly.

Source: KGP Analysis

FEATURES OF SERVICES

Servicification is a major opportunity

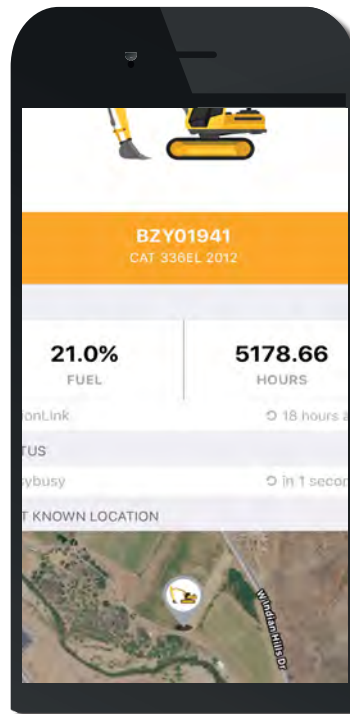
Servicification (sometimes referred to as servitisation), is the shift away from product centred sales to product-centric services - which deliver 'value in use'. Many machines today are sold with a degree of service contract, but the majority are still sold without.

Level 1

Base Service - Selling the product alone. With little added value in terms of continued service after purchase - pre 2015 level in the UK.

Level 2

Intermediate Service - the product comes with some services, such as maintenance or condition monitoring - current level in the UK.



Level 3

Advanced Service - product is still purchased but comes with advanced service to aid operation and efficiency - 2020 onwards.

Level 4

Pay Per Use - wholesale business model change, where a construction service is bought from an OEM/dealer that allows access to a number of machines, and additional services such as operator management, availability contracts and integrated solutions.

DIGITALISATION ROLES & SKILLS

Collaboration across stakeholders will be required

OEMs

Equipment OEMs will need to develop, adopt and help integrate advanced digitalisation software and equipment into the machinery. They will also have to fully buy into the cooperation ethos of integrated operational efficiency.

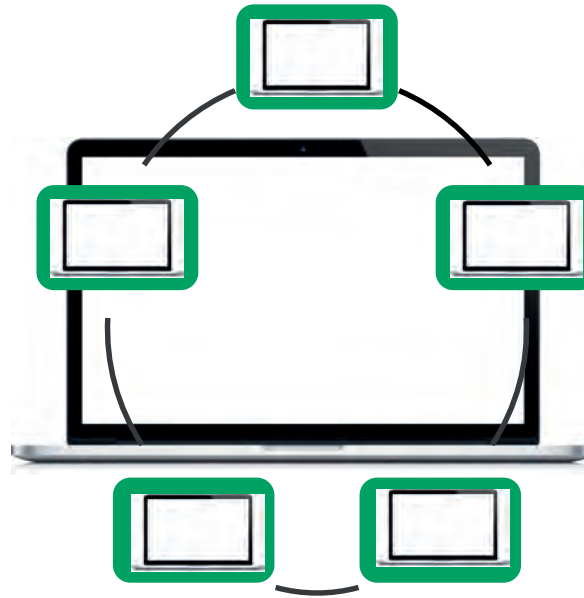
With the new levels of technology and digitalisation expected in the long-term future of the construction equipment industry, the need for highly skilled employees will be paramount. A serious threat seen by many key players interviewed for this study is the lack of 'top talent' entering the construction equipment careers pool.

Service Providers

It is highly likely that increased digitalisation will bring more competition into the market – digital players and software system providers will be an integral part of the future of construction sites.

Contractors

Using operational and performance data from the equipment gathered by the telematics software, the construction schedule can be adjusted frequently – without disrupting construction whilst improving overall efficiency of the job.



Government

The question of data ownership could put a spanner in the works of developing the required cooperation between all levels of the supply chain.

Transparency of data - the operating statistics of machinery - will become available with vast quantities of data to support it. This means that performance indicators such as breakdowns, cost and fuel consumption will be publicly available. OEMs will have to develop new strategies in order to cope with this transparency and maintain their customer base. Government may have to step in and manage this decisive step.

Suppliers

Key players in the market currently will need to move swiftly and implement digital tools and services to their products in order to engage with a market that is growing to point far larger than the traditional construction site.

Customer

The customer will have an abundance of performance data with which to make an informed purchasing decision. Collaboration and open communication with OEMs will drive innovation and efficiency improvements through the supply chain.

KEY ISSUES - SUSTAINABILITY

Sustainability will impact the whole of the supply chain and end users. Potentially it offers the opportunity for new suppliers to enter, but also existing ones to innovate and evolve.



01 Noxious Emissions

NO_x emissions from machinery above 56kW was one of the primary focuses of EU Stage IV legislation. Essentially it legislated the use of an SCR for all engines between 56 and 560 kW, Stage V added a Particulate Number (PN) effectively legislating a DPF. Further NO_x emissions are expected beyond Stage V - technological impact means some exhaust systems might expand to two SCR systems and the DPF. Low Emission Zones and Zero Emissions Zones impacting NRMM are relatively limited and weak in scope now, but likely to expand, as is CSR targets and incentives for cleaner machines.



02 Carbon Emissions

Specific CO₂ output is not yet legislated under European or UK law. With CECE successfully limiting the scope of the Clean Vehicles Directive for the near future CO₂ will remain un-legislated. However, the Commercial Vehicle sector has just seen legislation pass that will limit their specific CO₂ output. Historically the NRMM sector has always followed - therefore we strongly expect some CO₂ legislation beyond 2030. Fuel taxation increases, i.e. taxing RED diesel at vehicle levels is a potential driver for reduced fuel consumption.



03 Life Cycle Analysis

The life cycle of construction machinery will shift as cultural changes, digitalisation, servicification and globalisation impact the sector. Machinery will be more expensive as emissions legislation continues to become more stringent. R&D investment in connectivity technology will be required to maintain a competitive edge. At the same time the second life of a machine is being limited to highly regulated countries, potentially reducing the overall resale value of the machine.



