From Shortages to Solutions: Good Green Jobs and Labour Migration in Cities

Report developed by kMatrix Data Services for C40 Cities, the Climate Migration Council and the Mayors Migration Council

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Photo Credit: Raphael Pouget

Contents

Overview

This study covers 25 cities in 7 countries and provides a measurement for employment and GDP contribution of identified sectors for 2023, forecasting skills needs to 2040 under current climate action policies and identifies remaining shortages and economic advantage under two workforce development scenarios:

- Current technical and vocational training policies
- Increasing technical and vocational training investment by 50%

This study uses a similar definition of sectors and sub-sectors to previous Good Green Jobs C40 work but uses a different methodology. Comparisons between the relevant sizes of sectors for the two bodies of work are provided in Annex 4.

1. Methodological Overview (including research limitations)

1.1 Conceptual approach

The kMatrix big data triangulation methodology tool has been in the marketplace for over 35 years and was co-developed with Harvard University. It builds a 3D model of the economy of a city, region or country, with a focus on the activities, products or services within a defined sector or sectors to be studied, including those in the chains and networks of supply. The kMatrix methodology has routinely measured 226 countries and economic territories for over 3 decades, including mapping international trade and supply chains for many sectors.

As the methodology uses a complex system of verification of many thousands of sources of data to determine the most likely value for a measure, it is usually applied when a sector is either previously unmapped, is hard to measure, or where a high level of granulation is required. By leveraging data triangulation, in the form of a series of validation checks to verify if reported numbers fall into an accepted range of the 'likely true' value, the methodology therefore leverages several trusted sources per datapoint, such as national accounting systems or self-reporting by companies, and determines a triangulated value based on these multiple sources of input. This approach also mitigates against inflated reporting of values for political reasons, or simple mistakes of reporting by national bodies etc (e.g. for

the US, table 2 here reports construction employment of 8,017.9 people while table 3 reports construction employment of 8,017,900 people). Example sectors the methodology has measured, where evidence is available in the public domain via clients publishing reports or published peer-reviewed academic journals include: Low carbon environmental goods and services sector (London), Climate Change Adaptation (Nature, 2025), The Green economy (Nature), Carbon Finance (Nature), and Climate Services (Climate Services).

For this study, the overall objective was to provide 25 selected cities (Annex A) with local-level data on projected shortages of labour and skills in direct, green jobs for three key economic sectors (transport, waste, and construction) critical for the green transition for 2023, 2030, and 2040. Workers measured and forecasted within this study are those who work in the city or are based in the city. They are direct jobs (those in the 'obvious' market such as a Rail Operator, and those in the immediate chain and network of supply, such as the mechanic maintaining the train; they do not include the indirect jobs such as an outsourced accountancy firm. They also only include Green jobs as defined by C40 (Annex B). All sectors, occupations and workforce development scenarios were determined in collaboration with C40 and in alignment with previous C40 work. For each city, for each selected sector, five major components were measured:

- **Baseline data:** Employment and sales for 2023 to 'size' the market and capabilities.
- **Workforce demand:** Forecasting employment need to 2040 using policies from Climate Action Plans, other city-based policies where relevant, and national policies.
- **Workforce supply:** Projection of evolution of workforce size by 2040, for two scenarios:
    - Business as Usual: Current training policies and investment levels remain steady through 2040.
    - Optimistic: Increased training programs and investment levels by +50% through 2040.
- **Labour shortages:** Estimated labour shortages in 2040, determined by subtracting the workforce development from the forecast workforce demand.
- **Economic advantage:** Projected sales generated per employee in 2040, if shortages were filled.

The approach was to build economic models for each city and country. Each country-level dataset is ratified by comparison with city-level data for major economic hubs within the country, to mitigate against country-level data inaccuracies. Each city model is ratified against the national model, and against each other; they are also ratified against the wider economy of the city, country and neighbouring countries. For example, the number of employees measured as active in the operation of buses is compared against

reported numbers for comparable cities, with similar public transport schemes within the same country, and against any reported national numbers.

Where there are no publicly reported numbers to use as a starting point, adjacent sectors where values are reported are used as an indication of likely scale, and value triangulated through sources such as HR, recruitment, etc. All values for sectors are compared against the values for adjacent sectors, to ensure the model is aligned with wider sectoral sales and employment patterns. This process is continual throughout the study, with a series of draft datasets undergoing extensive testing of the model and sense testing of the size of the sector, until the final version is published.

Gaps in data are filled by international comparisons, combined with looking at the chains and networks of supply across the country, or between cities to ratify the supply of goods, services or labour and 'sense test' the modelled value. In effect, the same process routinely used to test country-level sources is applied in reverse to city-level sources. All sources have a defined confidence level, which is a measure of its historic accuracy for the metric being measured. These are combined to give a confidence level for the value, which is an indication of the likely accuracy of the source data used to calculate the value in the dataset. In cases where there was a gap in data, the model back-dated or forecasted values to align data to the same year. Where this is undertaken, those adjustments are made using intelligence from sources such as the World Bank, in-country economic institutions, sector-specific institutions and trade bodies and supply chain sources to indicate whether the activity was similar to the reported year, whether there was any unusual activity or contraction and model a likely 'true' value.

1.2 Measuring the market - Baseline Year (2023)

The model begins by establishing baseline year data for each key component being evaluated. Determining baseline year data is necessary to give a size of the market, which acts as a starting point for the model to forecast both demand and supply. The baseline year indicates how many people are currently employed to deliver current services, upon which population and economic growth and policies are then overlaid (sections below). For this study, the baseline year is 2023 given the time-lag between the end of a time period and measurements to allow for reporting of work completed, as such, 2024 data was not available at the start of the study.

