Low Carbon Environmental Goods and Services Sector Study 2024: Brief Methodology Document

This document includes an overview of the LCEGS sector and methodology.

Contents

Study Overview in Brief

This market intelligence study provides quantification of the Low Carbon Environmental Goods and Services sector for the Midlands Net Zero Hub, Regions and local authorities.

It is not intended as a policy document but provides data in evidence through a snapshot of the market across a 3-year period, to be used alongside other studies and market intelligence reporting.

The intension of the study is not to answer every question, but to be a tool to understand what is present in the MNZH, from which to build further capacity. The dataset and reporting has been designed to provide data in evidence, to answer as many questions as possible within the study boundaries, and to provide data at a level of granulation to enable it to answer most questions not yet asked, e.g., it will provide detail on some aspects of the Circular Economy, such as waste and recycling, but doesn't measure the entire ecosystem.

What the dataset measures

The data provides a snapshot of the market for goods and services which improve the environment and/or actively assist in the move to net zero. It measures the goods and services regardless of *where* they are used, e.g., solar panels on a hospital roof are included

What the dataset does not measure

It does not count those activities which the green economy is *applied to,* e.g., the hospital needs to use the solar panels to reach net zero, but the LCEGS dataset does not count the surgical team within healthcare

A good analogy is Cybersecurity, which was a niche market 25 years ago, until awareness and need grew. It is now relevant to some extent across every aspect of society, with every online activity having some element of cybersecurity embedded, but not every activity is counted as cybersecurity. Likewise, elements of the LCEGS sector need to be applied to the whole economy, but the whole economy is not counted in the LCEGS sector.

LCEGS Concept

Within LCEGS and this study, the dataset measures those products and services needed to reach net zero targets and other environmental activities, such as waste water treatment etc.

LCEGS Summary Sector Definition

The Low Carbon Environmental Goods and Services sector comprises products and services from across the economy, which actively enable a shift towards a green economy. The LCEGS sector is considered an 'umbrella' or horizontal sector, crossing many other traditional sectors, counting products and services from those sectors which can reduce carbon emissions and improve the environment:
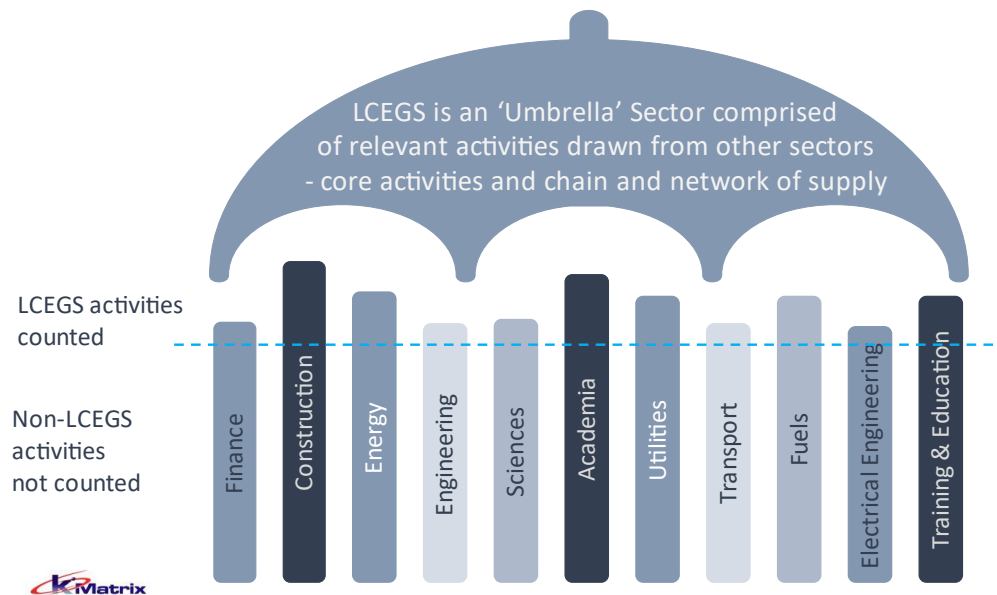
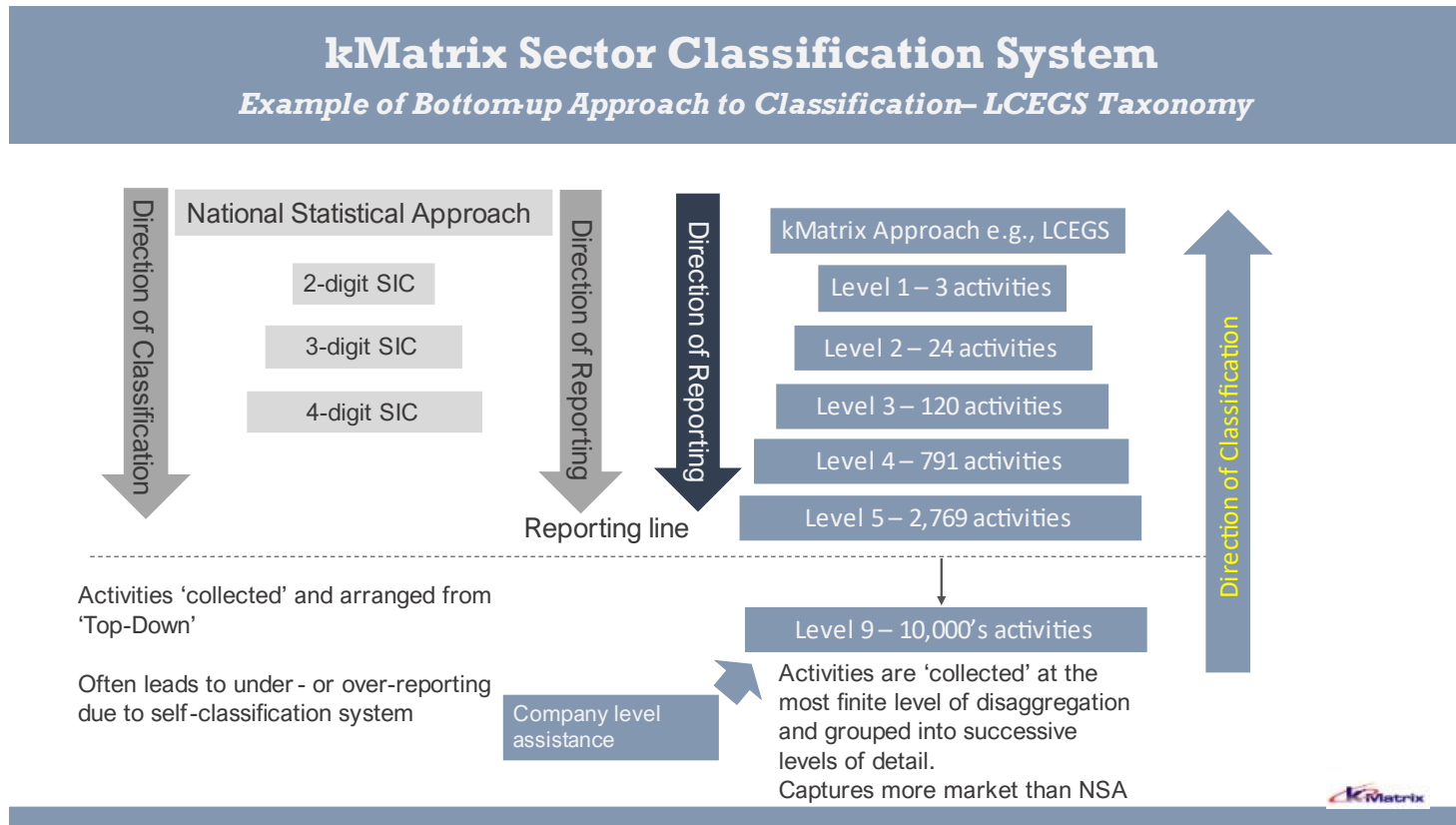The sector is comprised of both core elements and those in the chain and network of supply, without whom the sector could not function.

Brief Methodology

kMatrix uses a unique data triangulation methodology, developed with Professor R. Jaikumar of Harvard University over 35 years ago.

The process was originally developed to look at individual companies, providing evidenced data for development. As such, sectors are

classified from the 'bottom up', collecting activities from the most finite level of granulation and grouping them into successive levels of detail.

kMatrix Sector Classification System

Example of Bottom-up Approach to Classification– LCEGS Taxonomy

National Statistical Approach
- 2-digit SIC
- 3-digit SIC
- 4-digit SIC

Direction of Classification

Direction of Reporting

Direction of Reporting

Reporting line

Activities 'collected' and arranged from 'Top-Down'

Often leads to under - or over-reporting due to self-classification system

Company level assistance

kMatrix Approach e.g., LCEGS
- Level 1 – 3 activities
- Level 2 – 24 activities
- Level 3 – 120 activities
- Level 4 – 791 activities
- Level 5 – 2,769 activities
- Level 9 – 10,000's activities

Activities are 'collected' at the most finite level of disaggregation and grouped into successive levels of detail.
Captures more market than NSA

Direction of Classification

This is quite different to the National Statistical Approach, which classifies from the 'top down', with a company choosing their 2-digit code, then successive codes down through the classification system. The SIC system is very good as a national accounting system, but it struggles with hard to measure sectors such LCEGS. Here, the kMatrix system of data collection, which triangulates transactional data from many sources, over 80,000 for this study, provides the flexibility of a definition tailored to the sector being studied. Although the sector is classified from the bottom up, the sector taxonomy is reported from the sector level down, through a series of levels of complexity.

This process has measured the LCEGS sector for the Greater London Authority and the UK for over a decade. kMatrix also collaborate with academic colleagues in several fields, co-authoring academic papers, which are peer-reviewed and published in academic journals including Nature, Climate Services and the Lancet.

Example sectors the process has been applied to, where evidence is available in the public domain via published peer-reviewed academic journals include:

- Carbon Finance – Nature (2012)

- Adaptation Economy – Nature (2016)

- Weather and Climate – Science Advances (2017)

- The Green Economy – Geo: Geography and Environment (2017)

- The Green Economy – Nature (2019)

- Climate Services – Climate Services (2020)

- Adaptation and Resilience to Climate Change – The Lancet (annually 2017-2021)

The Lancet Countdown is a global collaboration of academics and represents the consensus of 43 academic institutions and UN agencies and has used the kMatrix A&RCC dataset for annual updates since 2017.

The LCEGS Dataset

The data used in this report is based upon the work and methodology used by kMatrix to provide datasets on the UK's Low Carbon Environmental Goods and Services (LCEGS) sector for UK Government reported annually by the Department for Business, Innovation and Skills (BIS) from 2008/09 to 2011/12 and further reported every 3 years for the UK and London by the Greater London Authority to 2017/18, representing a continuous annual timeseries of the LCEGS sector for over a decade.

The LCEGS sector has been defined using 24 sub-sectors (or Level 2 markets) grouped into three broad categories (or Level 1 markets) - Environmental, Renewable Energy and Low Carbon. The addition of the Renewable Energy and Low Carbon groupings illustrates the evolution of the current LCEGS sector definition from its original Environmental roots and reflects developments in the market as sectors across the economy evolve to address the environmental challenges that they and the world is facing.