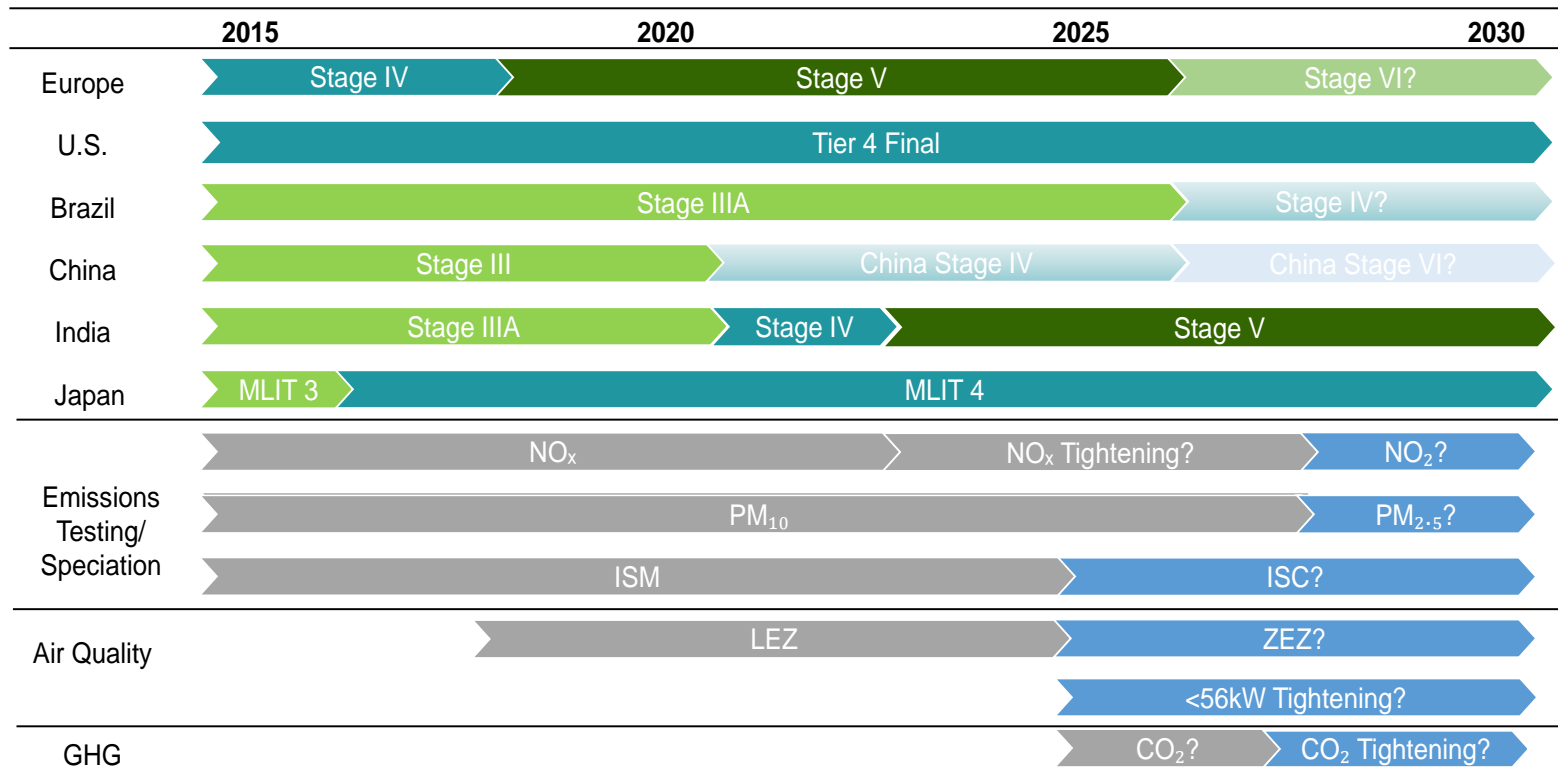
04 End of Life

Recycling of machinery and components will become increasingly important for the construction equipment sector in the future. For peak sustainability, over 90% re-use or recycling of key materials will be required. Batteries, motors and exhaust systems will need to be closely managed at the end of a machine's life to ensure the materials are recycled within the legislated framework.

LEGISLATION & STANDARDS

A wide range of standards and legislation applies to different global markets, including not just emissions, but the Machinery Directive, NOMAD, REACH and ROHSS, ROPS, TOPS, FOPS... However emissions is driving machine development globally, and legislation will continue to tighten. Europe's Stage V is the world's most stringent and will require testing of engines to ensure compliance during the minimum durability period, known as In-Service Monitoring. CO₂ emissions are not yet legislated in any market.

FIGURE 30 - GLOBAL EMISSIONS TIMING



EMISSIONS TIMING

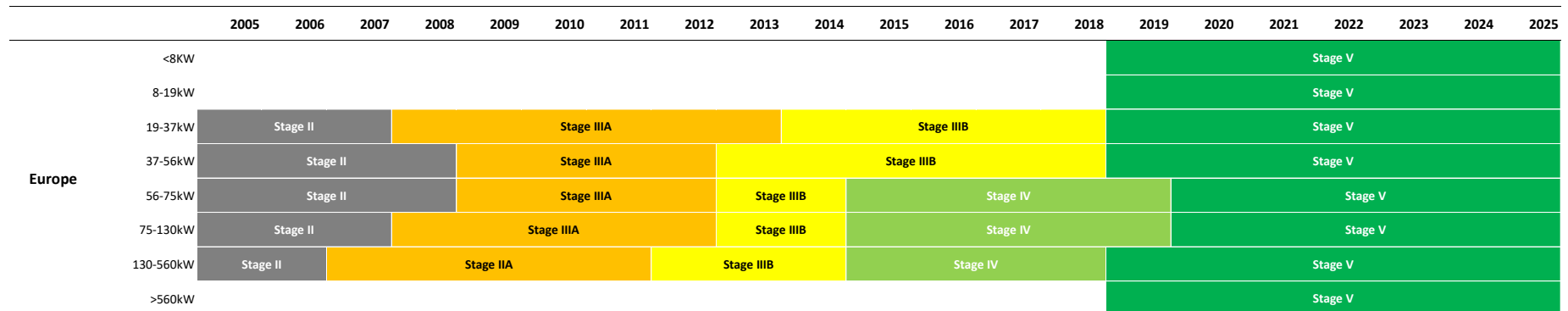
Starting in 2018 Stage V includes <19kW and >560kW for the first time, 19-56kW skips IV from Stage IIIB

Stage V includes machines under 19kW and above 560kW for the first time in Europe, also included is a limit for particulate number which will mandate a DPF for most types of equipment, alongside the SCR for above 56kW that was the result of Stage IV legislation.

The impact of this will make machines more expensive, an additional cost that is hard to absorb for the OEMs, so this is likely to pass down to the customer. Because of the cost increases in the design, development and production stages of machinery below 56kW, OEMs and supplier will look much more closely at hybridisation and electrification because of the lower operating costs can off-set the higher upfront cost that will come hand in hand with Stage V legislation. There is abundant evidence of this with JCB, Caterpillar, Wacker Neuson, Volvo and other OEMs introducing fully electric and umbilical hybrid mini excavators.

Beyond Stage V there are various theories as to where the European Commission's focus is likely to land, but the two overriding themes are ultra low NOx legislation - because NOx limits in a lot of major cities are still above safe levels - and CO2 legislation - following the commercial vehicle legislation, as the NRMM sector has historically done, and there is an environmental drive for lower GHG emissions from all types of industry.

FIGURE 31 - EUROPEAN EMISSIONS TIMING



Source: European Commission

DE-CARBONISATION

Decarbonisation of the UK economy is embedded in government policy, as part of the UN IPCC and subsequent Paris Accord and all sectors, including construction equipment are expected to contribute.

However CO₂ limits for NRMM are still a long way off. As a result Low and Zero emission zones, plus Corporate Social Responsibility policies are driving potential demand. Health and safety is also a consideration, where diesel exhaust is considered a risk. Globally fossil fuel demand is forecast to grow more strongly in absolute terms than renewables.

There are many barriers to de-carbonisation in the construction segment including:

- Battery energy density
- Charging access
- Renewable energy availability

FIGURE 32 - PRIMARY ENERGY CONSUMPTION BY FUEL (BILLION TOE)

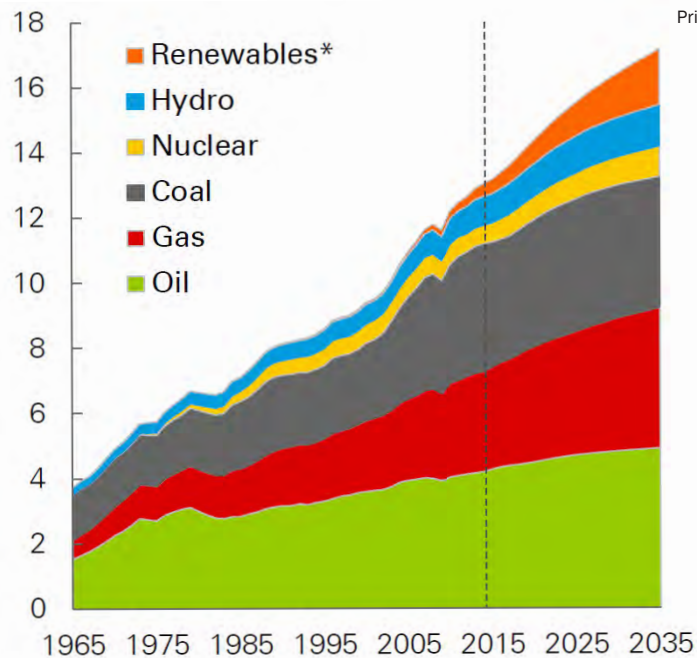
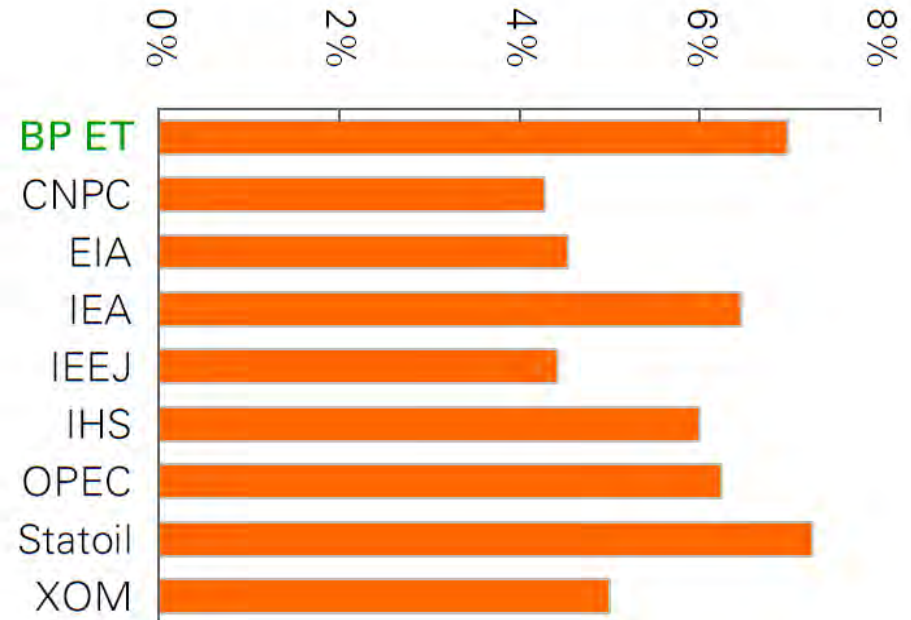