For each city or country, employment is measured first using a skills model, followed by sales generated within the sector using a different model. This approach allows for employment and sales to act as a sense-check of each other as sources used to determine employment are different to those used to measure sales.

- Sales values are triangulated from public, private, institutional, academic, industrial and trade sources, including advertising and HR, financial, legal and investment, other unpublished sources and over 2.5 million specialist datasets worldwide.
- Employment values are triangulated from industry-specific personnel associations, training associations, academic data sources, sub-sector training providers, trans-sector training data (via academia or trade associations) and over 16,000 other specialist skills datasets worldwide.

1.3 Forecasting the market demand to 2030 and 2040

Demand refers to the number of workers expected to be needed to service the market under forecast population and economic growth and with the policies and targets set by the City, and Nationally.

The heart of forecasts are the Climate Action Plan (or equivalents) of each city, which are generally produced in-line with country-level targets, augmented with NDCs and National Plans for a comprehensive picture of likely sector projections. The country-level data draws from national policy papers which provide an indication of the targets being set.

The demand value has been calculated for all occupations, across every sub-sector studied and is unaltered across the workforce development scenarios.

Climate Action Plans are variable in terms of the balance between qualitative and quantitative targets, where Climate Action Plans do involve measurable and therefore forecastable targets, they have been used within the forecasting to guide potential employment demand. Those which are more qualitative in their approach have been used within the study as a guide to areas of focus for the city, which have then been augmented with sources from within and around those target sectors to offer an estimate of the potential impact of the Climate Action Plan.

Example Salvador Recycling: Salvador has a target to increase recyclables in household solid waste to 45% in 2032 and 80% of recyclables by 2049. To forecast the impact on employment, we must first establish the rate of recycling in 2023 (the year we have calculated the current employment values). Recycling rates are not readily available for Salvador, however the Brazilian government enacted the National Solid Waste Plan in 2022[1]. This aims to increase recycling rates of all waste to 14% by 2024 and 48% by 2040. In 2022, recycling rates in Brazil were only 4%[2]. In the absence of recycling rates for Salvador, the national target for 2024 has been used, and reduced to 10% to allow for our baseline year of 2023 and potential slow implementation. We therefore assume the current workforce is able to service a recycling rate of 10%.

We then assess what the jobs within the city are, e.g., manufacturing, service, supply, installation etc, and forecast the needs to 2030 and 2040, adjusting the target from 80% in 2049 to 60% for 2040. In the absence of a pathway, we assume the activity split in the city will not change, for example we assume the city will not dramatically increase the manufacture of machinery beyond usual growth. Growth is not linear, so an increase of 35% in recycling does not lead to an increase of 35% in employment. The level of increase depends on the types of employment, activities, the sector and the chains of networks of supply (e.g., supply chain stability, ability to expand and service new requirements etc). The kMatrix methodology tool assesses the impact of the expected growth on the workforce demand in each city.

Example source lists for each city and country have been provided for the study and policies relevant to each city and country have been included as embedded excel files in the city/country sections in this report.

1.4 Comparative Workforce Development Scenarios

Workforce development refers to the strategies, initiatives and programs designed to train the workforce to meet the needs of industry for the current and future job market. These encompass current training, industry-led training provision (e.g., independent training providers) and public workforce development. With regards to this study, it is a measure of the size of the workforce the city or country is likely to be able to develop by 2040 within selected sectors.

[1] Brazil Waste Management

[2] Brazil recycling rate merely 4% | Agência Brasil

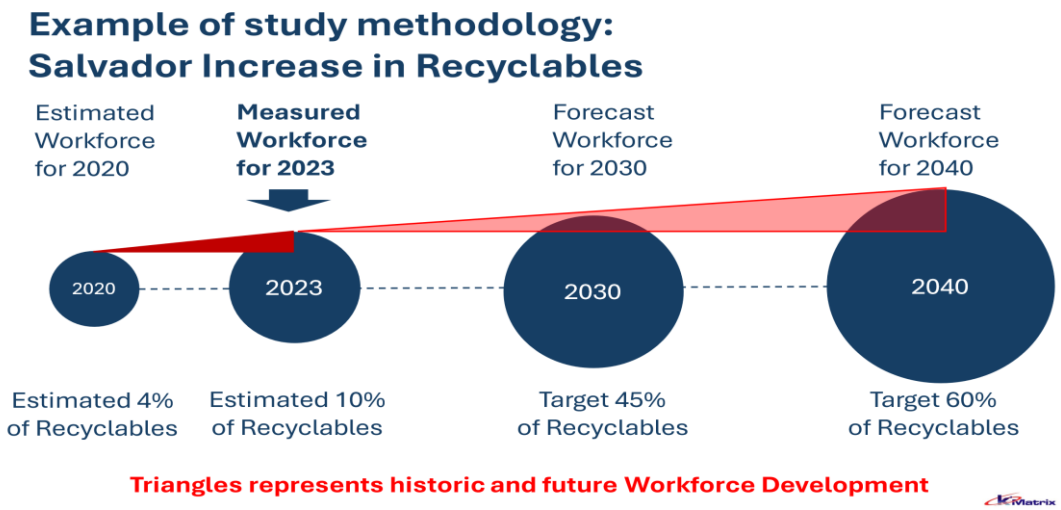
In this study, two workforce development scenarios were created and evaluated to determine whether a significant increase in workforce development investment (in this case, +50%) would reduce all, or most, projected labour shortages in cities.One scenario, business as usual, maintained current investment levels in workforce development steady from 2023 through 2040. The second scenario, optimistic, envisaged the impact of a +50% increase in workforce development by 2040. Investment in workforce development was measured through the value of TVET (Technical and Vocational Education and Training), which encompasses programs that train practical skills and knowledge for specific occupations, often including hands-on training and industry-relevant curricula. It can include a wide variety of direct skills, such as bricklaying and also health and safety etc. The total educational budget was not chosen as the indicative value as it was considered too broad to be meaningful, whereas TVET is more targeted and has the potential to offer stronger benefits for a smaller increase in investment, therefore being more achievable for a city.