The dataset measures the core activities of the sector along with those in the supply chain, without whom the LCEGS sector could not operate. For example, the Wind sector includes those companies which develop the systems integration software enabling the power generated though turbines to be integrated into the National Grid, but it also includes those companies installing and maintaining the system integration software itself. Another example would be the collection of household waste, where the collection, processing and recycling of the waste is included, along with those companies who design, manufacture and supply the waste collection equipment itself.

The UK time series provides 11 years of sales, companies and employment data and 10 years of growth rates for the LCEGS sector as a whole. The data is then broken down into three Level 1 sub-sectors (Low Carbon, Environmental and Renewable Energy) and then those three sub-sectors are split into further Level 2 sub-sectors to provide greater resolution and insights for analysing the data.

The kMatrix methodology is based around the production of a taxonomy, similar to that used for biological taxonomic ranking, with similar products and services being grouped together. In Table 1, the LCEGS sector is broken down into three Level 1 sub-sectors, one of which is Renewable Energy, which is in turn broken down into seven Level 2 sub-sectors, one of which is Wind, that is then broken down into a further three Level 3 sub-sectors, then Level 4 and so on:

Table 1: LCEGS Sector disaggregated into the first two levels:

Sector	Level 1	Level 2	Level 3	Etc.
LCEGS	Low Carbon	Additional Energy Sources	9 sub-sectors	Etc.
		Alternative Fuel Vehicle	2 sub-sectors	Etc.
		Alternative Fuels	5 sub-sectors	Etc.
		Building Technologies	4 sub-sectors	Etc.
		Carbon Capture & Storage	11 sub-sectors	Etc.
		Carbon Finance	5 sub-sectors	Etc.
		Energy Management	6 sub-sectors	Etc.
		Nuclear Power	7 sub-sectors	Etc.
	Renewable Energy	Biomass	5 sub-sectors	Etc.
		Geothermal	5 sub-sectors	Etc.
		Hydro	4 sub-sectors	Etc.
		Photovoltaic	5 sub-sectors	Etc.
		Renewable Consultancy	2 sub-sectors	Etc.

		Wave & Tidal	6 sub-sectors	Etc.
		Wind	3 sub-sectors	Etc.
	Environmental	Air Pollution	6 sub-sectors	Etc.
		Contaminated Land	2 sub-sectors	Etc.
		Environmental Consultancy	4 sub-sectors	Etc.
		Environmental Monitoring	3 sub-sectors	Etc.
		Marine Pollution Control	3 sub-sectors	Etc.
		Noise & Vibration Control	3 sub-sectors	Etc.
		Recovery and Recycling	18 sub-sectors	Etc.
		Waste Management	4 sub-sectors	Etc.
		Water & Waste Water Treatment	4 sub-sectors	Etc.

Although the taxonomy is reported and organised 'top down' as it goes from the sector to Level 1, to Level 2 etc., the data is gathered and organised from the 'bottom up'. The data is collected at the most finite disaggregation and then 'rolled up' to form the different levels. The current LCEGS sector definition, used in this section of the report, includes 2,769 product and service activities at level 5 that are derived from sector supply chain activities (componentry & assemblies) and value chain activities (R&D, Supply & Training).

A glossary of economic activities included for each sub-sector of LCEGS is included as Appendix 1, a brief explanation of the LCEGS methodology as Appendix 2 and then a high-level comparison of data and methodologies between the Office of National Statistics (ONS) Environmental Goods and Services sector and LCEGS is presented in Appendix 3.

What is actually measured?

The dataset measures the core activities of the sector along with enabling activities in the supply chain, without whom the LCEGS sector could not operate. For example, the Wind sector includes those companies which develop the systems integration software enabling the power generated though turbines to be integrated into the National Grid, but it also includes those companies installing and maintaining the system integration software itself. Another example would be the collection of household waste, where the collection, processing and recycling of the waste is included, along with those companies who design, manufacture and supply the waste collection equipment itself.

The purpose of the LCEGS dataset in its original form, is to provide a standardized measure of the complete LCEGS sector. The whole dataset includes those 'core' activities, which would immediately come to mind such as the manufacture of a wind turbine blade, but
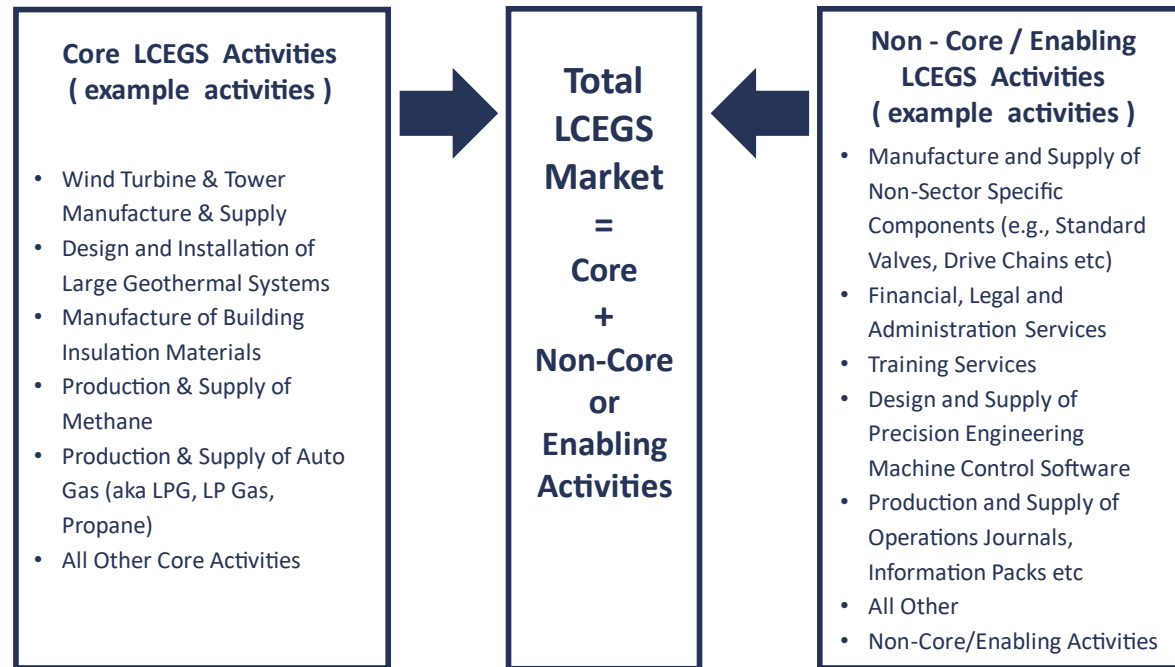
also the less obvious 'non-core' activities, such as the manufacture of the bearings for the turbine. Non-Core activities can be considered "enablers" for the Core sector and are often companies who have diversified from existing strengths into new sector activities. Non-core activities also include mid-stream activities, R&D, finance, training and other activities which cross multiple other sectors, but without which the LCEGS sector could not function.

$$\boxed{\text{Total LCEGS Market}} = \boxed{\text{Core LCEGS Market}} + \boxed{\text{Non-Core Enabling LCEGS Market}}$$

The definition of a sector is almost always open to debate, in terms of what is, or is not, considered to be part of the sector in question. The kMatrix methodology includes all aspects that could realistically be considered part of the LCEGS sector, within the bounds of the original 2007/08 definition. The taxonomy is built and interrogated by assembling activities and services which are then grouped together under different headings.

The following picture illustrates the two distinctive sides of the LCEGS market, the smaller Core market and the much larger Non-Core market, provided by enablers within the LCEGS sector. Examples give a simplistic overview of the types and differences between activities, with the Core side including activities such as manufacture of wind turbines and building insulation materials. The enablers providing Non-Core activities are offering components that are non-sector specific, such as valves, gaskets, drive chains etc., alongside financial, legal and administration activities.

In essence, Core activities are those products and services which are generally LCEGS specific, whereas the Non-Core activities, provided by enablers are products and services which are not LCEGS specific and can generally be found in other sectors. Core activities are considered vertical in nature, being sector specific, whereas Non-Core activities are horizontal, crossing other sectors. Both sides of the market are required for the sector to function.

Core LCEGS Activities (example activities)	Total LCEGS Market = Core + Non-Core or Enabling Activities	Non - Core / Enabling LCEGS Activities (example activities)
• Wind Turbine & Tower Manufacture & Supply • Design and Installation of Large Geothermal Systems • Manufacture of Building Insulation Materials • Production & Supply of Methane • Production & Supply of Auto Gas (aka LPG, LP Gas, Propane) • All Other Core Activities		• Manufacture and Supply of Non-Sector Specific Components (e.g., Standard Valves, Drive Chains etc) • Financial, Legal and Administration Services • Training Services • Design and Supply of Precision Engineering Machine Control Software • Production and Supply of Operations Journals, Information Packs etc • All Other • Non-Core/Enabling Activities

The economic values provided are Sales values, which are transactions made within the sector, which have an economic footprint that can be measured. For companies which service multiple sectors, for example in finance, the sales value is the value of sales that company has in the LCEGS market, it does not include finance sales into other sectors.

Sales values are Nominal and have not been adjusted for inflation. This allows consistency in the dataset over time and enables economists to overlay their own interpretations or calculations as required.

Skills Demand Analysis

This element of the study identifies current levels of employment, per Standard Occupational Classification, identifying sills gaps that are present in the sector and sub-sectors, and then estimate the skills requirements in employees needed to achieve net zero targets for 2030 and 2050.

The employment figures relate to those employed within the LCEGS sector, who are providing the goods and services to the wider economy to reach net zero, they do not include employees, such as sustainability officers from sectors within the wider economy, who then apply them in their own companies.

> **Note:** Forecasts for skills within the context of Net zero 2030 and 2050 targets are triangulated from industry forecasts, which are informed by targets such as the CCC's Balanced Pathway, during their forecasting process. As such, additional scenarios or assumptions have not been overlaid within this study, to avoid multiple-allocation of increased scaling of the workforce.

> They are regionally focused and represent the employment specifically within the LCEGS sector expected to be required for the region to reach net zero by 2030 or 2050.

> Additional policy, such as large infrastructure projects have not been applied to these forecasts, rather they are a baseline of expected growth required within the LCEGS sector workforce, to deliver products and services to the wider economy, for which LCEGS-specific activities will be relevant.

It is difficult to untangle the impact of Covid and the impact of Brexit on the LCEGS sector and for the purposes of this study, we have not attempted to do so. Although there was support for business during the pandemic, many people and businesses postponed work during that time. Additionally, the financial situation since the pandemic has increased uncertainty regarding forecasting. Despite these pressures, there is a large section of the LCEGS sector that will always function, for example waste will be collected, water purified, electricity produced etc.

It is anticipated that the sector will not be affected as much as some areas of the economy, partly due to large sections being a necessity and partly with not just the political will, but more so the social and environmental emphasis around the need to tackle climate change and get to net zero.