FIGURE 33 - RENEWABLE ENERGY GROWTH 2016 - 2040 (% PER ANNUM)

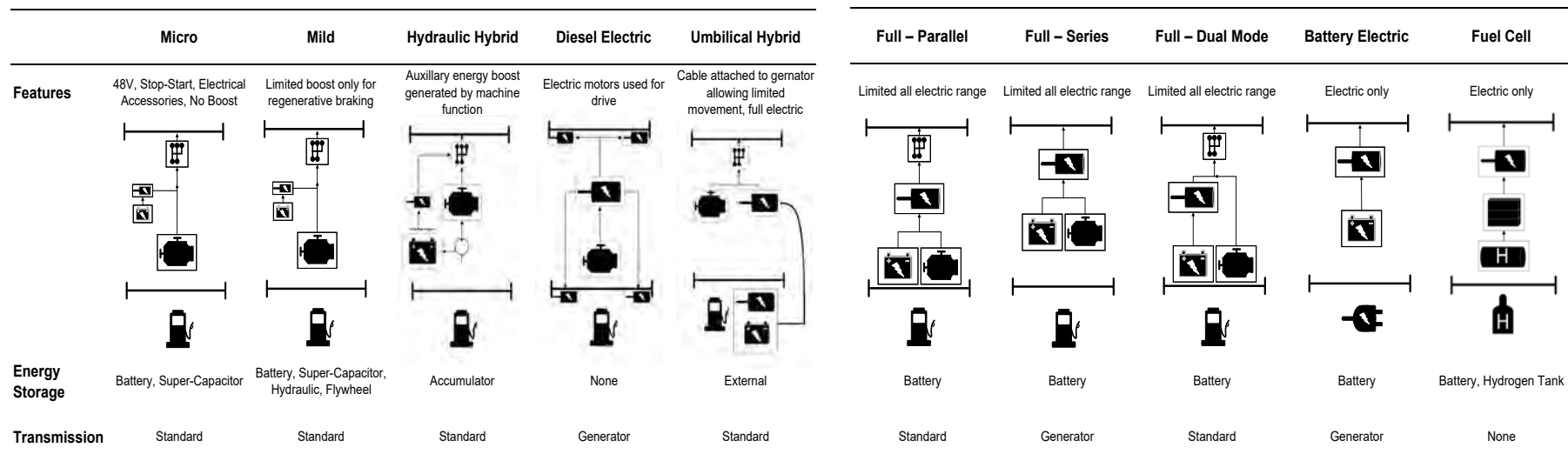


* Renewables includes wind, solar, geothermal, biomass and biofuels

ALTERNATIVE POWERTRAINS

Demands of various equipment segments varies massively, driving alternative architectures. Crawler vs. wheeled equipment have fundamentally different architectures, driving new technologies to improve efficiency. Energy storage - batteries, hydrogen tanks, hydraulic accumulators, super-capacitors or flywheels will vary according to machine type.

FIGURE 34 - POTENTIAL ALTERNATIVE FUEL ARCHITECTURES FOR NRMM



Source: KGP Non-Road Powertrain Forecast xEV Update Q2 2019¹²

There are various hybridisation and electrification options for construction equipment. Depending on type of machine, hours of operation, load cycles, power requirements and where the machine is operating all impact the pros and cons of any given technology path. However, in the current climate, the biggest negatively influencing factor for electrification is upfront cost being far too high for widespread adoption.

The construction equipment sector needs this stage of development and support in order to reduce overall cost of materials and components, improve efficiency of the technology and rationalise the supply-chain. At the moment, electrification is suitable only for niche applications, but all paths are leading in the right direction, and within 15 years mild hybridisation linked with engine downsizing will be a common trend in the construction equipment sector in most developed countries.

SUSTAINABILITY - MODEL AVAILABILITY

KGP has recently analysed over 150* alternative powertrain equipment models currently in various stages of development or production. (*Excluding forklift trucks and agricultural equipment).

The primary architecture being developed is battery electric - predominantly small, low powered equipment, where current battery technology can support 50-95% of an entire day's operation. These machines are typically around double the price of diesel equivalent machines, with very low sales volumes, Without legislative drivers, and poor payback periods there is very little demand for them outside of niche applications - such as in-door operation, or inner-city operation where air quality and noise become influencing factors.

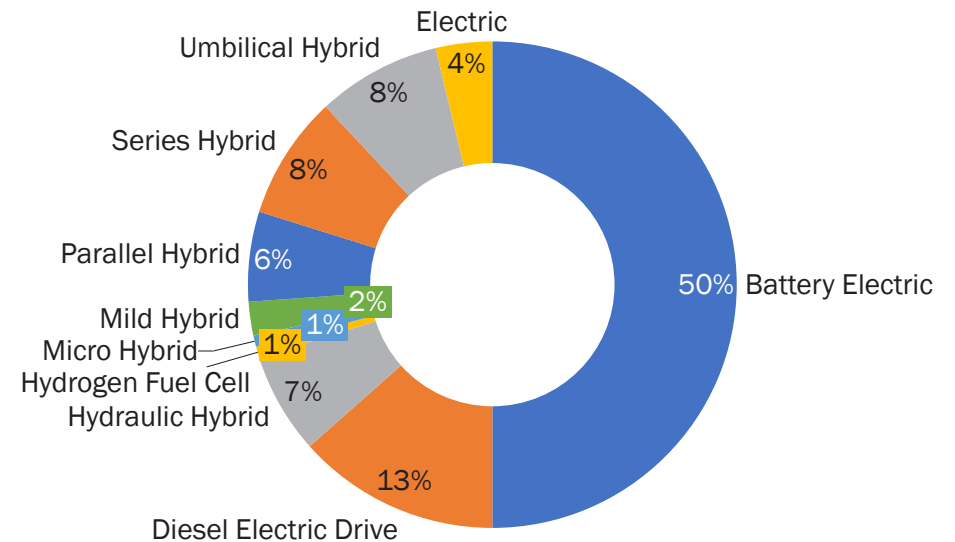
Diesel electric drive technology is used primarily in large, high powered machinery. It offers significant fuel savings when large machinery is operating under high load, high hours and offers productivity improvements. The combined TCO savings of large diesel electric drives makes it a very widely adopted technology in mining equipment. The production volume of machinery equipped with diesel electric drive might be low, but in value terms is very significant. As the technology develops and matures costs will fall, making it more suitable for smaller machines. A number of OEMs use diesel electric drive in a number of their models, including, but not limited to:

- Caterpillar - wheeled loaders, rigid dump trucks, crawler dozers
- Hitachi - rigid dump trucks
- John Deere - wheeled loaders
- Komatsu - wheeled loaders, rigid dump trucks
- Liebherr - rigid dump trucks

For excavators hybrid - electric or hydraulic is increasingly being adopted in premium excavators for high hours, high load applications, where energy recovery reduces fuel consumption and the hybrid system improves productivity, providing a short payback. As volumes increase there is also wider potential for 48V electric and hybrid systems, and fuel cell variants.

FIGURE 35 - ELECTRIFIED CONSTRUCTION EQUIPMENT MODELS BY ARCHITECTURE

>150 Hybrid and electric models available (ex. MH)
Full electric models growing most quickly in 2019



Source: KGP Non-Road Powertrain Forecast xEV Update Q2 2019

NEW PRODUCTS 2014-2019

Since the 2nd sector report in 2014 UK producers have invested substantially in new 'green' products across their various segments. All have invested in new Stage V emissions compliant engines and machines, as well as new battery electric, hybrid electric/hydraulic, tethered and fuel cell variants. Although the vast majority of demand is for diesel machines, specific customers and end users have started to buy these newer powered machines, primarily to meet local emissions or noise requirements.