The Workforce Development Scenario methodology is similar to that used for the employment forecasts. The first objective was to determine how many people were employed in 2023; the second was to forecast the number of people needed in 2040; the third was to then estimate the likely total workforce under each Workforce Development Scenario, i.e. 2023 values plus new employees. It represents a value for the total workforce per sector, per occupation likely to be developed. City-level figures can then be compared with Country-level figures.

Public sector workforce development programmes are not usually created from first principles, instead, they build on existing institutions and capabilities. Generally, the current training capacity, combined with the history of success are built on to further develop training provision. As such, looking backwards at the previous rate of sector development can indicate the potential for development in the immediate future.

Using the example from the previous section of the Salvador target to increase recyclables, Figure 1 illustrates how previous workforce development (pre-2023) can be used to give an indication of how each sector has grown its workforce in the past.

Figure 1



One of the core considerations in the projections of workforce development is not only how long it takes to train workers, but also how long it takes to train those who do the workforce training. The time to 'train the trainer' varies by subject matter, sector and any regulatory implications, for example it takes a shorter length of time to train a trainer to teach a Bricklaying course than it does to train a trainer to teach a course in Architectural Design with the associated regulatory requirements. The associated time to train a trainer has implications with regards to how quickly a sector can scale.

The kMatrix tool utilizes a second modelling tool within the kMatrix suite called sMatrix, which models these elements of the study. Detailed methodology in Annex F.

1.4.1 Scenario 1: Business as Usual - Current Training Provision Workforce Development Scenario

This forecast estimates the number of employees which could be trained and enter the workforce under current training provision and the likely ability of that provision to expand to meet climate action plan policies. It estimates the current training rates of the sector based on current national and local policies or commitments and assumes any increase in investment is in line with Climate Action Plans.

We look at what has been historically achieved (past performance, number of courses and jobs), what the current training provision is, and likely capacity to expand to reach targets. For this scenario, we assume that any increase in funding (Investment) is in line with policy targets.

This provides the total number of employees likely to be available to the sector in 2030 and 2040 under current training provision.

1.4.2 Scenario 2: Optimistic - Increased TVET Investment Workforce Development Scenario

This scenario builds on the current training provision scenario and maps the likely effect of increasing Technical and Vocational Education and Training (TVET) by 50% on top of 2023 spending levels. The values for workforce development in this scenario provides the total number of employees likely to be available to the sector in 2030 and 2040 if TVET investment is increased by 50%.

Estimates of TVET spending have been determined through the use of proxy values in line with government and international institutions data and reporting. The detailed table below provides more information.

The proxies used for TVET are:

	TVET as a % of GDP	Source	GDP 2023 (World Bank)	Estimated TVET Spend in 2023	TVET Spend + 50%
Brazil	0.2%	World Bank Proxy	$4,470bn	$8.9bn	$13.4bn
Colombia	0.2%		$764bn	$1.5bn	$2.3bn
Italy	0.46%		$2,410bn	$11.1bn	$16.6bn
Kenya	0.2%		$349bn	$0.7bn	$1.0bn
Mexico	0.34%	UNECLAC	$2,529bn	$8.6bn	$12.9bn
South Africa	0.2%	UNESCO	$690bn	$1.9bn	$2.9bn
USA	0.36%	Credential Engine	$21,737bn	$78.3bn	$117.4bn

To note: The USA has a different system of funding, with government expenditure on TVET-equivalent training, called Career and Technical Education (CTE) classification. It is taught in non-parallel subsystems with few structural connections and are aligned with National Career Clusters. There is no national TVET or CTE qualifications framework in the US, but CTE is based within the public

education system, largely limited to high school; community and technical colleges; government programmes; a very small apprenticeship system and most significantly, a large business-based training system which is disconnected from the others. As a consequence, a significant proportion of TVET-equivalent training in the USA is provided by companies to their employees, independent of government or educational connections. If 'official' TVET investment values were used, it would only represent 0.02% of GDP in 2021. A report produced by Credential Engine in 2021[3] used census data to estimate US government spending on training and education in 2017, and estimated CTE or TVET-equivalent training at 0.36% of GDP. Although not a direct comparator to TVET, it is more in-line with the 0.46% of GDP spent on average by HICs.

1.5 Calculation of Shortages

For simplicity of reporting, workforce development has been subtracted from the forecast employment in 2040 to provide the labour shortages expected by 2040.

Shortages are calculated using the simple formula:

$$Total\ Employment\ 2040 - Workforce\ Development\ Under\ Current\ Policy = Shortages\ 2040\ Under\ Current\ Policy$$

$$Total\ Employment\ 2040 - Workforce\ Development\ TVET + 50\% = Shortages\ 2040\ TVET + 50\%$$

Shortages have been calculated for all occupations in all sub-sectors.

1.6 Informal Employment

The methodology ensures that as much informal employment in each city in the research, per selected sector, as possible is captured, to ensure that cities included in the study had the most comprehensive view of their labour market.

Total Employment includes both formal and informal workers and informal value having been provided as a sub-set of total employment at Level 1 (not Level 2). The limit to Level 1 is a pragmatic trade-off between the budget and the benefit to the study, with Level 1 chosen in collaboration with C40 as providing useful information without being excessive on resources.

[3] Credential Engine. (2021). Education and training expenditures in the U.S. Washington, DC: Credential Engine.

As the definition of informal employment varies per country, with some countries having their own definition, the study is aligned - where possible - with the definition used by the country being measured. This is a pragmatic approach because reported values for informal labour will likely be using the national definition, and by using the national definition, the values are more likely to have salience with City representatives.