Due to the uncertainty surrounding the current and future economic performance of the UK (and global) economy, the forecasting estimates have been produced on a high – low range to account for the unpredictability within the economy.

As such, the forecasts are a potential growth range, i.e., forecast employment in LCEGS for regional 2030 net zero targets ranges from 209,154 to 325,124, depending on the strength and growth of the wider economy.

Whilst initially counterintuitive, the number of employees required to reach net zero will be larger in a stronger economy than in a weaker one, as the effort required to decarbonize will increase with the expansion of the whole economy.
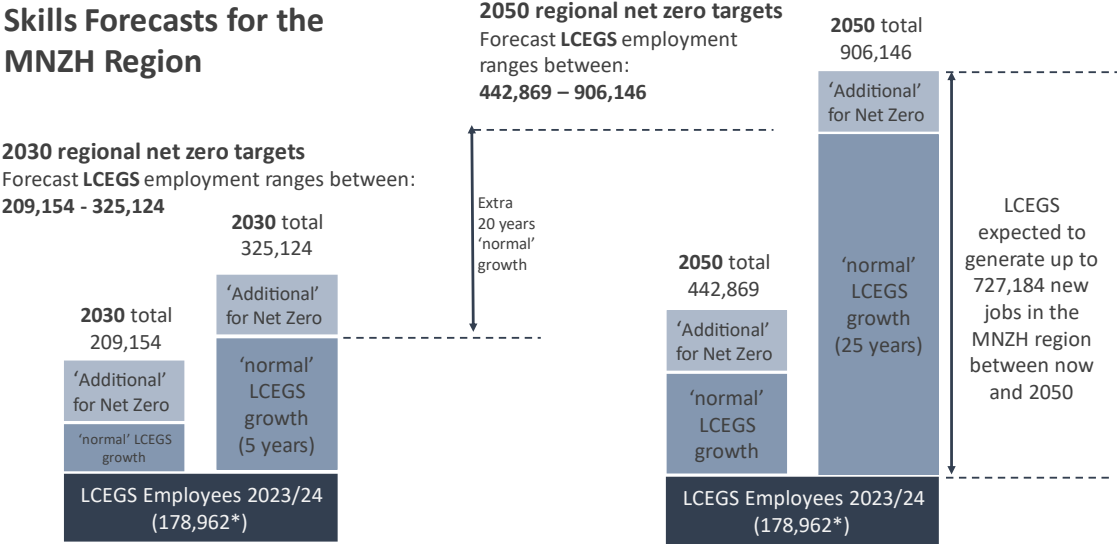
Note on Forecasts: Forecasts within this study are not kMatrix scenarios, they are a triangulation of scenario-planning undertaken by industry and represent an indication of the likely trajectory of sales and employment from the perspective of industry.

There have been no assumptions overlaid regarding GDP growth, as this is factored into the scenario-planning of industry and so already applied within the sources.

Employment forecasts are a range of potential employment expected within industry. They do not represent an 'ideal scenario' and do not start from a transition pathway.

They are not an indication of what the MNZH needs to do to reach net zero, as they don't include roles such as sustainability officers. Instead, they provide an indication of employment needed to produce the equipment, products and services required for net zero, which the sustainability officer would use.

They are the products and services, including the chain and networks of supply needed to reach net zero alongside the other activities within LCEGS which are not net zero oriented.

Skills Forecasts for the MNZH Region

2030 regional net zero targets
Forecast **LCEGS** employment ranges between:
209,154 - 325,124

2050 regional net zero targets
Forecast **LCEGS** employment ranges between:
442,869 – 906,146

2050 total
906,146

'Additional' for Net Zero

2030 total
325,124

'Additional' for Net Zero

Extra 20 years 'normal' growth

LCEGS expected to generate up to 727,184 new jobs in the MNZH region between now and 2050

'normal' LCEGS growth (25 years)

2030 total
209,154

'Additional' for Net Zero

2050 total
442,869

'Additional' for Net Zero

'normal' LCEGS growth (5 years)

'normal' LCEGS growth

'normal' LCEGS growth

LCEGS Employees 2023/24 (178,962*)

LCEGS Employees 2023/24 (178,962*)

*Lower value than sector total due to some employees in Micro and SMEs being difficult to allocate to SOC codes. LCEGS sector = high proportion of Micro and SMEs.

kMatrix

kMatrix

The growth forecasts for both 2030 and 2050 begin with the same baseline LECGS employment figures for 2022/23, illustrated by the same dark blue base layer in the diagram.

The normal growth in the LCEGS sector that will increase between 2024 and 2030 or 2050 sits on top of that base and has the greatest effect on the growth of the employment numbers. The effect of normal sector growth is more significant for the 2050 target than the 2030 target due to an additional 15 years of normal growth. The extent of growth is determined by the strength of the UK economy as a whole over time.

On top of that initial employment growth there is also additional employment required to develop the sector's capacity to achieve net zero. In this diagram, the additional employment section is sized the same for both targets. This is to emphasise that to reach net zero by 2030 would require *relatively* more people with less technology, whereas by 2050, the combination of streamlined processes, new technologies, technology compression and changes in working practices are likely to lead to a situation requiring *relatively* fewer people combined with improved technology and processes. In addition, whilst the transition to net zero will create significant jobs within MNZH region, many of the jobs will be in traditional 'non-LCEGS' sectors, such as construction, which are not captured here.

In essence, most of the employment growth is likely to be a consequence of traditional sector growth, resulting in a higher number of employees in 2050 than 2030, regardless of the impact of net zero targets. The LCEGS sector will not stand still during decarbonisation and the transition to a low carbon and circular economy as new technologies and processes will be developed, and the wider economy will continue to grow.

Decarbonisation will not be linear, the quicker it is achieved, the more people are likely to be needed, however, the longer it takes, the more opportunity there is for technology to make a greater impact. But in reality, the additional employment component of growth required in pursuit of net zero is more nuanced and varies between sub-sectors and geographical area.

Appendix 1: LCEGS Sector Definition

The **Low Carbon and Environmental Goods and Services** (LCEGS) is divided into three Level 1 sub-sectors - Environmental, Renewable Energy and Low Carbon. These are in turn divided into 24 Level 2 sub-sectors:

- The Environmental sub-sector is made up of the following: Air Pollution Control, Contaminated Land Reclamation & Remediation, Environmental Consultancy, Environmental Monitoring, Marine Pollution Control, Noise & Vibration Control, Recovery & Recycling, Waste Management and Water Supply & Waste Water Treatment
- The Renewable Energy sub-sector is made up of the following: Biomass, Geothermal, Hydro, Photovoltaic, Renewable Energy Consultancy, Wave & Tidal and Wind
- The Low Carbon sub-sector is made up of the following: Additional Energy Sources, Alternative Fuels & Vehicles, Alternative Fuels, Building Technologies, Carbon Capture & Storage, Carbon Finance, Energy Management and Nuclear Power

Environmental activities include 9 Level 2 sub-sectors, divided into 47 Level 3 activity groupings:

- Air Pollution includes indoor and industrial air quality and emissions control.
- Contaminated Land Reclamation/Remediation includes Decommissioning of Nuclear Sites.
- Environmental Consulting includes consulting, training & other services.
- Environmental Monitoring includes analysis, monitoring and instrumentation.
- Marine Pollution and Noise & Vibration Control both include abatement, consulting and R&D.
- Recovery & Recycling includes Waste Collection and various recycling processes
- Waste Management includes Waste Treatment Facilities & Equipment, consulting and R&D
- Water Supply and Waste Water Treatment includes treatment, distribution, consulting and R&D.

Low Carbon includes 8 Level 2 sub-sectors, divided into 49 Level 3 activity groupings:

- Carbon Finance includes Credits Finance, Fund Management, Trading and Research
- Carbon Capture & Storage includes Capture, Pipeline, Storage and Engineering.
- Energy Management includes Lighting, Heating & Ventilation and Engineering.
- Nuclear Power includes Construction, Commissioning, Operations, Engineering and Testing Services.
- Additional Energy Sources include Energy Storage Research, Fuel Cells & Hydrogen.
- Alternative Fuels & Vehicles includes main stream and other vehicle fuels.

- Alternative Fuels includes Main Stream and other Bio Fuels, Batteries and Other Fuels.
- Building Technologies includes Doors, Windows, Monitoring & Control Systems and Insulation/Heat Retention Materials.

Renewable Energy includes 7 Level 2 sub-sectors, divided into 30 Level 3 activity groupings:
- Wind includes Large Turbines, Small Turbines and Wind Farm Systems.
- Wave & Tidal includes Ebb & Flood, Pumps & Equipment, Turbine & Generation etc.
- Photovoltaic includes Systems & Equipment, Cells and Chemicals.
- Hydro includes Turbines, Pumps, Electricity Supply and Dams.
- Geothermal includes Whole Systems, Specialist Equipment, Consulting and R&D.
- Biomass includes Energy, Furnace, Boilers and Related Systems.
- Renewable Energy consulting includes specialist consulting and legal advice.

Further detail on the Level 2 sub-sectors are provided below in their Level 1 groupings:

Environmental

Air Pollution Control sub-sector includes a wide range of manufacturing, operations, consulting and engineering functions that relate to improving and maintaining air quality. It includes:
- Emission Control sensing and monitoring systems and technologies.
- Indoor Air Quality Control (domestic and industrial) through ventilation, cooling and purification systems.
- Dust & Particulate control through installed technologies like filters, towers, scrubbers, cyclones and eliminators.
- Process Engineering for odour control and other cleaner technologies.
- Industrial Emission Control technologies and equipment (manufacture, installation, operations and maintenance).
- Emission Control through manufacture, installation and operation of sampling, control and evaluation systems.

Contaminated Land Reclamation and Remediation sub-sector includes all activities that bring land back into agricultural, industrial, community or commercial use. This includes longer term activities like the decommissioning of nuclear sites.

Remediation and land reclamation include land forming, bunds, geotextiles, storage & containment, oil interceptors, drainage systems, monitoring systems, proprietary treatment processes, sampling & analysis, site investigation, specialist cleaning services, cleaner technology R&D, surface & ground water services, organic waste composting and other services.

Decommissioning includes equipment, consulting, project management, safety critical assessment, pollution control, enviro risk analysis & impact assessment, recycling & compaction, waste collection & containment, waste water treatment, site assessment, excavation, sampling & analysis and monitoring.

Environmental Consulting and Services sub-sector includes consulting, training and management services that are specific to the environmental sector. It includes:
- Specialist consulting - habitat assessment, regulations, compliance and management systems, audits and impact assessment, eco design, eco-investment, climate change modelling, insurance and bio-diversity advice & assessment
- Manpower and executive recruitment, temporary and permanent recruitment, contracted and interim management services.
- Management services - general consulting, financial, IT, software and marketing services.
- Training and education - publications, online publications, teaching aids, newsletters and courses for waste management, waste water treatment etc.