JCB Electric Mini Excavator



Terex PowerScreen Warrior 1400XE Screen



TCP Ecolite Fuel Cell Light Tower



Komatsu Hybrid Excavator

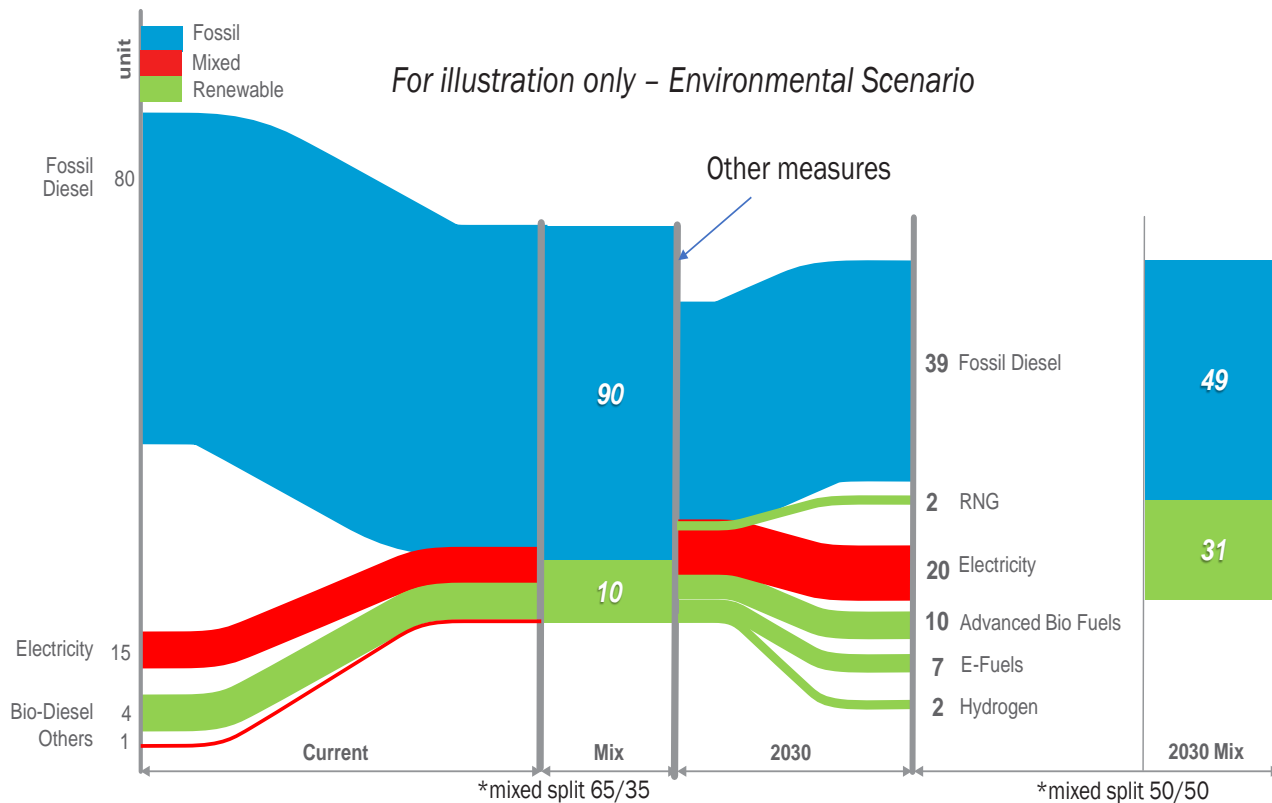


SUSTAINABILITY - RENEWABLE FUELS

Decarbonisation of construction equipment will rely on renewable fuel availability.

Although the UK is a leader in electricity generation from renewables, the UK's total energy demand including liquid transport fuels is much higher than forecast renewable capacity in the medium term. However transport fuels, as an example have been included in the Renewable Energy Directive II (RED II) and a target of 14% of total fuels has been set for 2030. This will impact Non-Road Fuels, even though they are not included in RED II. A potential scenario across NRMM for 2030-2035 would see overall energy demand split between a wider range of fuels than is currently the case, but with fossil fuels to fall significantly in the overall mix. Current UK government research, including the recommendations of the Committee on Climate Change (CCC)¹³ suggest a net zero carbon target for 2050, which would require high levels of battery electric, fuel cell electric and tethered electric equipment starting in the 2030s.

FIGURE 36 - POTENTIAL NRMM FUEL USAGE SCENARIO 2030-2035



Source: KGP Non-Road Powertrain Forecast xEV Update Q2 2019

CASE STUDY VOLVO X-ELECTRIC SITE

Volvo and several partners have implemented an ultra-low carbon electrified quarrying site to demonstrate various new technologies.



2017: The prototype HX1 - autonomous, battery electric, load carrier

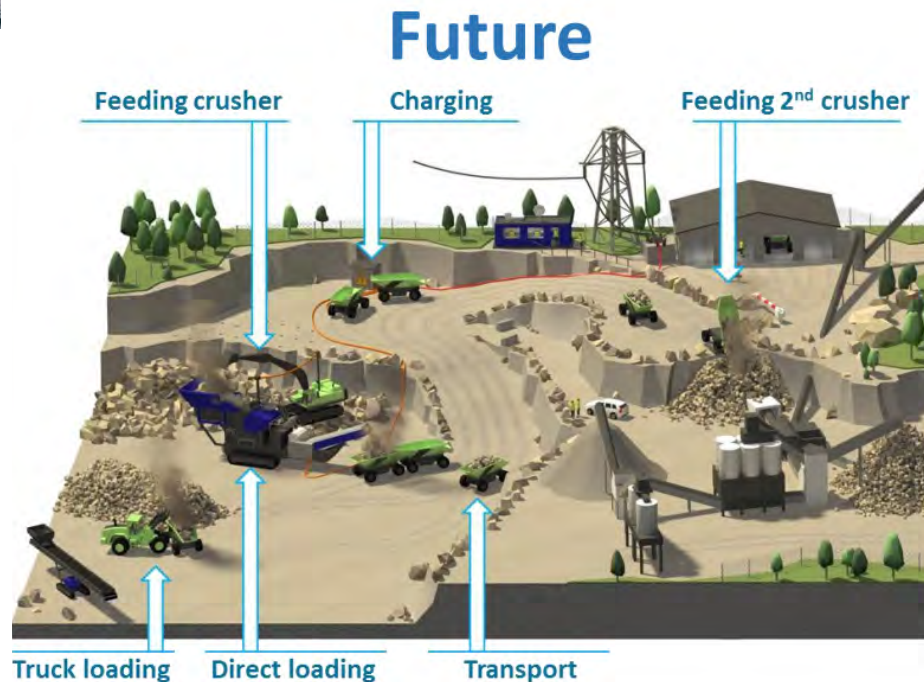
2018: HX2 - second generation load carrier, with advanced battery technology and inductive charging.



2018: The EX1 - a cable connected excavator

- Static operation loading blast rock into a mobile crusher.
- Almost 3 and a half years development
- Very high power requirements - between 250 - 500kW
- Drivetrain is an advanced version of the umbilical hybrid seen on mini excavators.

Volvo claim they are going to revolutionise the quarrying and aggregates sector by reducing carbon emissions by up to 95% and TCO by up to 25%. The project was first conceived as a concept in October 2015, and was centred around electrifying the transport stage within a quarry. The results of two years research and development were announced in 2017.



The EX1's static operation means it is very suitable for umbilical all electric operation. There are probably multiple options for umbilical connection - i.e. generator, battery bank charged by solar energy, installed mains electricity in some circumstances.



Process efficiency of the site was improved with new site management systems - including telematics and digitalisation:

- Machine and fleet control systems
- Logistical solutions for optimal route planning and minimal idle for engine driven equipment

2017: The prototype LX1 hybrid wheeled loader - series hybrid system, lithium ion battery storage, downsized 4.5 litre engine (from approximately 13 litres), inverter generator.



SUPPORT NETWORKS

UK Government funding supported networks are investing in R&D of advanced technologies for construction, energy and powertrain



Advanced Propulsion Centre (APC)

Founded in 2013 the APC facilitates funding, providing expertise and enabling collaboration to create the technologies for a cleaner automotive future – including construction.



Transforming Construction Alliance

Formed in 2018, as an alliance between MTC, BRE and CBDD, the Construction Innovation Hub is funded by HM Government to support research into construction digital and advanced manufacturing technologies

Energy Technologies Institute

Industry-Government Partnership, funded 50% by HMG and 50% by seven industrial partners. Founded in 2007. Caterpillar and Rolls-Royce are lead industry partners.