Example from Brazil the IBGE Instituto Brasileiro De Geografia E Estatistica:

> "Formal includes employees with a signed employment record, domestic workers with a signed employment record, military personnel, statutory public servants, self-employed workers and employers who contributed to social security."
>
> Informal employment is assumed to include all other employment with a traceable economic footprint.

Where country-specific definitions are not available, informal labour has been measured using the International Labour Organisation definition, from "International Labour Organisation What is informal employment?" Jan 2023:

> "Informal employment refers to working arrangements that are in practice or by law not subject to national labour legislation, income taxation, or entitlement to social protection or other employment guarantees; for example, advance notice of dismissal, severance pay or paid annual or sick leave.
>
> Informality can exist even in the 'formal' sector. Casual, temporary, and seasonal workers who lack social protection coverage or other employment benefits, or who fall short of full legal status, have informal employment status even when they work in the 'formal' sector."

1.7 Identification of Occupations and Occupational Groups and Evaluation of Skill Level

As occupational classifications differ between countries, the International Labour Organisation International Standard Classification of Occupations (ISCO) has been chosen as they are internationally accepted and enable consistency of reporting across cities and countries. Additionally, the ISCO has well-defined definitions. The Major groups are:

Clerical Support Workers	Plant and Machine Operators and Assemblers
Craft and Related Trades Workers	Professionals

Elementary Occupations	Service and Sales Workers
Managers	Technicians and Associate Professionals

Two ISCO groups have been removed: Skilled Agricultural, Forestry & Fishing Workers and Armed Forces Occupations, as neither are relevant to the study.

All relevant occupations can be arranged into the groups, for example, Waste Pickers are listed as being within the Elementary Occupations, while Garbage Truck Drivers are located in Plant and Machine Operators and Assemblers.

The kMatrix methodology provides information on the skill level of each job in the research, based upon the categorizations identified above. Educational or training requirements for occupations have been split by:

1. No Qualifications Needed – Occupations which either do not involve training or education, or it can be provided on-the-job
2. Qualifications Needed – Occupations which require education and/or training to have been undertaken before applying for the job.

A full comparative analysis of this is in Annex C.

Apprenticeships are included, where entry-level apprenticeships would be included in the 'No Qualifications Needed' group and more advanced apprenticeships which require applicants to hold existing qualifications before starting the apprenticeship are included in the 'Qualifications Needed' group.

Evaluation of how many workers in each occupation are within each group are defined through the sMatrix skills modelling process and are based on what tasks the worker would be doing and if pre-training would be needed to fulfil the role.

1.8 Calculation of Economic Advantage

Economic Advantage of filling shortages has been calculated as a simply as possible, by applying the sales per employee in 2023 to the shortages in 2040 using the formula:

$$\left(\frac{2023\ Sales}{2023\ Employment}\right) x 2040\ Shortage$$

It is intended as a simplistic guide economists can then overlay scenarios if desired. This does not take into account inflation, any changes to work patterns (longer/shorter days) or changes to workforce composition (e.g. automation requiring fewer employees). It is not intended and cannot be used as an indication of the value of TVET training per $ spent, because the Sales value includes materials, equipment and ancillary provisions which elevate the sales per employee value.

1.9 Limitations of the Study

Research Limitations include:

1. Some large, non-green sub-sectors are not measured within the dataset, for example, the dataset does include transport by rail, bus, maritime and inland waterways (Green) and by taxi (Partially Green), but it does not include aviation or domestic vehicle use, with the exception of the installation of domestic EV charge points (Green) and Gas/Petrol stations (Non-green). This lack of large sub-sectors is only a limitation with respect to monitoring the decline of those non-green sub-sectors, or the split between green/non-green jobs.
2. Some sub-sectors designated as 100% Green include non-green elements. For example, rail transport is considered 100% green, regardless of whether the train itself is electric/hydrogen/diesel. As for the previous point, the only limitation here is the lack of visibility for these sectors making improvements in their green credentials over time.
3. Education and Training are arguably overrepresented in the dataset. Education and training were originally designated as green, regardless of topic due to the social benefits. It was decided within the study to include a 'mixed' category which would include that training within a sub-sector which was undeniably non-green, e.g., training specifically for the operation of landfill sites. This allows those activities to be filtered out, a complication is any training not directly related to the operation of a landfill site, such as health and safety training of landfill operatives would be included.
4. The dataset includes both direct and indirect employment, however, only green jobs are split by direct and indirect. The benefit of measuring both direct and indirect jobs is measuring as large a sector as possible. The limitation means only the combined

value for the green jobs can be compared with the non-green jobs, which isn't considered a significant limitation as the green jobs are the focus of the study.

5. Unemployment has not been factored into the study due to complications around skills levels of the unemployed cohort. There are a lack of sources able to quantify the skills of those who are unemployed, certainly across cities and countries to confidently incorporate into the study, and it would not be robust to assume the make-up of the unemployed cohort to be similar to the employed. Additionally, by not factoring in the unemployed, the study can be used as a baseline from which unemployment modelling can be applied for a city if required as a further research project.

2. Data Analysis C40 Consolidated Cities

This section provides and overview of the key findings for the consolidated 25 Cities, including forecasts of shortage in green jobs, the economic advantage of those shortages (at the sector-level, both green and non-green), followed by the ISCO categories of job shortages.

2.1 Datasets for C40 Consolidated Cities and Consolidated Countries

The quantitative datasets upon which this analysis is based are available from the kMatrix report webpage here.

2.2 C40 Consolidated Cities High Level Trends

Analysis in this section refers to the three core sectors of Construction, Transport and Waste Management, for green jobs only. Table 1 gives the total number of green jobs and shortages, for the three core sectors of Construction, Transport and Waste Management combined. This includes only green, direct jobs.