Environmental Monitoring, Instrumentation and Analysis sub-sector includes activities that measure water, soil and air quality and that support wider pollution control activities in other land, water, marine or air- based environmental sub-sectors. It includes:
- Environmental monitoring- development of cleaner monitoring processes and technologies, vehicle testing, oil spill detection, food testing, nitrate levels, meteorological, water/soil/air quality testing and monitoring.
- Instrumentation equipment & control manufacture, supply, maintenance and development of instrumentation, laboratory equipment and software for environmental/ air/ water/ land/ marine analysis.
- Environmental analysis - laboratory testing, data logging & recording, quality reporting, collection & collation of samples, auto sampling systems, in-field measurement and reporting and R&D in water, soil and emissions analysis.

Marine Pollution Control sub-sector includes responses to pollution hazards at sea and also discharged from land-based sources. It includes the following products and services for deep sea, coastal waters and inland waterways. It includes:

- Marine pollution abatement - manufacture, supply and maintenance of booms, chemical discharge treatment equipment, solid & liquid waste/radioactive containment and treatment equipment and monitoring services, spillage clean-up services, shoreline & shallow water remediation and maintenance services and collection & containment services.
- R&D - cleaner processes and technologies, monitoring systems, oil absorbents, boom and containment systems, water containment and treatment technologies.
- Specialist consulting and training - chemical discharge prevention, education, policy & planning, training, publications, sewerage discharge management, radioactive waste management and solid and liquid waste management.

Noise & Vibration Control sub-sector includes all activities that prevent or control noise and vibration pollution. It includes:
- Noise abatement - manufacture, supply, installation and maintenance of barriers, acoustic management equipment, noise insulation, noise & vibration control and monitoring equipment, acoustic management equipment, noise insulation materials, monitoring services, large plant services and surface modifications.
- R&D - noise attenuation, noise sensing, vibration sensing, vibration control and noise & vibration abatement equipment and cleaner technologies and process by development.
- Consulting and training - consulting, publications, training and noise monitoring services.

Recovery & Recycling sub-sector includes all activities relating to the collection and processing of domestic and industrial waste products. It includes:
- Waste collection - manufacture, supply, installation and operation of equipment and services for collection of household, industrial and hazardous waste, treatment of waste prior to landfill and supply of pre-treated recyclates.
- Engineering & equipment - engineering services and process control for the complete range of recycling stock
- Consulting & training - collection and processing consultancy and training, publishing, legal & insurance advice.
- R&D - metals recovery, pyrolysis, bio-based systems, new recyclable materials, new collection & processing technologies.
- Recycling stock - recovery, recycling, processing, sorting, supply and packaging of rubber, plastics, paper, oil, electrical, electronics, glass, composting, construction & demolition, automotive, wood and textiles stocks.

Waste Management sub-sector includes the treatment/management of domestic and industrial waste that cannot otherwise be recycled. It includes:
- Construction & operation of waste treatment facilities for anaerobic digestion, composting, incineration, landfill, waste to energy conversion and the supporting engineering services.

- Equipment for Waste treatment, manufacture, supply, installation and maintenance of bio filters, bio reactors, collection equipment, grease traps, oil interceptors, materials processing equipment, monitoring & control equipment and nightsoil & landfill leachate treatment.
- R&D - incineration technologies, energy from waste systems, cleaner processing & treatment technologies, disposal of hazardous waste and other materials processing technologies.
- Consultancy and training - books, periodicals & publications, specialist consulting and training for asbestos, hazardous materials and other waste management systems.

Water Supply and Waste Water Treatment sub-sector includes activities relating to the treatment of pollutants in the water supply. It includes:
- Water treatment and distribution, manufacture, supply, installation and maintenance of systems for activated sludge, aerobic & anaerobic treatment, biological odour & corrosion control, demand management & leakage reduction, effluent treatment, filters, microbial treatment, screens, sequencing batch reactors, water disinfection and storm/grey water treatment.
- Engineering - field engineering, pipe & valve maintenance, fitting & construction, fabrication & welding and engineering design.
- R&D - water purification, water management, black/grey water treatment, biocides, bio reactors and aerobic/anaerobic treatment technologies.
- Consulting and training - engineering and water management training, publishing and specialist consulting for water systems treatment, management and engineering.

Renewable Energy

Biomass Energy sub-sector includes all activities that convert biomass into energy but excludes biomass materials (see Alternative Fuels). It includes:
- Biomass furnace systems - manufacture, supply, consulting, design, installation, engineering and other services for domestic, industrial and community applications.
- Biomass energy systems - manufacture, supply, consulting, design, installation, engineering and other services for domestic, industrial and community applications.
- Manufacture of biomass boilers and systems including boilers, cogeneration, heat exchange and packaged power systems for domestic, industrial and community applications.

- Biomass boilers and related systems including supply, consulting, design, engineering, installation and other services for boilers, cogeneration, heat exchange and packaged power systems for domestic, industrial and community applications.
- Technical and operational consulting.

Geothermal Energy sub-sector includes all activities relating to the extraction and use of heat generated from the earth. It includes:
- Manufacture and supply of specialist thermally enhanced equipment - grout, heat pumps, pipes, flow control valves, drilling equipment, installation rigs and ancillary equipment.
- Whole systems manufacture and supply for industrial, residential and community geothermal energy applications.
- Component design and research - design services, component research and component recycling.
- Consulting & related services - architectural, construction, systems design, consulting, engineering, installation and project development services.

Hydroelectric Energy sub-sector includes activities that help to extract energy from river and other water sources held in dams (as opposed to wave or tidal energy) that is used to drive turbines and generators. Large scale civil engineering/construction activities associated with dam building have not been included in this analysis. It includes:
- Turbines - manufacture, supply, installation and maintenance of turbine generators, control systems, spares and structural supports and fittings.
- Dams & structures - manufacture, supply, installation and maintenance of dam operational systems, control systems, maintenance services and sluice gates and actuators.
- Pumping & lubrication - manufacture, supply, installation and maintenance of pumps, spares, storage and lubrication systems and spares.
- Electricity supply - manufacture, supply, installation and maintenance of power factor, power distribution and grid connections and supporting structures.

Nuclear Power sub-sector includes all activities that relate to the generation of nuclear power, excluding decommissioning of nuclear sites. It includes:
- Nuclear safety engineering services, regulatory compliance, reactor management, fail-to-safety engineering.
- Nuclear power plant operations management, engineering and PR.
- Nuclear cooling equipment - manufacture, installation and maintenance.
- Construction of plant and equipment - site development, reactor and buildings and power plant/equipment construction.

- Commissioning engineering services - cooling & thermal control, engineering maintenance, instrumentation, power distribution, reactor & plant commissioning.
- Sampling & testing services - thermal control testing, remote monitoring, back-up plant monitoring and effluent discharge testing.
- Nuclear scientific services - research, laboratory testing and fuel management.

Photovoltaic Energy sub-sector includes all activities that help to convert solar radiation into useable energy. It includes:
- Chemicals - production and supply of solar chemicals and solar pond salt.
- Systems & equipment - manufacture, supply, installation and maintenance of active and batch systems, clerestory windows, light shelves and tubes, solar box cookers, solar combi-systems and solar lighting design.
- R&D - solar power and solar car research.
- Photovoltaic cells - manufacture, supply, installation and maintenance of photovoltaic modules, mounting systems, ancillary components, cells and cell materials.
- Other equipment & chemicals - manufacture, supply, installation and maintenance of glass houses, convection towers, heliostats, parabolic collectors, turbines, trough collectors, towers and solar trackers.

Renewable Energy Consulting sub-sector includes consulting and legal services specific to Renewables i.e., not included in general or specific environmental consulting. It includes:
- Legal services - wind farm location and other renewable energies.
- Consulting - turbines, solar and photovoltaic applications, public sector and corporate Renewables policies, nuclear energy, insulation technologies and alternative fuel technologies.

Wave & Tidal Energy sub-sector includes all activities that help to convert the energy from waves and tides into usable power (also known as marine renewable energy). It includes:
- Turbines & generators - the manufacture, supply, installation and maintenance of tidal turbines, structural supports and fittings, spares and turbine control systems.
- Pumps & equipment - the manufacture, supply, installation and maintenance of pumps and pump spares.
- Two basin schemes - provision of structural engineering and field maintenance services.
- Ebb & flow systems - manufacture, supply, installation and maintenance of ebb and flood generation systems.

- Assessment & Measurement - waves, water levels, turbidity, tidal energy, sediment, salinity pollutants, fish stocks monitoring and local/ global environmental impact assessment.
- Other general services - financial planning, operational and maintenance services.

Wind Energy sub-sector includes all activities that convert wind power into usable energy. This includes wind farm systems, large and small wind turbines. The sub-sector is divided by size of turbine rather than location (onshore and offshore) because it is easier to differentiate and map supply chain activities in this way. It includes:
- Wind farm systems - manufacture, supply, installation, operation and maintenance of integration, power plant, power control, grid entry equipment and systems and electrical and mechanical componentry.
- Small wind turbines - manufacture, supply, installation, operation and maintenance of small turbine systems (blades, towers, fixing structures, cowlings, enclosures, gear boxes and drive trains), componentry and research.
- Large Wind Turbines - manufacture, supply, installation, operation and maintenance of large turbine systems (blades, towers, fixing structures, cowlings, enclosures, gear boxes and drive trains), componentry and research.

Low Carbon

Additional Energy Sources sub-sector groups together R&D, Design and Prototyping activities relating to a range of new Low Carbon energy sources.

These energy sources include: Fuel Cells, Hydraulic Accumulators, Hydrogen, Molten Salt, Thermal Mass, Compressed Air, Superconducting Magnets and more general energy storage research.

This is a small sub-sector (in value and impact) because only energy sources that have a current economic footprint (i.e. trading) are included. This excludes a number of promising energy sources that are still in development and for which economic evidence is not yet available.

Alternative Fuel and Vehicles sub-sector includes Low Carbon Fuel and technology activities that relate to (predominantly) automotive transport. It is divided into Alternative Fuels (main stream) and Other Fuels and Vehicles. This sub-sector does not include bio diesel (see Alternative Fuels). It includes:

- Alternative Fuels includes the production, supply and distribution of Natural Gas (Compressed or Liquefied), Synthetic Fuel and Auto Gas (LPG, LP Gas or Propane).
- Other Fuels and Vehicles includes vehicle technologies and fuel sources that are still at an early stage.
- Research, Design, Development and Prototyping activities are included for: Hydrogen fuel cells and hydrogen internal combustion, Electric, Hybrid Electric, Steam powered, Organic waste fuel, Wood gas, Solar powered and Air, Spring & Wind powered vehicles.

Alternative Fuels sub-sector includes a wide range of Low(er) carbon fuel sources that are not included under Renewable Energy. It includes the manufacture, production, supply and distribution of:
- Batteries - chemicals, chargers, controllers, cables, connectors, containers, suppliers and testing equipment.
- Bio fuels for Vehicles - bio diesel, butanol, ethanol and vegetable oils.
- Mainstream Bio fuel applications (non-transport) - bio diesel, butanol and ethanol.
- Other Bio fuels - biomass, methane, peanut oil, vegetable oil, wood and woodgas.
- Other fuels - Hydrogen.