Construction Leadership Council

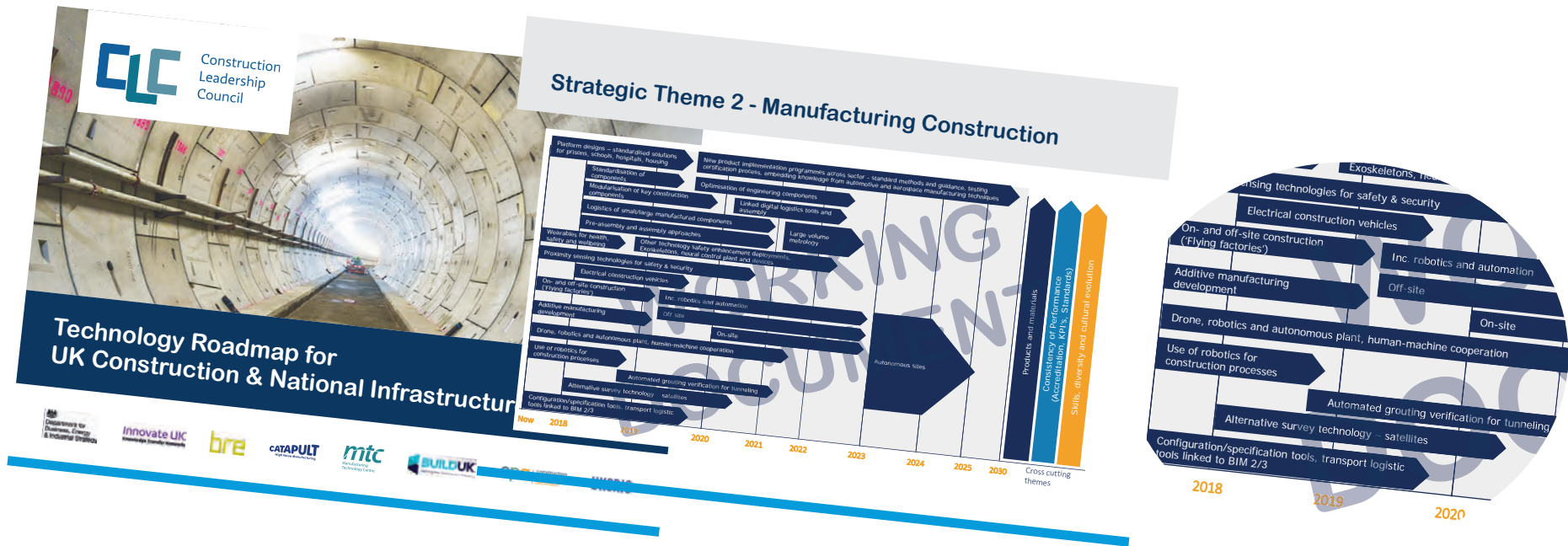
Business leaders from across the construction sector. Ambitions are for a 33% reduction in cost, a 50% reduction in project time, and a 50% reduction in carbon emissions.



I3P TECHNOLOGY ROADMAP

Collaboration is needed throughout the UK's construction industry supply chain and end users

The definition of common industry standards for job-site technologies needs to be co-ordinated between the various stakeholders. To meet future legislative, performance and economic requirements equipment needs should be planned many years in advance of construction starting. For example the *Technology Roadmap for UK Construction and National Infrastructure*¹⁵ indicates a requirement for technology 'Electrical Construction Vehicles' that are not widely available in the market, nor economic in 2019.



KEY ISSUES - SUPPLY CHAIN

A number of key issues are critical to meeting future technological demands. New capabilities, processes and skills will require significant UK investment

01 Powertrain

The UK is supported well by domestic powertrain suppliers, especially for engines with Perkins in Peterborough and Cummins in Daventry. However, with Turner Powertrain being closed by Caterpillar, transmission production is lacking somewhat - the large Germany based suppliers are benefiting from this.

02 Hydraulics

Hydraulics are progressing towards managed flow technologies. With load sensing hydraulics becoming cheaper and more available, they are being fitted to cheaper, lower powered machinery - which is in turn making these machines more effective and efficient. There are several UK component suppliers for hydraulic systems that operate throughout the EU, but there is a lot of import for other components - the UK does have strong design, R&D, and maintenance capabilities.

03 Telematics & Human Machine Interface

A relatively new concept for most construction equipment applications, having only found any volume of uptake in the last 5 years. Although the technology itself isn't particularly new, adoption of greater amounts of telematics and HMI is expected because of the efficiency improvements it can offer. The UK has several start-ups providing advanced telematics services, which the market is warming too now the benefits are being realised.

04 Materials & Other Parts

Even with Tata Steel and British Steel disassembling and reforming after the financial crisis, the materials management supply and incorporation within the construction sector is well supported domestically.

SUPPLY CHAIN

The UK is home to many leading component suppliers & leading new entrants

The UK construction equipment segment has a strong domestic supply chain. Powertrain is a key strength, with all OEMs upgrading products to Stage V over the past few years. Sadly a number of companies have closed or moved facilities abroad, including Caterpillar's Turner Powertrain and Thyssen's Berco. Globalisation has seen a number of Perkins engines moved to its Chinese plant, but the revenue remains strong as demand for Stage V engines, and investment in its new Synchro engine range will increase added value in Peterborough. In parallel JCB has invested in its 444/448 engines for Stage V and also added the smaller 430 engine following extensive investment since 2014. New entrants will also enter into the electrical machines space, and other solutions for more efficient machines are being developed in the UK.



Perkins Engines



JCB Power Systems



Cummins



Johnson Matthey

Kawasaki

Hydraforce

Denso Marston

BorgWarner



AVID Technology

Artemis Intelligent Power

Hyperdrive Innovation



ACADEMIA AND INDUSTRY SUPPORT

UK OEMs and supply chain can access extensive support from academia and other bodies

The industry is benefiting from widely available support through academia and industry partnerships. A number of UK located OEMs have their own dedicated partnerships with academic institutions. For example, the Caterpillar Innovation and Research Centre (IRC) at Bath University and Mecalac with Harper Adams, Shropshire. The High Value Manufacturing Catapult and MTC also provide support to the industry. The UK also has the National Fluid Power Centre, which provides world leading education and support services for hydraulics, other fluid systems and electronics related to construction and other equipment types



Warwick Manufacturing Group

WMG, part of the University of Warwick, provides innovative solutions to industry; through research, education and collaboration.



NFPC

The National Fluid Power Centre is based in Worksop. It is supported by many of the UK's OEMs and suppliers, providing education and training related to hydraulics and other fluid related systems, and electronics,

Kings College London

Collaboration with AVID Technologies and Caterpillar on electrified machinery and the telematics required to make it sustainable and improving efficiency. Development of NRMM emissions inventory with Emissions Analytics.



Faraday Challenge

£246 million investment from the Industrial Strategy Challenge Fund towards development of batteries for automotive applications. Also promotes jobs within the automotive sector.



KEY FINDINGS 2019

Three megatrends to drive industry forward, but all drivers are accelerating. 12 themes have and will transform the industry through the next decade...



Sustainability

Equipment must be considered as part of a productive, sustainable system. Near zero and zero tailpipe emissions equipment and alternative fuels will broaden product ranges further. Decarbonisation will be a driver in some segments, to meet CSR and LEZ requirements.



Productivity

Productivity improvements will require collaboration between OEMs, customers and government. Digitalisation will be a foundation, but competitiveness of the construction sector will also be critical.



Skills

Skills development will need to focus on a wider range of skills, with digitalisation, servification*, autonomy and electrical machines requiring IT skills over and above mechanical skills.

*Servicification (sometimes referred to as servitisation), is the shift away from product centred sales to product-centric services - which deliver 'value in use'.

CONCLUSIONS - OPPORTUNITIES FROM TECHNOLOGY DEVELOPMENT

Targeting combined process, operational and machine efficiency improvements will require further investment in technology and skills. But at the same time it offers additional revenue streams for OEMs and their supply chain.

A potential evolution of machines is illustrated here.