Table 1: Green Jobs forecast to 2040 for 25 Consolidated Cities and Consolidated Countries, Core Sectors Aggregated

	Forecast 2040 FTE Total Employment	2040 Shortage Current Policy	2040 Shortage TVET 150%
Consolidated Cities	13,142,122	6,632,933	2,952,960
Consolidated Countries	83,186,549	41,951,389	23,589,703
Consolidated City Share of Consolidated Countries	15.8%	15.8%	12.5%

Table 1 shows the combined cities share of the combined national employment for green jobs is expected to be 15.8% in 2040. Share of shortages is expected to be 15.8% in 2040 with current policy, reducing to 12.5% with an additional 50% investment in TVET. The lower proportion of shortages with an additional 50% investment in TVET is due to the concentration of TVET training in the cities compared with the rest of the countries.

Table 2 shows the total number of jobs and economic advantage of shortages, for the three core sectors of Construction, Transport and Waste Management combined. This includes all green jobs within the sector, direct and indirect.

Table 2: Green Sector Sales and forecast to 2040 with Economic Advantage for 25 Consolidated Cities and Consolidated Countries, Core Sectors Aggregated

	Forecast 2040 Sales	2040 Shortage Current Policy	2040 Shortage TVET +50%	Economic Advantage of Filling 2040 Current Policy Shortages	Economic Advantage of Filling 2040 TVET +50% Shortages
Consolidated Cities	626,022	6,632,933	2,952,960	279,329	123,868
Consolidated Countries	8,497,773	41,951,389	23,589,703	3,779,018	2,185,709
Consolidated City Share of Consolidated Countries	7.4%	15.8%	12.5%	7.4%	5.7%

Note: *Shortages are direct jobs only, sales and economic advantage include both direct and indirect sales and jobs*

Table 2 shows for green sector, direct and indirect jobs, the combined cities share of the combined national Sales is expected to be 7.4% in 2040. Share of economic advantage is expected to be 7.4% after filling shortages remaining after current TVET policy; and 5.7% if TVET is increased by 50%, because of the concentration of TVET in the cities.

2.3 C40 Consolidated Cities Sectoral Analysis

Table 3 gives the total number of green jobs and shortages, for the three core sectors of Construction, Transport and Waste Management for the Consolidated Cities and Consolidated Countries. This includes only green, direct jobs.

Table 3: Green Jobs in 2023 and forecast to 2040 for Consolidated Cities and Consolidated Countries, Core Sectors

	Sector	Forecast 2040 FTE Total Employment	2040 Shortage Current Policy	2040 Shortage TVET +50%
Consolidated Cities	Construction	6,625,634	3,369,305	1,523,893
	Transport	5,535,381	2,776,698	1,233,519
	Waste Management	981,107	486,930	195,548
Consolidated Countries	Construction	39,862,190	20,299,109	12,064,119
	Transport	36,061,608	17,823,281	9,665,001
	Waste Management	7,262,751	3,828,999	1,860,583
	Construction	16.6%	16.6%	12.6%

Consolidated Cities Share of Consolidated Countries	Transport	15.3%	15.6%	12.8%
	Waste Management	13.5%	12.7%	10.5%

The Consolidated Cities share of the Consolidated Countries employment for green jobs is significant, due to the cities combined economic roles in their countries. Employment is expected to vary between 13.5% for Waste Management and 16.6% for Construction in 2040. Share of shortages is expected to be between 12.7% and 16.6% with current policy, reducing to between 10.5% and 12.6% with an additional 50% investment in TVET. The lower proportion of shortages with an additional 50% investment in TVET is due to the concentration of TVET training in the cities compared with the rest of the countries.

Table 4 gives the total number of green jobs and shortages, for the three core sectors of Construction, Transport and Waste Management. This includes only green, direct jobs.

Table 4: Green Sector Sales and Jobs, forecast to 2040 with Economic Advantage for 25 Consolidated Cities and Consolidated Countries, Core Sectors Disaggregated

	Sector	Forecast 2040 Sales	2040 Shortage Current Policy	2040 Shortage TVET +50%	Economic Advantage of Filling 2040 Current Policy Shortages	Economic Advantage of Filling 2040 TVET +50% Shortages
Consolidated Cities	Construction	$363bn	3,369,305	1,523,893	$162bn	$73bn
	Transport	$214bn	2,776,698	1,233,519	$97bn	$42bn
	Waste Management	$48bn	486,930	195,548	$21bn	$9bn
Consolidated Countries	Construction	$5,501bn	20,299,109	12,064,119	$2,438bn	$1,425bn
	Transport	$2,408bn	17,823,281	9,665,001	$1,079bn	$610bn
	Waste Management	$588bn	3,828,999	1,860,583	$263bn	$151bn
Consolidated Cities Share of Consolidated Countries	Construction	6.6%	16.6%	12.6%	6.6%	5.1%
	Transport	8.9%	15.6%	12.8%	9.0%	6.8%
	Waste Management	8.2%	12.7%	10.5%	7.9%	6.1%

Note: *Shortages are direct jobs only, sales and economic advantage include both direct and indirect sales and jobs*

Table 4 shows for green sector, direct and indirect jobs, the Combined Cities share of the Combined Countries Sales is forecast to be between 6.6% for Construction and 8.9% for Transport in 2040. Share of economic advantage is expected to be between 6.6% and 9.0%

after filling shortages remaining after current TVET policy; and between 5.1% and 6.8% if TVET is increased by 50%, because of the concentration of TVET in the Consolidated Cities. The Consolidated Cities are forecast to account for 10.5% of the population of the Consolidated Countries in 2040; the comparatively higher proportion of employment and shortages in these three sectors illustrate the concentration of green jobs in these cities, compared with the wider country.