Building Technologies sub-sector includes main stream building materials and systems that contribute to reduced energy use and to lowering the carbon footprint of buildings. It includes:
- Windows - the manufacture, supply, distribution, installation and development of double glazed, electro chromatic, insulated alloy, honeycomb and triple glazed units.
- Doors - the manufacture, supply, distribution, installation and development of insulated alloy and plastic doors.
- Insulation and heat retention materials - the manufacture, supply, distribution, installation and development of insulation materials, heat retention surfaces & ceramics, electronic control systems and controlled venting and ducting systems.
- Monitoring and control systems - the manufacture, supply, distribution, installation and development of energy and distributed energy control, monitoring, management and analysis systems.

Carbon Capture & Storage sub-sector includes activities that store carbon emissions - from locations like power plants and prevent them entering the atmosphere. It includes manufacturing, supply, distribution, installation, maintenance, development and design of:
- Pre combustion capture systems
- Post combustion capture systems
- Oxy-Fuel combustion systems
- Pipeline systems and services
- Ocean storage equipment and services
- Mineral storage equipment and services

- Ship storage and discharge systems
- Geological storage equipment and services
- Engineering, project management and consulting services.

Carbon Finance sub-sector includes investment activities and financial instruments for emission reduction projects and carbon trading. This includes:

- Carbon credits finance and fund management - land, project or general trading services from finance houses and investment funds.
- Carbon credits trading - development and supply of trading systems, land/project/general trading houses and transactions.
- Carbon market intelligence - carbon markets analysis & reporting and carbon trading by forecasting and reporting from journals, online, data providers or other publishing sources.
- Projects and verification - data collection, verification, legal, project development, capacity development and carbon declaration services.
- Press and journalism - financial press and periodicals, other journals, data providers and online services.

Energy Management sub-sector includes energy saving and power management activities for industrial and domestic use. It includes:

- R&D into high efficiency lighting, heating & ventilation, power, lighting, equipment & pumps and advance management systems.
- Gas Supply - monitoring, meterage, leak detection & maintenance, gas supply control and manufacture of high efficiency consumer equipment and devices.
- Lighting - manufacture, supply, distribution and installation of energy saving light bulbs & tubes, lighting and control systems.
- Heating & Ventilation - manufacture, supply, distribution and installation of energy saving equipment and systems.
- Electrical - manufacture, supply and installation of energy saving power control, building control, power consumption control & monitoring systems.
- Consulting and other services - advice & consultancy, publication, training and design of management systems.

Appendix 2: The kMatrix Methodology

A2.1 Introduction

The methodology works beyond standard industrial and market classifications and looks for multiple sources of industrial-based evidence to quantify market values. kMatrix is unique in how it identifies, assembles, evaluates, monitors and develops rules for the use of those sources to quantify 'difficult-to-measure' markets.

Market activities are only included when there are multiple data sources. These sources are screened to remove duplicate references to any single source and then shortlisted by removing outliers and unreliable sources. This shortlist is then screened again until some consistency in value is achieved.

Market values created in this way are then "reality tested" by comparing these values within and across sectors, against known national/regional industrial specialism, across nations, against known trade flows and recognised industry benchmarks.

This methodology is quantitative and data intensive. Its uniqueness resides in the ability to manage and select reliable sources that are specific to each market activity. The data sources are global in nature and derive from government, private sector, institutional, industrial, trade, advertising, HR, financial, investor, academic and other (unpublished) sources. Up to 900 sources are used to compile the national LCEGS data set.

Sources are carefully managed. kMatrix measure and rate their sources' accuracy and reliability over time and exclude sources that are outdated or without a measurable track record. They use no less than seven qualified sources showing some consistency in results for deriving any values that they print. They create a mean value from these selected values and then assign a confidence level (generally of about 85%) based upon the spread of selected values around the mean

In contrast to most research or consulting reports kMatrix do not identify, copy and then acknowledge single data sources for specific tables or analytical comments. This is impossible for them to do because they multi-source every aspect of their data and then "transform" it into a new value. This makes single source attribution meaningless.

A2.2 Data Triangulation – the Cornerstone of kMatrix

kMatrix uses a propriety data triangulation methodology to calculate over 100 metrics for many sectors including Domestic Retrofit, Space, Climate Services, Green Economy, Marine, Security, Cybersecurity, Adaptation & Resilience, Water, Design and others.

The methodology for sector analysis is definition and source-driven. The definition determines WHAT gets measured and the source model determines HOW it gets measured.

All of the data measures are multi-sourced, and the process starts by defining the financial value of the sector (based upon our inclusive definition) from a wide variety of sources.

When kMatrix create a sector definition they always check that multiple sources of economic data exist for each included activity. This financial value is checked against existing sector values and also against the value of other economic sectors.

This is an iterative process that continues until they arrive at robust values and comparisons for all activities within the sector (comparative values of Wind vs. Photovoltaic vs. Biomass) that can then be meaningfully compared across global economies (UK vs. US vs. China etc.) and across different sectors (environmental consultancy vs. other specialist consulting activities). It is important that the methodology triangulates economic values in this way so that they:

a) Can exclude the research bias that often occurs from focusing on a single sector in a single country and

b) Ensure that they are effectively monitoring a sector that is still evolving by absorbing activities often included in other sectors.

The same general research methodology is used across all sectors and metrics, while the requirements for each industrial sector research project vary, the methodology and process always follow the same five key stages:

1. Define – Identify, select and group the target market activities, whilst conducting an initial check for the right volume and quality of data sources

2. Assemble – Populate the data measures for each market activity, carefully filtering the core data sources to ensure that confidence levels are within bounds

3. Check – Apply quality assurance checks to ensure data accuracy/consistency across market activities and different countries and, in some cases, cross-check with different sector values

4. Validate – Sense-check and spot-check market data values against specific projects/authoritative sources/expert knowledge/customers or clients

5. Publish – Recalculate, update confidence levels and publish research data set

This process is illustrated in more detail by the Sector Research Model (Figure 1), where the numbers correspond to the process stages above.

Sector Research Model

kMatrix Data Services - *Data Triangulation*

If you can measure it– you can manage it
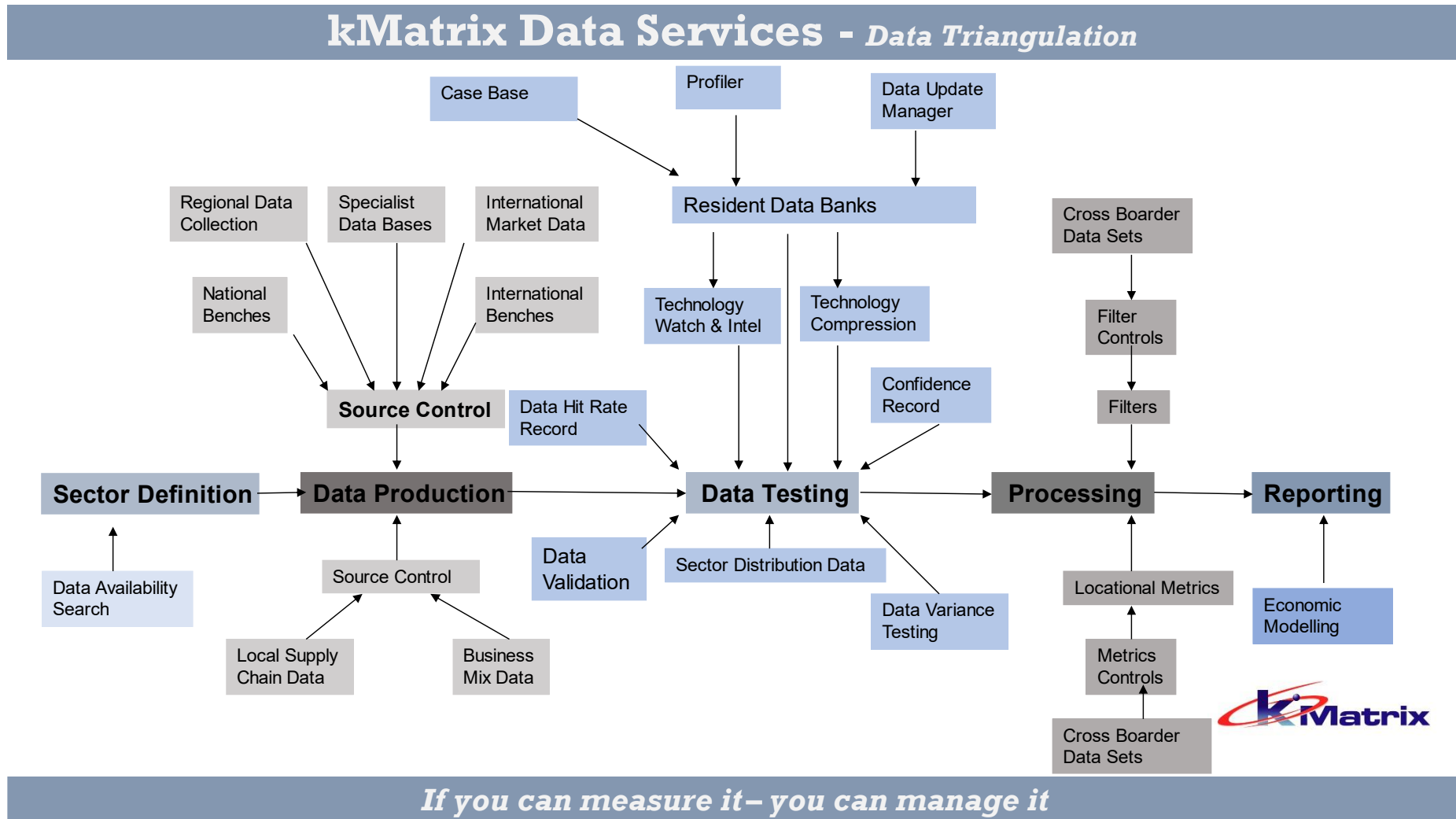
The research model used by kMatrix comprises distinct but iterative phases. This is because kMatrix needs to "create" its own data before it can analyse it. This is fundamentally different from any SIC-based sector analysis that takes its data as a "given."

Within the above model a range of different research methods are employed. Some aspects of the research system are semi-automated (necessary when dealing with large volumes of data), but the rulesets and software algorithms are based upon 35+ years' experience in compiling and reporting complex markets and all final decisions about reported outputs are subject to intense analyst scrutiny.

The research methods employed include:

- Desk research to define sector content and determine sector boundaries

- Industrial templates that identify core and supply chain activities in detail for inclusion in sector definition

- Data discovery tools to identify new data and sources relating to the defined sector activities

- Data coding systems to ensure that sector, company-level data and other classification systems are aligned for analysis and reporting purposes

- Data management techniques and systems to maintain existing source libraries and integrate them with new source materials

- Software systems with defined (but flexible) rulesets to filter source content

- Semi-automated processes for modelling and calculating data values from selected source lists

- Knowledge base of case study materials that can be accessed to help fill data gaps and provide industrial performance benchmarks

- Quality assurance processes and tools that check all values against a range of international, national and industrial comparators

- Data management and visualisation tools for presenting and reporting data

A2.3   Measures

Throughout this dataset the focus is on a small number of key measures. To summarise, these are:

- **Sales** – This is the estimate (in £m) of economic activity by identified companies in a defined region within the supply/value chain for market products and services. The estimate is based upon where sales activity takes place rather than where it is reported.