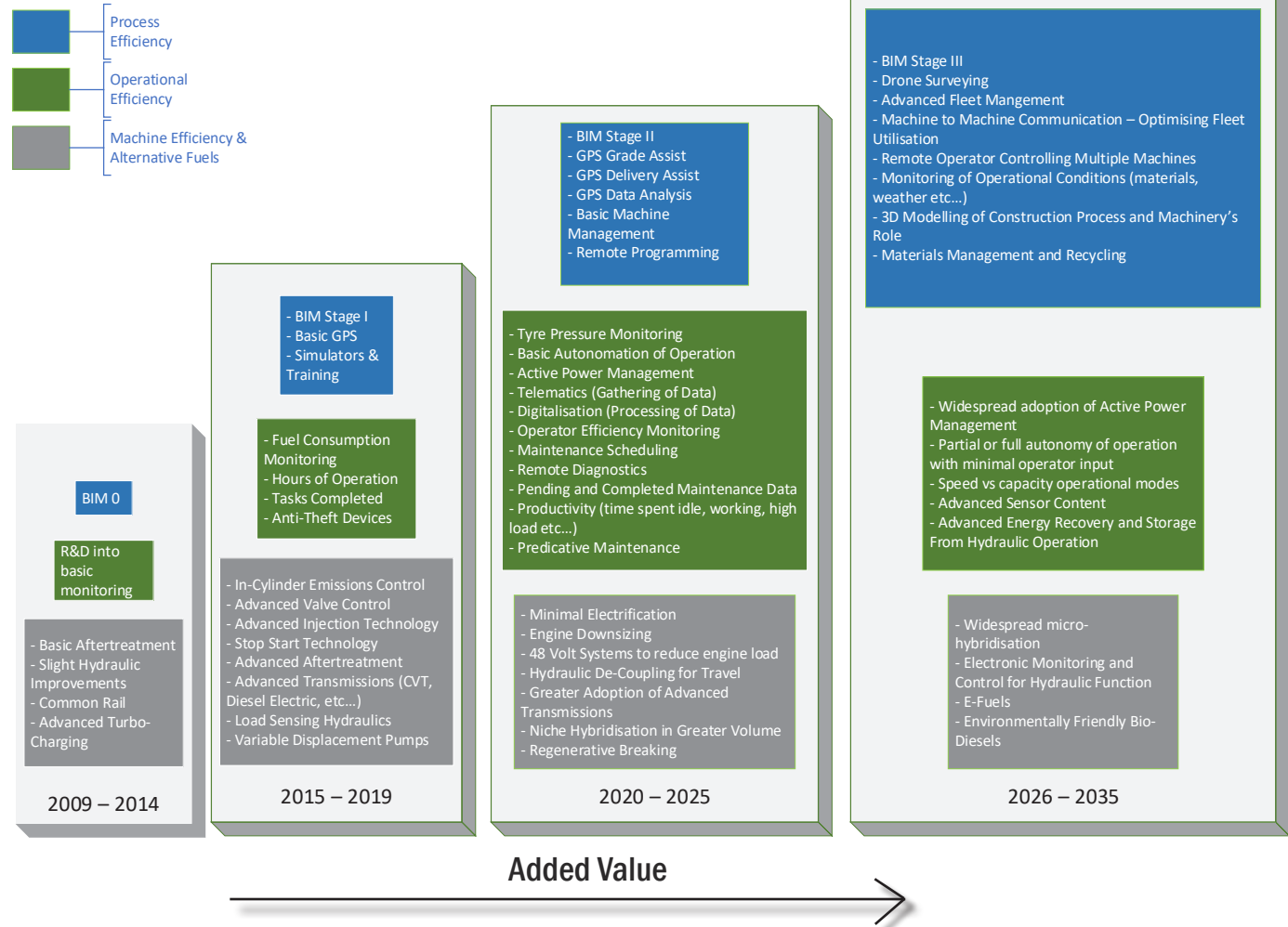
In 2009, the vast majority of investment, time and budget throughout the supply chain; was spent on improving machine emissions and efficiency. New features included advanced electro-hydraulics, exhaust after-treatment solutions and in-cylinder emissions controls. However in 2019 onwards the focus of investment is changing and embracing new technologies that are only just beginning their development curve in 2018/9.

In the period 2020-2025, we see significant investment into operational efficiency aids, primarily in the form of advanced telematics - in addition the alternative fuels development curve is starting to rise quickly.

In the long term future, the most investment will be in process efficiency tools, which are tools that bring all technology on the job-site, the machine and the operator into communication and best possible practice.

It should be evident that the construction equipment sector is becoming increasingly complex, adding value for many established and new stakeholders in the supply chain.

FIGURE 37 - OPPORTUNITIES FOR TECHNOLOGY DEVELOPMENT



Source: KGP analysis

CONCLUSIONS - MACHINE INFRASTRUCTURE INTEGRATION

The importance of communication and collaboration between services providers is going to be critical to a sustainable, competitive and efficient future UK construction equipment sector.

There is an abundance of evidence highlighting the potential benefits of the key technologies: - automation and telematics. These services will be interlinked with the key drivers in the global marketplace. Without continually greater communication and collaboration between stakeholders, equipment and infrastructure the full benefits are unlikely to be recognised.

Telematics, for example, feeds data that can be analysed and converted to information that ultimately adds value, throughout the value chain.

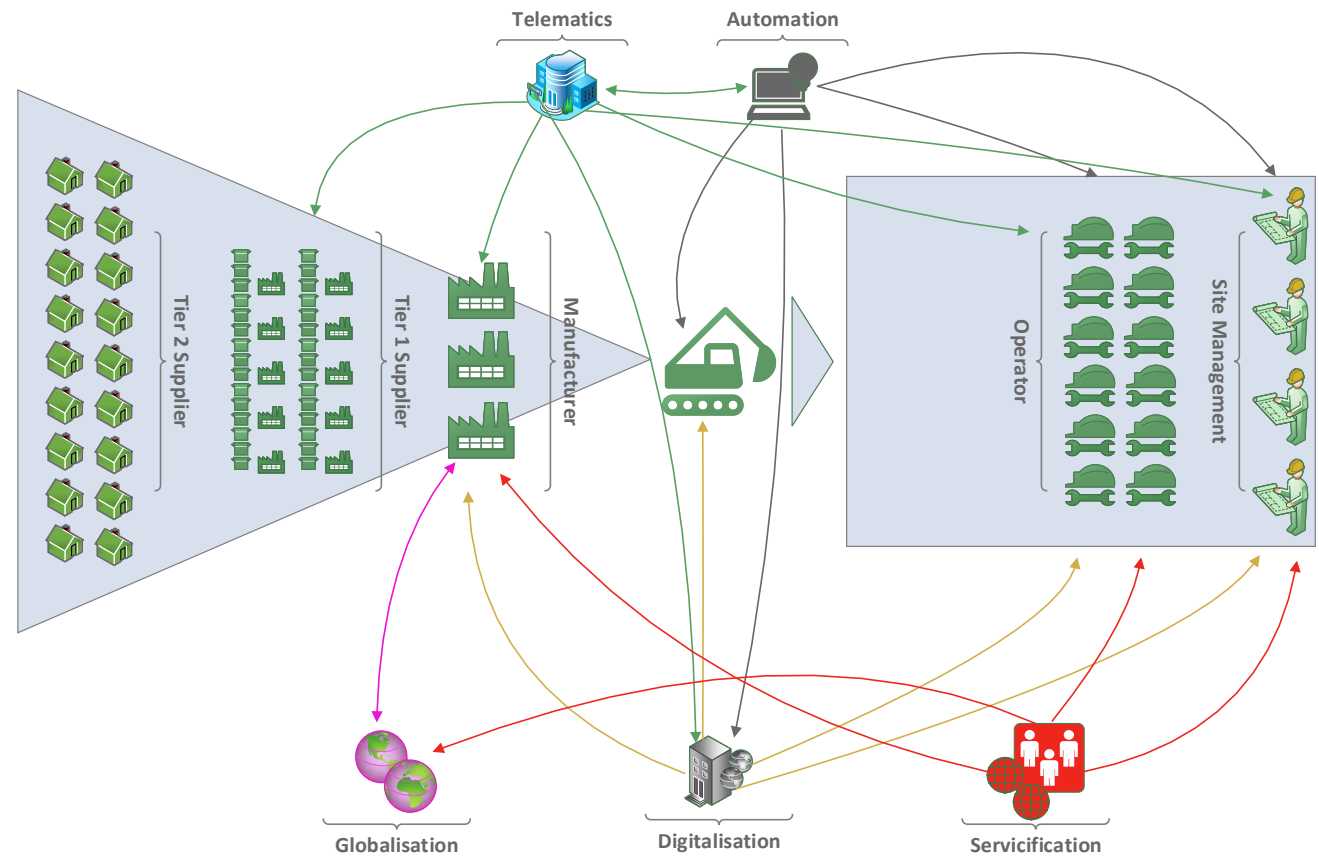
Without communication and sharing between all parties within this chain, validation and analysis of key telematics data cannot help to provide efficiency improvements in the construction industry.