2.4 C40 Consolidated Cities Sub-Sector Analysis

Despite generally strong Workforce Development within Consolidated Cities, shortages are expected to persist in sectors:

Construction:

Table 5: Green Sector Sales and Jobs, forecast to 2040, Shortages and Economic Advantage for 25 Consolidated Cities - Construction

Consolidated Cities	Forecast 2040 Sales	Forecast 2040 FTE Total Employment	2040 FTE Shortage Current Policy	2040 FTE Shortage TVET +50%	Economic Advantage of Filling 2040 Current Policy Shortages	Economic Advantage of Filling 2040 TVET +50% Shortages
Construction	**$363,285m**	**6,625,634**	**3,369,304**	**1,523,893**	**$161,733m**	**$73,079m**
Construction of Energy/Heat Infrastructure Projects	$50,425m	975,461	481,609	232,264	$21,998m	$10,442m
Construction of Transport Infrastructure	$53,526m	1,395,233	688,444	338,685	$23,668m	$11,802m
Construction of Utility Infrastructure Projects	$141,628m	2,148,145	1,087,581	472,154	$63,512m	$27,479m
Installation of Domestic Energy Solutions	$32,201m	972,726	525,085	220,585	$15,291m	$6,243m
Installation of Domestic Plumbing, Heat and Air-conditioning	$14,802m	462,015	266,229	104,747	$7,517m	$2,914m
Training & Education	$70,703m	672,054	320,357	155,458	$29,747m	$14,200m

Note: *Shortages are direct jobs only, sales and economic advantage include both direct and indirect sales and jobs*

Transport:

Table 6: Green Sector Sales and Jobs, forecast to 2040, Shortages and Economic Advantage for 25 Consolidated Cities - Transport

Consolidated Cities	Forecast 2040 Sales	Forecast 2040 FTE Total Employment	2040 FTE Shortage Current Policy	2040 FTE Shortage TVET +50%	Economic Advantage of Filling 2040 Current Policy Shortages	Economic Advantage of Filling 2040 TVET +50% Shortages
Transport	**$214,394m**	**5,535,381**	**2,776,698**	**1,233,519**	**$96,860m**	**$41,576m**
Inland Waterways	$45m	837	432	151	$22m	$8m
Maritime	$1,164m	9,697	4,199	1,536	$448m	$161m
Railways	$130,191m	3,210,248	1,603,651	697,968	$59,383m	$25,243m
Road Transport	$63,553m	1,875,817	961,471	432,831	$29,088m	$12,579m
Training & Education	$19,441m	438,783	206,945	101,033	$7,919m	$3,585m

Note: *Shortages are direct jobs only, sales and economic advantage include both direct and indirect sales and jobs*

Waste Management:

Table 7: Green Sector Sales and Jobs, forecast to 2040, Shortages and Economic Advantage for 25 Consolidated Cities – Waste Management

Consolidated Cities	Forecast 2040 Sales	Forecast 2040 FTE Total Employment	2040 FTE Shortage Current Policy	2040 FTE Shortage TVET +50%	Economic Advantage of Filling 2040 Current Policy Shortages	Economic Advantage of Filling 2040 TVET +50% Shortages
Waste Management	**$48,344m**	**981,107**	**486,930**	**195,548**	**$20,736m**	**$9,213m**
Ancillary Activities	$972m	23,672	12,785	4,727	$457m	$182m
Training & Education	$1,837m	39,170	20,652	8,343	$842m	$364m
Waste Collection	$36,473m	778,570	383,734	154,096	$15,659m	$6,861m
Waste Handling	$2,179m	66,509	36,994	13,095	$1,065m	$413m
Water	$6,884m	73,185	32,764	15,287	$2,714m	$1,394m

Note: *Shortages are direct jobs only, sales and economic advantage include both direct and indirect sales and jobs*

2.5 C40 Consolidated Cities Skills Analysis

Tables 8a and 8b show the shortages per ISCO Group, for the three core sectors of Construction, Transport and Waste Management. This includes only green, direct jobs in the sector.

Table 8a: Green Job Shortages in 2040 under Current Training Policies, by ISCO, for 25 Consolidated Cities

	Low Skill	**Medium Skill**				**High Skill**		
	Elementary Occupations	Clerical Support Workers	Service and Sales Workers	Plant and Machine Operators, and Assemblers	Technicians and Associate Professionals	Craft and Related Trades Workers	Managers	Professionals
Waste	206,383	18,526	36,892	43,112	56,699	44,180	41,427	39,713
Transport	513,534	152,493	310,583	348,525	465,602	356,598	311,691	317,671
Construction	581,699	175,851	377,758	433,479	570,926	419,548	404,848	405,196
Total	1,301,615	346,870	725,233	825,115	1,093,228	820,327	757,965	762,580

Table 8b: Green Job Shortages in 2040 if TVET was increased by 50%, by ISCO, for 25 Consolidated Cities

	Low Skill	**Medium Skill**				**High Skill**		
	Elementary Occupations	Clerical Support Workers	Service and Sales Workers	Plant and Machine Operators, and Assemblers	Technicians and Associate Professionals	Craft and Related Trades Workers	Managers	Professionals
Waste	82,649	7,467	15,126	17,507	22,277	17,659	16,941	15,922
Transport	231,869	66,186	139,473	158,521	206,304	155,345	137,652	138,169
Construction	265,196	80,214	168,501	198,525	257,242	188,953	182,735	182,527
Total	579,713	153,868	323,100	374,552	485,823	361,958	337,328	336,618

Note: by averaging a large number of cities, the shortages have become very similar. At the City-level there is more variation between the sectors, and between cities within the same country and cities within different countries.

Tables 8a and 8b show at this level of analysis, the largest shortages are expected to be in Elementary Occupations, followed by Technicians and Associate Professionals; with the lowest shortages expected in Clerical Support Workers.