- **Companies** – This is a measure of the total number of companies in a defined region that match, or fit within, the market activity headings.

- **Employment** – This is a measure of the estimated employment numbers across all aspects of the supply/value chain. National, regional and other economic data sources have been used to estimate current employment levels for each area of market activity.

- **Growth** – This is a multi-year measure that includes historical AND forecast growth. The growth measure is derived from live, rapidly changing and multi-sourced data links and is specifically based upon growth in Sales. Growth is generally a measure of increased market opportunity and can be used for trend analysis, comparison across different markets or as a moving indicator of market confidence (growth time series).

- **Exports** – This is a measure of products and services sold overseas and is calculated using in-country/out-of-country data and additional data from the logistics and freight forwarding industry.

Sales

The key measure that is used for financial value is Sales i.e., the value of sector products and services sold either to other businesses or directly to consumers from the geographically located company base, whether it be national, regional, sub-regional or Local Authority. This means that the analysis only includes activities where there is a measurable economic footprint. It does not include publicly-funded research or pre-commercial consumption of funds, except where those activities result in the purchase of product and services from third parties

As they derive the financial value for the sector they also assemble and assess the UK company base that is contributing to this value. In the first case they identify all "significant" or "specialist" companies, these are companies where LCEGS account for over 80% of company sales, and then the supply/value chain companies where LCEGS sales is an

important and measurable component of their overall sales - (over 20%). These percentages are indicative and vary for different LCEGS activities.

Companies

The company count acts as a further reality check on the financial value of the sector by comparing company turnover values in this and other sectors and also assists in the geographical analysis of where LCEGS value is created. For company counts and company listings we use standard data sources, international sources, industry/trade sources, the advertising industry and, with caution, company-published information.

One important fact about the methodology is that in a typical SIC approach to sector analysis, a company is counted once and the value of its activities are very often assigned to a single category (which may or may not reflect what a company actually sells now), within a single sector and from a single geographical location.

This approach is to identify and assign value to different activities within a company that may fall within the same sector and to exclude values associated with different sectors. Where possible, they also break the reported activity down within larger multi-site companies so that only the value created within a region/LA is reported for that region/LA.

By analysing a sector in this way, they are able to capture the economic value generated by all "specialist" and supply/value chain companies, without any double counting of value. However, the methodology does mean that a single company may contribute value to multiple activities, and we have to be careful not to double-count companies. To avoid this we assign portions of a company, for counting purposes, to the activities that account for most of its sector sales. This does mean that on some occasions some of the smaller activities in our analysis may have a financial value in the sales column but a zero in the company column.

Employment

When financial values and company numbers have been calculated the methodology then looks at the employment base for the sector. The analysis of employment includes HR/Recruitment industry data, trade/industry data, government statistics, company reported employment levels and a variety of industry benchmarks that show employee input ratios into different products and processes. They do not survey companies directly for this information.

From these different sources we calculate employment numbers for LCEGS sector activities, taking into account how staff can operate processes that produce products for different markets. We, therefore, measure our employment numbers in Full Time Equivalents (FTE), equivalent to a standard 40 hour week.

Growth

Sales Growth is both an historical and a forecast measure and the methodology applies the same multi-source rigour to assessing growth that has already occurred as to growth that may occur. Growth forecasting shows the importance of both multi sourcing AND tracking the historical reliability/accuracy of sources used. It is based upon continuous monitoring of forecast "opinions" that are constantly being updated and re-evaluated, as a result "in-year" measurements of predicted growth can vary depending on when the sample is taken and change as sources respond to events like recession.

For this reason, we measure annual growth as a) a value frozen at a point in time and b) a time series (monthly or quarterly) measured throughout the year. In this file we include only the single (frozen) forecast. Separate files with detailed time series forecasts and trend analysis for the LCEGS sector are available.

Annual growth figures are useful in calculating and comparing the future contribution of sector activities beyond the current baseline. The percentage growth shows the RATE of change, the application of growth rates to the current sales baseline shows the IMPACT of change. Measuring the impact of change in financial terms shows how the ranking and importance of existing activities to the region/local authority may change over time and suggests when and where action may need to be taken to accommodate changes in the employment and company base.

The quoted growth rates in this dataset apply specifically to sales value. A growth in sales is indicative of changes in company numbers/employment but 5% sales growth does not necessarily equate to 5% employment growth. Companies can achieve growth in different ways and the recession has shown that companies will consume any "slack" before creating new jobs.

Geography

The methodology is designed to locate and measure economic activity at various geographical levels. The smallest unit of measurement is the Local Authority, but it can analyse data at county, sub-regional, LEP, regional and UK level.

When the methodology calculates and measures economic activity at the local authority level it takes into account existing local government boundaries, local GDP calculations and demographics, the postcode location of companies in the sector and any other local data that is available and relevant to the sector. When we measure sales and employment, therefore, our numbers are based upon where the business is located, rather than where people live.

There are some limits to what economic measures can be meaningfully or accurately applied at the local level. This is due to the range and specificity of data sources. Most of the economic development measures within this dataset can be accurately represented at a local level.

A2.4 Calculating Skills - Employment

The foundation of the workforce data within this study is not derived from surveying the industry but from the in-house kMatrix Data Triangulation of multiple sources from within and around the industry.

The kMatrix methodology has the ability to measure economic activity at the product, service and skill-level of detail, without the use of either the Standard Industrial Classification (SIC) or Standard Occupational Classification (SOC) systems. This allows the development of a detailed market segmentation model, with in-depth skills measurement and analysis, which is specific to LCEGS, without undue burden on the industry.

The data itself comes partly from trade bodies and companies, so although companies do not contribute directly to the quantitative data within the study, they are indirectly involved through the big data triangulation process.

Employment is a measure of the estimated employment numbers. National, regional, and other economic data sources have been used to estimate current employment levels for each sector activity. Where employment information is scarce, or where employment is estimated as a proportion of a company's sales, a comprehensive range of case study materials are assessed to provide sensible industry-specific ratios and benchmarks.

Terminology for jobs within industry is often varied, e.g., 'technician' and 'engineer', particularly within LCEGS and are used interchangeably and where culture within a company can determine terminology used for non-protected jobs. Additionally, there is also variation in terminology by both region and country, e.g., 'engineer' is a protected title in Canada, while in the UK, 'engineer' is not protected and can refer to everything from cleaning (domestic engineer) through to a 'civil engineer'. As such, kMatrix converts the data into common definitions.

Data has been collected from multiple sources including:

- ➢ Industry specific personnel associations
- ➢ Industry specific training associations
- ➢ Academic Data sources (sector specific)

- Sub-sector specific training providers

- Trans-sector training data (via academia and sector associations)

- Over 7,500 datasets in total

Total Employment at the job role level, is a measure of who has been employed in which role, it does not track their qualifications or whether the hire was successful, i.e., whether they had to undergo extensive training or upskilling to perform the role, or for how long. It doesn't measure quality, only quantity.

The measurement is a Full Time Equivalent (FTE), which is a calculation of the number of hours worked within a Job Role, performing the tasks within the service being undertaken. It is an indication of how many people working full-time would be required to fulfil the work being measured. If two people worked part-time, they would be counted as one FTE.

The benefit of this form of measurement is it provides a clear indication of how many hours of work are undertaken and how this varies between skill-sets, between sub-sectors and between the same skills in different sub-sectors. It also gives an indication of how many people are working within the sector, without double-counting people who are multi-skilled.

The limitation of the FTE measurement is that it does not give an indication of how many people in total are providing the service. Because it measures the hours worked, it does not count a person working 2 hours as an individual within the sector, i.e., it does not count how many people work part-time within the sector. Conversely, it has the benefit of not over-reporting or under-reporting workers depending on a set criteria. For example, if only those working more than 60% of the time in the sector were included and the sector is defined by high numbers of part-time workers, the employment figures have the potential to be vastly under-reported and visa-versa.

By using the FTE system of measurement, with the advantages and limitations clearly stated, the absolute time worked can be used for skills analysis.

The data is calculated from the employment side, grouping employees into activities within markets, as opposed to selecting the market and then looking at the employees within it. By using this distinction, we can view how many people are doing what, where and why.

A2.5 Data Confidence Levels

All kMatrix datasets incorporate a measure of data Confidence Level. This is partly a mathematical function of the historic hit-rate of sources in terms of their previous forecasting accuracy for each metric and activity being measured. Confidence levels vary by activity, measure, geography and forecast year. Typically a confidence level of above 90% is achievable, meaning corroborative sources may vary from the mean value by +/-10%. The focus in the research process is to obtain an across-the board level of data confidence rather than attempt to achieve 100% confidence in any one set of numbers. As each data point has its own set of sources, so each data point has its own level of data confidence. Data confidence levels can vary according to how mature or emergent a product or service is, and how mature the reporting systems may be or for any given country. Developed nations typically have a wider range of robust sources to choose from.

kMatrix tracks the accuracy of sources over a period of time, with Confidence Levels being built up from the history of the accuracy of a source for a specific metric. The history or 'hit-rate' of a source is held for each metric, with some sources accepted for some metrics and rejected for other metrics, dependent on how accurate they have been in the past. Hit-rates are 'live' and the hit-rate of a source can change over time, as their performance changes over time, with some sources hit-rates being tracked over the last 35 years. The ability to select, reject and assess the validity of the extensive source list, for different markets, metrics and geographies is a fundamental aspect of the kMatrix process.

The bubble graph below plots the confidence values for 2,769 data points for all 65 Local Authorities in the MNZH region. The bubbles are not sized, they are only markers representing the percentage data confidence for each datapoint. Here we can see the confidence varies between 77-91% confidence, with most data points concentrated between 81-86%.