Consideration therefore needs to be given to:

- Common platform delivery;
- Data ownership;
- Public availability of data;
- Integration with BIM;
- Operator training.

The highest efficiency gains will require global reach and post BREXIT co-operation agreements will have to include services, not just goods.

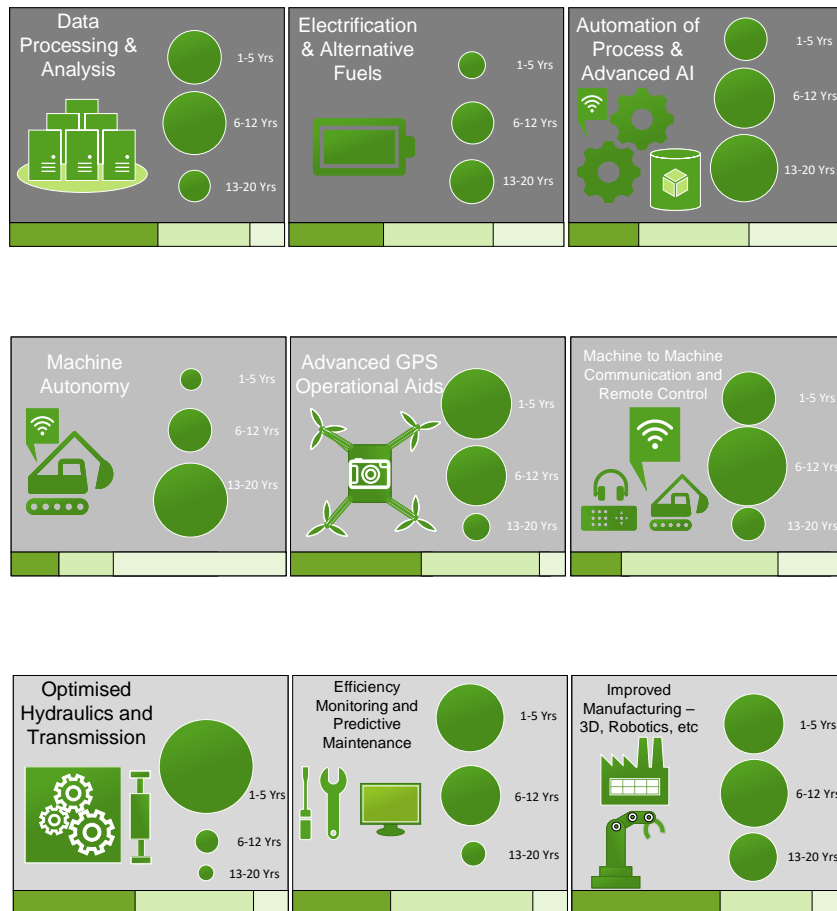
FIGURE 38 - MACHINE INFRASTRUCTURE INTEGRATION



Source: KGP analysis

CONCLUSIONS - TECHNOLOGY ROADMAP

FIGURE 39 - TECHNOLOGY ROADMAP



Source: KGP analysis



A number of technologies will be adopted to meet future efficiency and sustainability goals.

Each technology comes with a number of important considerations. Widespread electrification, for example, is unlikely in the short term. However for lower powered or niche applications the shift could be much quicker. Therefore the analysis here provides merely a high level of:

1. What the key technology items are
2. What is the potential timing for widespread adoption for each?
3. What is the ability of the UK construction sector to develop these for the domestic market?

Many are already in low volume production, and most may be adopted rapidly over the next 5-10 years, despite the often conservative nature of machine buyers and rental companies:

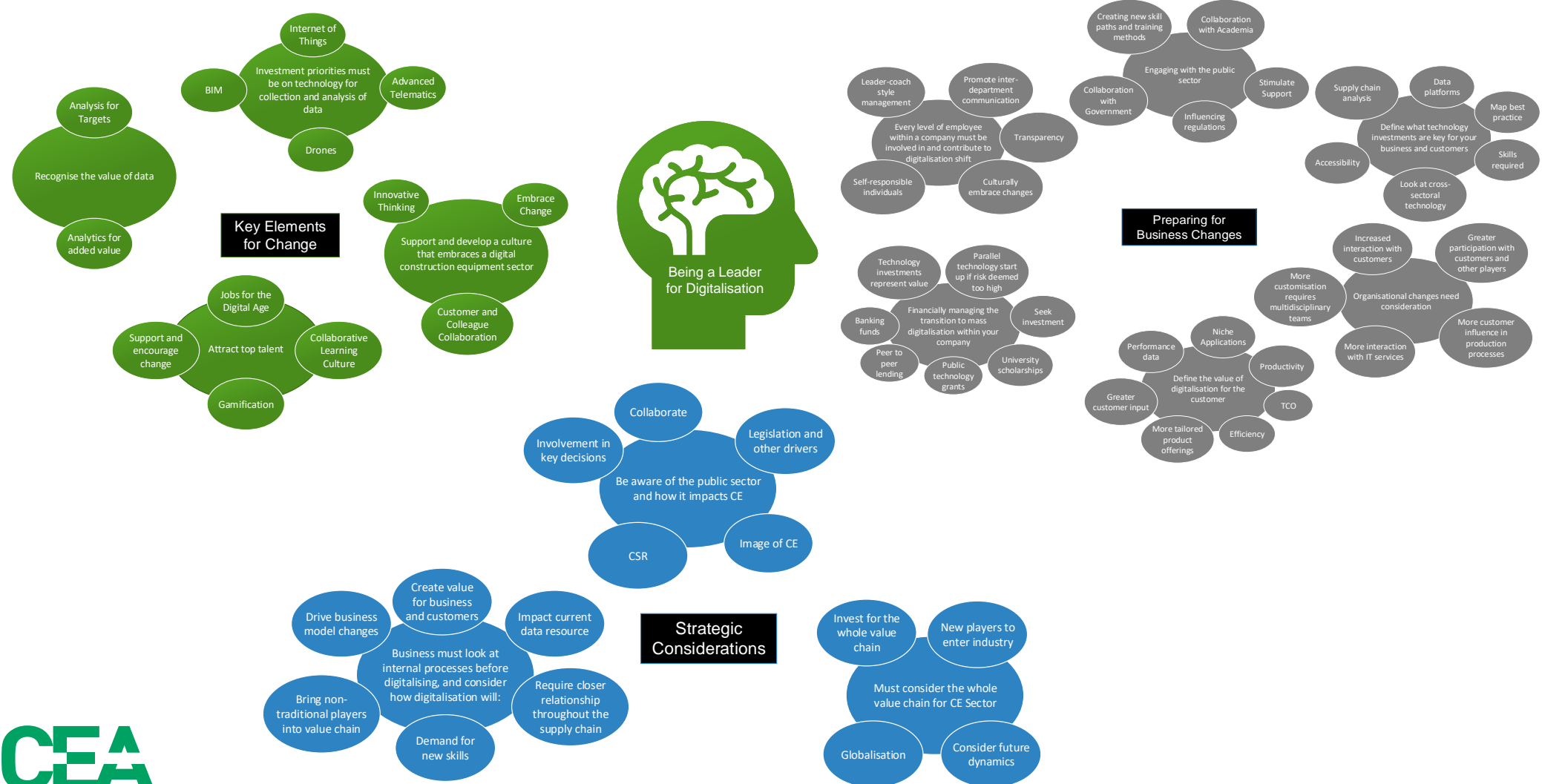
- Data analysis & Processing (advanced telematics and the proper use of the resulting data)
- Advanced GPS and Operational Aids (drones, geographical mapping etc... giving machines and operators the most information possible in order for them to control the machinery in the most efficient way.
- Optimised Hydraulics and Transmissions (using the most efficient powertrain components for each given task)
- Efficiency Monitoring & Predictive Maintenance (minimising downtime to maximise profits and efficiency of the job-site)

It is a positive that all these items are reasonably well covered by UK suppliers current capabilities. However it future technologies such as Machine to Machine communication, Automation of Process and AI, and Machine Autonomy where investment in UK skills is necessary. These items are all heavily influenced by the IT sector, and it is likely new players without historic customers in the construction equipment sector will enter the market as these opportunities mature. Attracting top talent straight into the UK sector is a primary challenge for development and benefit maximisation of these 'future technology items'. However, are gamification and trying to glamorise the construction industry enough?