Table 9 shows the forecast 2040 employment and shortages, split by whether qualifications are needed or not, for the three core sectors of Construction, Transport and Waste Management. This includes only green, direct jobs in the sector.

Table 9: Green Job Shortages in 2040, Split by Qualification, for 25 Consolidated Cities

	Sector	**Forecast 2040 FTE Total Employment**		**2040 Shortage Current Policy**		**2040 Shortage TVET +50%**	
		No Qualifications needed	Qualifications needed	No Qualifications needed	Qualifications needed	No Qualifications needed	Qualifications needed
Consolidated Cities	Waste	657,607	323,500	332,237	154,693	135,446	60,102
	Transport	3,125,079	2,410,302	1,572,160	1,204,537	700,504	533,015
	Construction	3,824,593	2,801,041	1,950,193	1,419,111	893,032	630,861
	Total	7,607,279	5,534,843	3,854,590	2,778,341	1,728,982	1,223,978
Consolidated Countries	Waste	4,823,061	2,439,689	2,575,253	1,253,745	1,250,157	610,425
	Transport	21,544,867	14,516,741	10,696,430	7,126,851	5,925,233	3,739,768
	Construction	22,306,276	17,555,914	11,085,397	9,213,712	6,428,398	5,635,720
	Total	48,674,204	34,512,344	24,357,080	17,594,308	13,603,788	9,985,913
Consolidated City share of Consolidated Countries	Waste	13.6%	13.3%	12.9%	12.3%	10.8%	9.8%
	Transport	14.5%	16.6%	14.7%	16.9%	11.8%	14.3%
	Construction	17.1%	16.0%	17.6%	15.4%	13.9%	11.2%

	Total	15.6%	16.0%	15.8%	15.8%	12.7%	12.3%

Table 9 shows the consolidated city share of consolidated country green jobs, shortages reduce for jobs that need qualifications and for those who do not. This is because, for an increase in TVET to be effective, it has to be advertised that those sectors offer job opportunities to attract learners, which also highlights these sectors are expected to be high growth and so attracting those who do not need qualifications. Essentially, by overtly training skilled people in a sector, unskilled workers are attracted by the promotion of the sector as being high growth, stable, and with associated potential for long-term employment.

Annexes

Annex A. Geographic Scope of the Study

COUNTRY	CITY
Brazil	Curitiba
	Fortaleza
	Rio de Janeiro
	Salvador
	São Paulo
Colombia	Barranquilla
	Bogotá
	Cali
	Medellín
Italy	Milan
	Rome
Kenya	Nairobi
Mexico	Guadalajara
	Mexico City
South Africa	Cape Town
	Durban
	Ekurhuleni
	Johannesburg
United States	Boston
	Chicago
	Denver
	Madison
	Phoenix
	Seattle
	Washington DC

Annex B. Sectors & Occupations in this Study

Sector	Level 1	Level 2	Definition
Waste Management	Waste Collection	**Waste Transportation (Manufacture & Maintenance)**	The manufacture and/or maintenance of waste transportation trucks. These activities can be for city-based trucks or services provided for out-of-city clients
Waste Management		**Kerbside Collection / Doorstep Waste Pickers (incl. Drivers)**	The regular or irregular collection of household or commercial waste from residences, businesses or municipal premises. These services typically utilise trucks, drivers and waste collection operatives and are distinguishable from 'waste pickers' by the scheduled nature of collections, either by routine regular collection slots or collection via arrangement
Waste Management		**Municipal Waste Site Operation**	The unloading of waste from collection trucks, including the operation of plant and equipment, e.g., heavy lifting equipment where necessary. Compliance and record keeping activities, weighing and loading of trucks. Public-facing waste sites also include the traffic management, public safety and assistance to the public with regards to waste sorting.
Waste Management		**Waste Picking**	Salvage of reusable or recyclable materials (segregated or mixed) from residential or commercial waste bins, refuse dump sites or public spaces and streets to either reuse, repurpose or direct materials into recycling streams for income.
Waste Management	Waste Handling	**Waste Sorting Services**	The process of sorting waste into categories, according to materials or recyclability. It includes the inspection of waste materials, identification and removal of contaminant or non-recyclable items and ultimately sorting into relevant waste streams. This is often undertaken on a conveyor belt system and can include high-tech waste sorting robots or be undertaken entirely by hand. The waste is then either sent for re-use, recycling or disposal. Waste sorting can be performed multiple times, on different premises as part of municipal site operations, at specific waste sorting facilities (e.g. plastic from glass), and as part of the recycling process (e.g. different colours of glass), with each stage including additional sorting operations.

Waste Management		**Composting Operations**	The recycling of biodegradable waste, such as vegetation, food waste, bio-soils, paper not suitable for recycling, wood or other organic materials. This can involve checking waste for contamination, sizing, shredding, mixing, forming into windrows and regularly turning to optimise the composting process. The end product is a soil conditioner /compost
Waste Management	Water	**Water Collection, Treatment & Supply**	This includes the collection of water from various sources, including aquifers, reservoirs, lakes etc, treating it and distributing to end users (it does not include the construction or maintenance of the infrastructure, which is included in the construction sector)
Waste Management		**Sewerage**	This includes the collection, treatment and disposal of human waste. Specifically, it includes the screening, sedimentation, biological treatment and disinfection of the resulting water for reuse or release. The resultant sludge waste are often further treated via anaerobic digestors or composting - any composting process is measured in the composting operations sub-sector. Alternatively it is sometimes disposed of in landfill, or used as fertiliser. Operation of the facilities includes system monitoring, environmental monitoring, maintenance work and desludging. (it does not include the construction or maintenance of the infrastructure, which is included in the construction sector).
Waste Management	Ancillary Activities	**Engineering & Equipment (Manufacture, Installation & Maintenance)**	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.
Waste Management		**Technologies, Research & Development**	R&D into subjects including metals recovery, pyrolysis, bio-based systems, new recyclable materials, new collection & processing technologies, incineration technologies, cleaner processing & treatment technologies, disposal of hazardous waste and other materials processing technologies.
Waste Management	Training & Education	**Training (Waste Management)**	Training aims to develop specific, practical skills for jobs within the Waste Management Sector and is usually specific and short-term. 'Green' training refers to those elements which are either within the Green sub-sectors (e.g., all composting training), while 'Mixed' training refers to green training within sub-sectors not classified as 'Green' (e.g., sustainability courses in recycling and processing centres)
Waste Management		**Education (Waste Management)**	Education refers to a broader understanding of a subject or field in Waste Management. 'Green' education refers to those elements which are either within the Green sub-sectors (e.g., further education courses in Environmental Science and Waste Management), while 'Mixed' refers to green education within sub-sectors not classified as 'Green' (e.g., Environmental Sciences used within the operation of landfills)