32
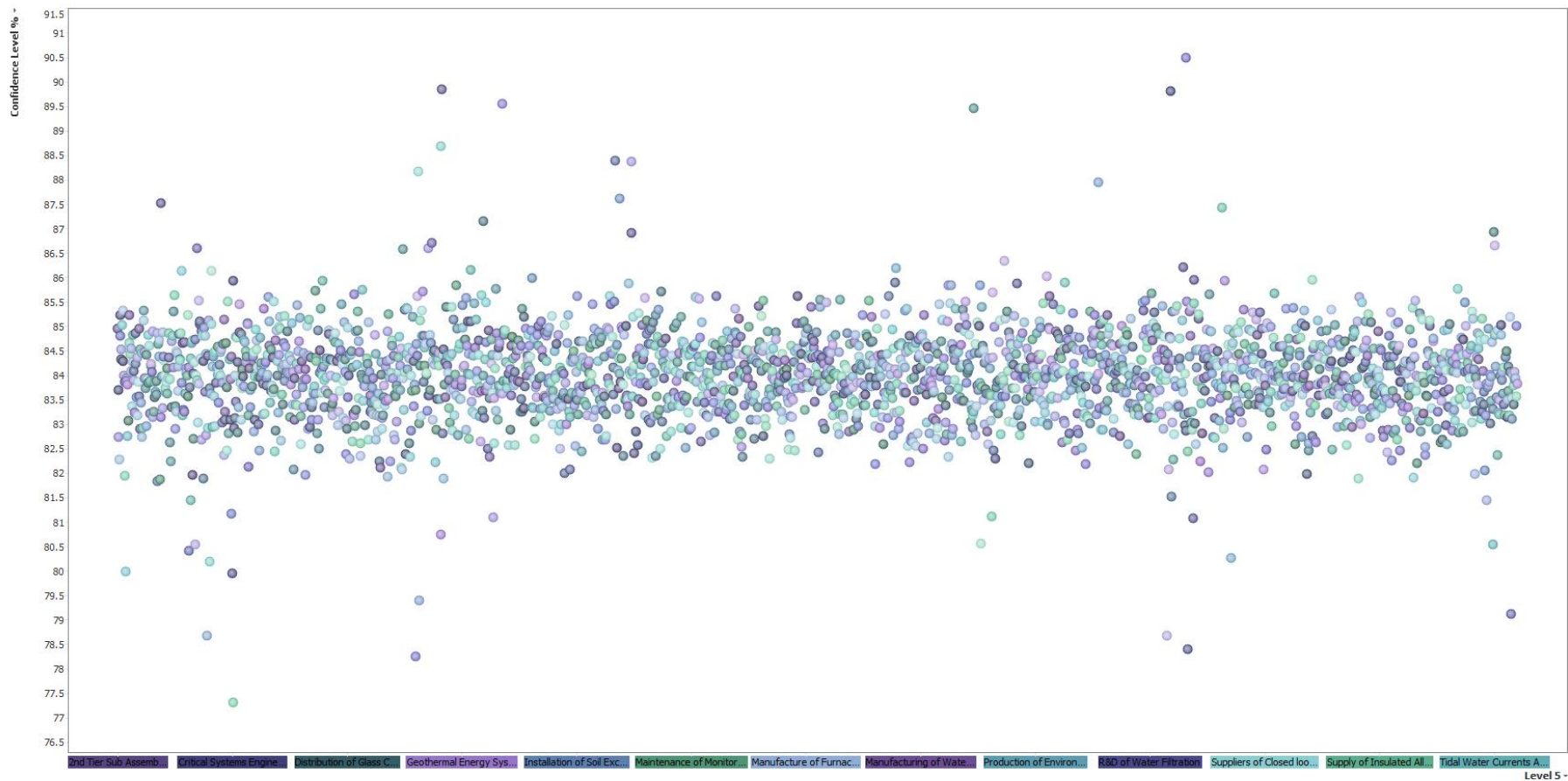
A2.6 Difference Between Data Confidence Levels and Data Confidence Intervals

Data Confidence Intervals are often used within survey data, where they give an indication of the degree of uncertainty of an estimate within a sample, specifying the range of values likely to contain the unknown population value, by defining upper and lower limits within a data sample.

The difference between this and the Confidence Level above, is it provides the variance, but it weights all data as being equally valid and does not factor in the likely validity of each data source.

In summary, Data Confidence Levels are different to Data Confidence Intervals:

- **Data Confidence Levels** estimate the accuracy of a triangulated data point, based on the likely accuracy of each of the multiple sources of data that are used in the triangulation process, through tracking historical accuracy
- **Data Confidence Intervals** provide a range of values where the true number could lie, but do not provide detail on the validity of the values used within the production of the range

Confidence Intervals are not provided within the dataset because the data sources within the triangulation process for each datapoint are varied, created for many different reasons and will each have an individual hit-rate.

A2.7 "Deep Dive" Example – Employment for Private Sector Contracts of Insulation

This example provides an illustration of how the multi-source approach has been used to calculate labour values. This worked example would give a figure for total number of insulation installers in England (separate study from 2022).

The multi-source approach includes six stages:

1. Select the data point
2. Identify the source data
3. Select sources for further analysis
4. Triage the sources to achieve a more consistent range of values
5. Calculate the mean value from the sources
6. Calculate the confidence level

Stage 1 involves selecting the data point. In this example, the data point is England employment for "Insulation".

Stage 2 involves identifying the data sources that are relevant to the calculation of the data point and is the source list that is used to calculate the value, for this datapoint, it would run to over 4,000 sources.

Stage 3 involves an initial sort and selection from the full list of sources to identify those of the most direct relevance to the data point. They are rejected if they are duplicates, i.e., using 3rd party data, if their hit rate is too low or if the value is excessively high or low with no

evidence for deviation.

Stage 4 of the process involves "smoothing" the results by excluding the outlier values from the final calculation. In this case, 75 sources were ultimately selected and these are shown at Table A.1 and are labelled Source 1 through to Source 75. Their selection depends upon several factors stored within our source management system (columns 4-8 of Table A.1). These are:

- Value reported (Employees) – only sources showing value that are proximate to other values are included

- Year of data – ideally sources should be current, in this case all are 2021

- Hit rate over the past 5 years – level of assessed accuracy for this source over 5 years

- Number of times accessed – number of times this source has been used previously for this purpose i.e., same data point different years, identical data point different country etc.

- Triangulated – is the data extracted from a larger data set for the purposes of comparison?

Table A.1 shows that the 75 sources were all current, with employment values between 68,584 and 102,534, hit rates of between 72.3% and 94.8% and had been accessed previously between 34 and 155 times each. The source list is split (52/23) between sources used for triangulation and those that are not.

All the values in the data set are unique, which means that multiple sources that may quote the same value (possibly from an identical source) are eliminated from the final selection.

Table A.1: Long List of Sources

No	DATA Source	Employees	Country	Year of Data	Hit Rate History %	Times Accessed	Triangulated	Accept Reject
1	Advanced Portfolio Technologies	81,325.7	England	2021	92.2	119	YES	accept
2	Advanced Technologies Inc	87,653.9	England	2021	94.7	130	YES	accept
3	Advantage Capital Limited	75,767.2	England	2021	85.7	76	YES	accept
4	Advantage Early Growth Limited	85,430.5	England	2021	73.4	88	NO	accept

5	Advent Venture Partners LLP	82,437.4	England	2021	82.4	57	YES	accept
6	Alliance for Climate Protection	73,971.3	England	2021	89.5	88	YES	accept
7	Alliance to Save Energy	79,444.4	England	2021	76.9	34	NO	accept
8	Alternative Investment Solutions	69,952.1	England	2021	86.4	96	YES	accept
9	Aluminium Federation	68,583.8	England	2021	91.8	77	NO	accept
10	Applied Environmental Research Foundation - AERF	81,753.3	England	2021	84.6	46	YES	accept
11	Architectural & Specialist Door Manufacturers Association	80,385.0	England	2021	82.3	58	YES	accept
12	Architectural Association (AA) School of Architecture	73,458.2	England	2021	72.3	64	YES	accept
13	Architectural Cladding Association	95,008.3	England	2021	76.1	94	YES	accept
14	Architectural Engineering Institute	98,257.9	England	2021	86.3	123	NO	accept
15	Architecture and Design Scotland	76,280.3	England	2021	76.8	126	YES	accept
16	Association for Environment Conscious Building	95,093.8	England	2021	92.7	49	NO	accept
17	Association for Project Management	68,669.3	England	2021	79.6	83	YES	accept
18	Association for Specialist Fire Protection	78,760.2	England	2021	83.4	121	YES	accept
19	Association for the Conservation of Energy	98,514.4	England	2021	90.6	57	YES	accept
20	Association for solar thermal industry	78,503.7	England	2021	77.9	123	NO	accept
21	Association of Average Adjusters	95,863.4	England	2021	75.6	56	NO	accept
22	Association of Builders' Hardware Manufacturers	89,962.8	England	2021	89.7	53	NO	accept
23	Association of Building Component Manufacturers Ltd	102,533.7	England	2021	92.0	133	NO	accept
24	Association of Building Engineers	85,516.0	England	2021	74.6	50	YES	accept
25	Association of Consulting Engineers	94,922.8	England	2021	76.1	108	YES	accept
26	Association of Environmental and Resource Economists (AERE)	93,126.9	England	2021	94.7	61	YES	accept
27	Association of Facilities Engineers	101,165.4	England	2021	78.6	50	YES	accept
28	Association of Rooflight Manufacturers	82,779.5	England	2021	81.0	124	YES	accept

29	Association of Tank & Cistern Manufacturers	70,379.7	England	2021	77.7	73	YES	accept
30	Biomass - Biomass Thermal Energy Council (BTEC)	80,299.5	England	2021	83.2	93	YES	accept
31	Biomass - Pellet Fuels Institute	89,791.8	England	2021	74.2	55	NO	accept
32	Biomass Energy Research Association (BERA)	86,713.2	England	2021	74.1	54	YES	accept
33	Blomberg	79,615.4	England	2021	79.1	85	YES	accept
34	BLT Financial Group	97,830.3	England	2021	76.9	92	YES	accept
35	BNP	92,357.3	England	2021	93.2	114	NO	accept
36	British Architectural Library	77,392.0	England	2021	85.0	102	YES	accept
37	British BioGen	83,292.6	England	2021	77.3	148	YES	accept
38	British Blind & Shutter Association	76,536.8	England	2021	89.4	67	NO	accept
39	British Board of Agreement	88,338.0	England	2021	91.9	127	YES	accept
40	British Cement Association	97,060.7	England	2021	87.5	69	NO	accept
41	British Computer Society	73,201.7	England	2021	79.4	155	YES	accept
42	British Concrete Masonry Association	94,153.1	England	2021	73.3	62	NO	accept
43	British Constructional Steelwork Association	96,120.0	England	2021	77.2	132	NO	accept
44	British Fire Protection Systems Association	76,622.3	England	2021	84.4	62	YES	accept
45	British Floor Covering Manufacturers Association	88,081.5	England	2021	85.3	138	YES	accept
46	British Foundry Association	89,535.3	England	2021	78.5	137	YES	accept
47	British Glass Manufacturers Association	76,023.7	England	2021	75.9	79	YES	accept
48	British Hard Metals Association	101,079.9	England	2021	81.8	36	YES	accept
49	British Hydropower Association - UK	95,435.9	England	2021	79.1	38	NO	accept
50	British Institute of Architectural Technologists	71,662.4	England	2021	81.9	97	NO	accept
51	British Institute of Non-Destructive Testing	91,844.2	England	2021	88.7	105	NO	accept
52	British Laminate Fabricators Association Ltd.	83,207.1	England	2021	94.8	116	YES	accept