DIGITALISATION LEADERSHIP

It should be fairly clear that for all stakeholders the future of the construction equipment sector is going to require different business models, strategic thinking and change to meet the future demands of its customers.

FIGURE 40 - DIGITALISATION STRATEGIC CONSIDERATIONS



Source: KGP analysis

NEXT PAGE

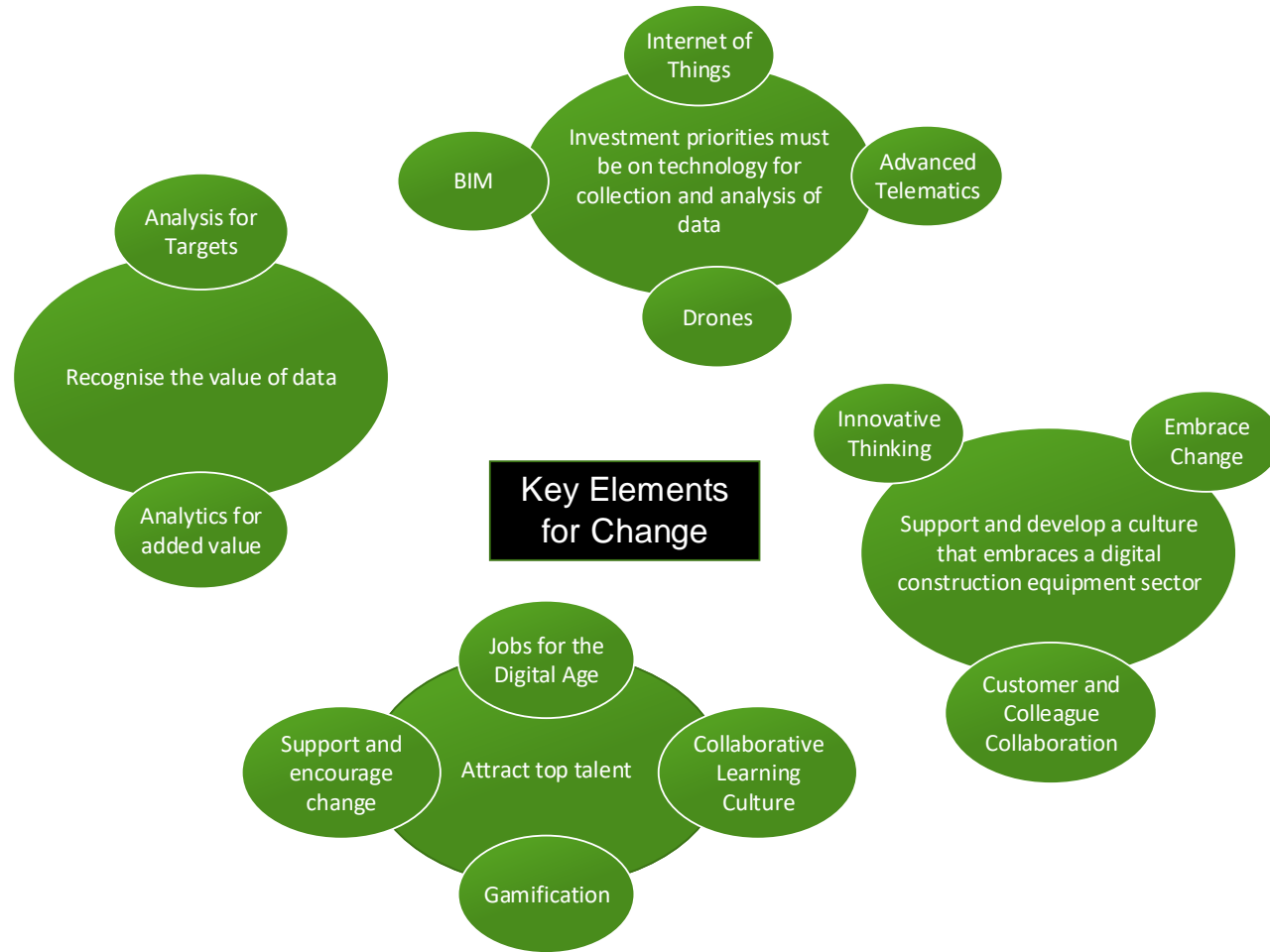
APPENDICES

DIGITALISATION LEADERSHIP



Source: KGP analysis

DIGITALISATION LEADERSHIP



Source: KGP analysis

DIGITALISATION LEADERSHIP



Source: KGP analysis

SOURCES

- 1 Companies House <https://www.gov.uk/government/organisations/companies-house>
- 2 Off-Highway Research European Service <https://offhighwayresearch.com/Geographic-Coverage/Europe>
- 3 World Bank <http://www.worldbank.org/en/publication/global-economic-prospects>, 2019
- 4 Construction Sector Deal, <https://www.gov.uk/government/publications/construction-sector-deal>, 2018
- 5 UK Construction Margin Pressure, Ernst Young, - <https://www.ey.com/uk/en/industries/real-estate>
- 6 Modern Industrial Strategy, <https://www.gov.uk/government/topical-events/the-uks-industrial-strategy>, 2018
- 7 National Infrastructure Delivery Plan, <https://www.gov.uk/government/collections/national-infrastructure-plan>, 2013
- 8 Optimising our industry 2 reduce emissions, CECE, <https://www.cece.eu/news/new-brochure-cece-and-cema-optimising-our-industry-2-reduce-emissions>, 2018
- 9 Digitalising the Construction Sector, CECE, <https://www.cece.eu/industry-and-market/digital-machines>, 2019
- 10 The European Construction Industry Manifesto for Digitalisation, CECE, <https://www.cece.eu/industry-and-market/digital-machines>, 2018
- 11 BP Energy Outlook, BP 2019, <https://www.bp.com/en/global/corporate/energy-economics/energy-outlook.html>, 2019
- 12 KGP Non-Road Powertrain Forecast xEV Update Q2 2019, <https://www.kgpauto.com>
- 13 Committee on Climate Change Net Zero Report, <https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/>, 2019
- 14 Volvo Construction Equipment X-Electric site, <https://www.volvoce.com/global/en/this-is-volvo-ce/what-we-believe-in/innovation/electric-site/>, 2019
- 15 Technology Roadmap for UK Construction and National Infrastructure, <https://www.i3p.org.uk/wp-content/uploads/2017/07/i3P-CI-Technology-Roadmap-Booklet-FINAL.pdf>, 2018

DEFINITIONS

- ADT/RDT – Articulated/Rigid Dump Truck
- AG – Agricultural machinery
- BEV – Battery Electric Vehicle
- BHL – Backhoe Loader
- BIM - Building Information Model
- CAGR – Compound Annual Growth Rate
- CECE - European Construction Manufacturers Association
- CEMA – European Agricultural Equipment Manufacturers Associations
- CON – Construction Equipment
- CREX – Crawler Excavator
- CSR – Corporate Social Responsibility
- CV – Commercial Vehicle
- DOC – Diesel Oxidation Catalyst
- DPF – Diesel Particulate Filter
- EGR – Exhaust Gas Recirculation
- FCEV – Fuel Cell Electric Vehicle
- GHG – Green House Gases
- GHG – Greenhouse Gas (CO₂, CH₄ etc.)
- HCCI – Homogenous Charge Compression Ignition
- ISC/ISM – In-service Compliance/Monitoring
- LEZ – Low Emission Zone
- MEX – Mini Excavator
- MH – Materials Handling Equipment
- NRMM – Non-Road Mobile Machinery
- OBD – Onboard Diagnostics
- PHEV – Plug-in Hybrid Electric Vehicle
- RCCI – Reactivity Control Compression Ignition
- SCR – Selective Catalytic Reduction
- SSL/CTL – Skid-Steer Loader/Compact Track Loader
- TCO – Total Cost of Ownership
- TIV – Total Industry Volume
- TOE - Tonnes of Oil Equivalent
- TTW – Tank to Wheel
- V2V – Vehicle to Vehicle Communication
- VECTO – Vehicle Energy Consumption Calculation Tool
- WHL – Wheeled Loader
- WTW – Well to Wheel
- ZEZ – Zero Emission Zone

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Researched and Authored by James Dorling and Alex Woodrow, Knibb, Gormezano and Partners W: www.kgpauto.com

Tel: +44 (0)20 8253 4502

E: cea@admin.co.uk W: www.thecea.org.uk

Postal address/Registered Office: Unit 19, Omega Business Village, Thurston Road, Northallerton, North Yorkshire, DL6 2NJ, United Kingdom

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