53	British Marine Equipment Association (BMEA),	92,613.8	England	2021	81.3	71	YES	accept
54	British Metals Castings Association	85,601.5	England	2021	86.3	112	YES	accept
55	British Metals Federation	94,153.1	England	2021	81.8	69	YES	accept
56	British Non-Ferrous Metals Federation	77,563.0	England	2021	86.3	136	YES	accept
57	British Photovoltaic Association	86,200.1	England	2021	93.1	87	YES	accept
58	British Plastics Federation	97,659.3	England	2021	82.2	91	NO	accept
59	British Precast Concrete Federation	78,931.3	England	2021	94.2	154	YES	accept
60	British Pump Manufacturers Association	71,149.3	England	2021	77.0	60	YES	accept
61	British Quality foundation	91,758.7	England	2021	90.8	44	YES	accept
62	British Resilient Flooring Manufacturers Association	81,411.2	England	2021	84.0	35	NO	accept
63	British Stainless Steel Association	88,338.0	England	2021	79.7	151	YES	accept
64	British Steel Corporation	70,978.3	England	2021	73.0	97	YES	accept
65	British Steel Strip Products	70,807.2	England	2021	84.0	136	YES	accept
66	British Urethane Foam Contractors Association	100,310.3	England	2021	89.5	49	YES	accept
67	British Wind Energy Association	76,451.3	England	2021	76.1	150	NO	accept
68	British Wood Preserving & Damp Proofing Association	83,805.7	England	2021	79.7	124	YES	accept
69	British Institute of Employment Studies	90,732.5	England	2021	90.6	130	YES	accept
70	Polo Tweed	71,747.9	England	2021	87.6	132	YES	accept
71	The Recruitment and Employment Confederation	70,123.1	England	2021	88.3	139	NO	accept
72	Ranstad Education	97,573.8	England	2021	93.7	105	YES	accept
73	Robert Half	75,339.6	England	2021	79.3	106	YES	accept
74	Blue Care	97,573.8	England	2021	77.2	56	NO	accept
75	A O C Jobs	100,395.8	England	2021	92.5	78	YES	accept

Typically, the process for deciding which sources to include/exclude as part of the final calculation is visualised using radar charts. These charts are a key feature of the QA system and provide a rapid insight into the variation in source values. A radar showing sharp and frequent spikes is due for radical surgery, while a radar with a more consistent pattern (representing a degree of consensus in the sources) is subject to judicious pruning. An example of an outlier would be a good which is usually £10, but someone is selling for £90 on Amazon, this would be considered an outlier and removed from the dataset. These are removed from the dataset because an overpriced good can distort a dataset. This process is undertaken by an analyst (not an algorithm) and can take several iterations before a satisfactory final selection of sources is achieved. The final radar chart based upon the final selection of sources is shown at Figure A.1.

Figure A.1 Radar Chart for Final 75 Sources
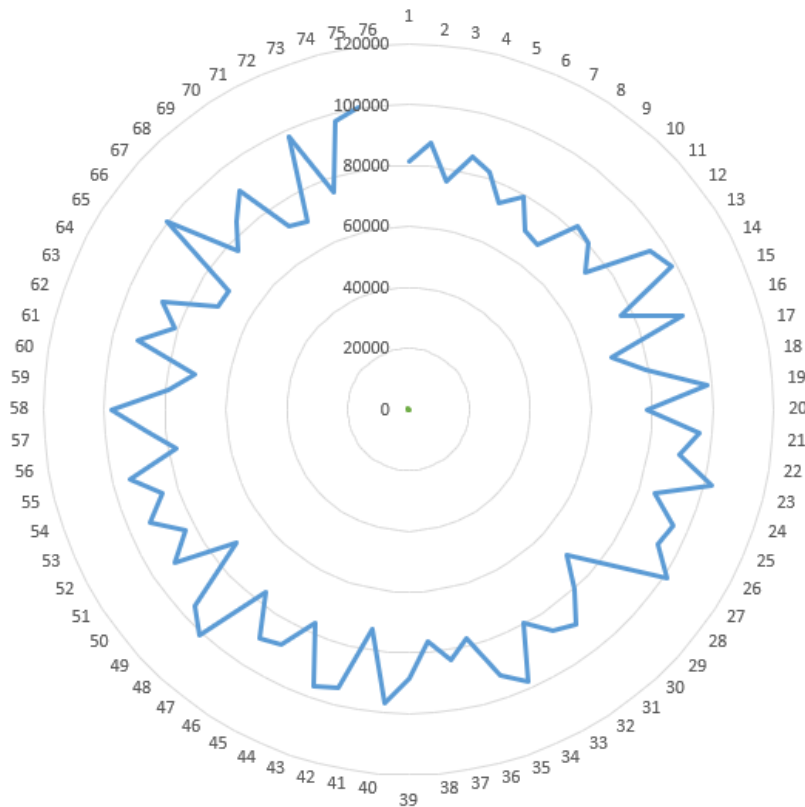
Stage 5 involves the calculation of the mean value from the final list of 75 sources, now ranging between 68,584 and 102,534 employees. The adjusted mean value from this range is 85,106.

Stage 6 calculates the confidence level for the data point, which is an indication of the validity, based on the historic hit-rate of the sources used to triangulate the data point, in this case the confidence level is 83%.

Each data point that progresses through this process is then subject to further checks that ensure that the data point value is consistent with:

- Values in previous year's data
- Comparative values of UK employment compared with employment levels of same service in other countries
- Comparative analysis of UK employment values when related to other Installation services in the same category or family of services
- Consistency in employment trends over time
- Consistency in confidence levels over time

Where any uncertainty about the final data point remains, this may be due to either market uncertainty or data uncertainty. In the case of market uncertainty, the value remains unchanged, but in the case of data uncertainty, then Stages 1-6 are repeated, but this time with additional or alternative data sources.

Appendix 3: LCEGS and Office of National Statistics Environmental Goods and Services Sector Comparison

The purpose of this appendix is to provide a brief description of some of the differences between the Office of National Statistics (ONS) Environmental Goods and Services Sector (EGSS) data and the LCEGS data provided by kMatrix. The two methodologies differ in the way data is collected, their methodologies, and in terms of their sector definitions.

kMatrix is a data house that specialises in providing evidential data for business modelling and analysis on a multi-sectoral basis. We provide back-room services to the likes of Deloitte and PWC amongst others in the UK, New Zealand, Australia, US and the EU for sectoral analysis and due diligence for sectoral development and investment. We also provide our business and technology profiling services through these channels to market, as well as direct to universities for technology spinouts and individual businesses for development purposes. Further customers include government departments such as BEIS, Home Office and various local and regional government departments.

The ONS EGSS data is produced primarily for the purpose of national accounting. It is sector-specific, using narrow sector definitions and takes no account of the value or supply chains in a sector. In contrast, the kMatrix methodology was originally designed to help companies by measuring technologies or activities using small taxonomies, to assist with investment and developmental planning. This capability was expanded to provide market data for a number of economic sectors, by creating larger taxonomies to capture as much of the market as possible, including the supply and value chains. Each taxonomy for a sector will draw relevant activities from many other sectors, to fully capture all activity. In this way, the LCEGS taxonomy captures activities across multiple sectors and down the value and supply chains. This difference in *what* is being measured is the fundamental reason why the definitions used by ONS and LCEGS do not align.

The kMatrix methodology uses a unique process of 'triangulation' to measure metrics such as employment and other characteristics of a sector at varying levels of detail. This process has been developed over 30 years and has been adopted by various governments, universities and major corporates to provide economic industry data for hard to measure sectors. It is similar in concept to the triangulation of satellites to work GPS satellite navigation systems. The methodology uses multiple data points which can be economic or non-economic in origin, from a number of different sources to 'triangulate' the value of a product or service in question.

This process is different to the methodology used by the ONS to produce the EGSS data, predominantly because the ONS data relies on self-certification of companies into SIC codes, whereas the kMatrix methodology calculates values based on multiple sources of data. The ONS data is based on where companies choose to classify themselves. kMatrix data looks at the activities of companies and attributes those activities to different sub-sectors. In effect, the ONS system is limited to the ability or willingness of companies to list which sectors their products or services are used in, this method is likely to produce both over and underestimates of market size as

companies will attribute more or less of their activities to relevant SIC codes. The kMatrix methodology does not rely on company cooperation but looks at their activities and breaks them down into the levels or sub-sectors they are relevant to.

The kMatrix process operates on a 'bottom up' basis, meaning we look at products and services delivered, rather than company classifications and turnover, which is classed as 'top down' (SIC system). The bottom up process was developed to assist individual companies based on sectoral analysis findings and provide evidential data and advice. By looking at the sector from the bottom up (by each activity, product or service), the sector can be determined in accordance with the relevant sector definition, whilst allowing the flexibility to 'add in' or 'opt out' of various activities depending on the purpose of the reporting. ONS data itself is not used to produce kMatrix figures, but the kMatrix values can be reported out through the ONS classification system if required.

Table 1 shows a comparison between employment analysis for the London region using the SIC classification methodology and the kMatrix methodology for the Manufacturing sector and the Construction sector.

Table 1: Comparison of 2011 - 2016 Employment Data for SIC and kMatrix in London

Methodology	Sector	2011 Jobs	2012 Jobs	2013 Jobs	2014 Jobs	2015 Jobs	2016 Jobs
SIC based	Manufacturing	106,750	108,250	106,750	112,000	108,000	105,250
SIC based	Construction	133,250	150,500	146,500	146,250	145,250	155,750
kMatrix	Manufacturing	137,351	135,943	138,951	141,873	140,308	131,230
kMatrix	Construction	166,629	195,334	177,915	184,022	184,317	199,038
Indexed numbers for the rows above show		100		101.4	100.0	104.9	101.2	98.6
that growth in the manufacturing and construction		100		112.9	109.9	109.8	109.0	116.9
sectors is similar for both the SIC and kMatrix definitions		100		99.0	101.2	103.3	102.2	95.5
		100		117.2	106.8	110.4	110.6	119.4

Sector - LCEGS is made up of elements from many different traditional sectors (including manufacturing, finance, construction, consulting and energy) therefore as a grouping it includes products and services from those sectors that together amount to the total value of the LCEGS grouping.

Scale - The ONS system only produces estimates of the sector size at the country level, whereas the LCEGS data can be provided by Country, Region, City, Local Authority etc.

Table 2 shows a summary of the main differences between the kMatrix data and the ONS EGSS data.

Table 2: kMatrix and ONS – EGSS Comparison Summary Table

	kMatrix - LCEGS	ONS - EGSS
Sector definition	The LCEGS sector includes the EGSS definition but expands it to include all activities that contribute and enable growth in the sector. Those elements which are excluded from EGSS which are produced for purposes that, while beneficial to the environment, primarily satisfy technical, human and economic needs or that are requirements for health and safety are included in LCEGS if they contribute to the sector. For more information, please see Appendix 3 and Appendix 4 of this report.	The environmental goods and services sector is made up of areas of the economy engaged in producing goods and services for environmental protection purposes, as well as those engaged in conserving and maintaining natural resources. Excluded from the scope of EGSS are goods and services produced for purposes that, while beneficial to the environment, primarily satisfy technical, human and economic needs or that are requirements for health and safety.
Sector size measurement	Triangulation of data from multiple sources	Company surveys via company self-certification
Sector sales coverage	Full value of sales for the sector, including supply and value chain	Only sector sales, not including supply or value chains
Geographic range of coverage	Global, Country, Regional, City & Local Authority	Country
Available data includes	Sales, number of employees, number of companies, exports, growth rates (historical and forecast) & 60+ more metrics	Output, GVA, employee count and exports
For further information and detail on the ONS – EGSS definition: https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/ukenvironmentalaccounts/2010to2015		