Construction	Construction of Utility Infrastructure Projects	**Potable Water Infrastructure**	Construction of potable water treatment plants and pumping stations, including supply, installation and maintenance of equipment (except daily routine maintenance), supply and installation of communication pipes, including all trenching and making good after works, main pipe installation including all trenching and making good after works. This sub-sector includes all maintenance-related activities including water leak identification and correction, including replacement of pipework etc.
Construction		**Grey Water Infrastructure**	Construction of grey/waste water treatment facilities and pumping stations, including supply, installation and maintenance of equipment (except daily routine maintenance e.g. desludging), supply and installation of all drain and sewer infrastructure, including all trenching and making good after works. This sub-sector also includes sustainable urban draining systems.
Construction	Construction of Energy/Heat Infrastructure Projects	**Wind**	Includes all groundworks, cabling, supply, installation and maintenance of towers, turbines, gearboxes, cowlings, blades, directional equipment, energy systems, central control systems and grid connections. This includes all ground works, construction services including landscaping
Construction		**Solar Farms**	This includes solar farms and utility-scale large roof-top installations on commercial buildings. It includes site preparation, the supply and installation of cabling, inverters, solar frames, solar panels, substations and transformers and any associated finishing and landscaping activities.
Construction	Installation of Domestic Energy Solutions	**Installation of Solar Panels**	The supply, installation and maintenance of Solar Panels for domestic use. This includes any roof strengthening, scaffolding, ancillary cabling, trenching and associated installation activities. They also include both roof-mounted and ground-based systems. Where connected to a grid system, it does not include grid-based management (communications etc). It also includes any associated battery equipment
Construction		**Installation of EV Charge Points**	The supply, installation and maintenance of EV Charge points for domestic use. This includes any ancillary cabling, trenching and associated installation activities
Construction	Installation of Domestic Plumbing, Heat and Air-conditioning	**Installation of Heat Pumps or central climate control**	The supply, installation and maintenance of Heat Pumps and associated plumbing, for domestic use. This includes any ancillary cabling, pipework, radiators etc, and associated installation activities. Where associated with a domestic geothermal system, the heat pump is included and the rest of the geothermal system is within 'other'. It does not include heat pumps associated with geothermal heat networks.
Construction	Construction of Transport Infrastructure	**Construction of Railways**	Construction of railways including all ground works, tunnelling, bridges, track laying, installation of signalling, cabling, operating systems etc, along with the construction of stations, platforms, ancillary structure e.g. car parks, along with railway sidings, maintenance facilities etc. It does not include railway operation, passenger services or rolling stock purchase/maintenance. It does include heavy rail, light rail/trams, metro/subways and cable cars. It also includes rail freight facilities at ports. It does include electric systems and those for diesel and other fuel types (e.g., hydrogen). Maintenance is included in the Transport sector.

Construction	Training & Education	**Training (Construction)**	Training aims to develop specific, practical skills for jobs within the Construction sector and is usually specific and short-term. 'Green' training refers to those elements which are either within the Green sub-sectors (e.g., all grey water infrastructure training including health and safety training), while 'Mixed' training refers to green training within sub-sectors not classified as 'Green' (e.g., sustainability training or energy reduction training in gas infrastructure).
Construction		**Education (Construction)**	Education refers to a broader understanding of a subject or field in Construction. 'Green' education refers to those elements which are either within the Green sub-sectors (e.g., further education courses in engineering and technology for the construction of wind), while 'Mixed' refers to green education within sub-sectors not classified as 'Green' (e.g., Environmental Sciences used within the construction of roads)
Transport	Railways	**Station Operation**	This involves administration (e.g., on demand ticketing), operations management (including compliance for health & safety), passenger coordination (barrier control), platform staff, signal management and train scheduling. Customer services, luggage re-direction, porter services, some catering activities (permanent venues are classed as direct, temporary kiosks as indirect) etc.
Transport		**Passenger Rail Operation**	This involves administration (e.g., direct purchase of tickets from rail operator), operations management (including compliance for health & safety), train purchase and maintenance scheduling and rail operations (e.g. operation of rail services). This includes for heavy rail, light rail/trams, metro/subway and cable cars. They also include electric, diesel and other fuels (e.g. hydrogen)
Transport		**Freight Rail Transport Operation**	Administration (e.g. documentation, compliance), loading and unloading of cargo at terminals and customer locations, routing trains through yards for sorting and maintenance, other administration and management (e.g., freight forwarding activities).
Transport		**Railway Maintenance**	Maintenance of railways including all tunnels, bridges, track, signalling, operating systems, cabling etc, along with the maintenance of stations, platforms, ancillary structure e.g. car parks, along with railway sidings, maintenance facilities etc. It does not include railway operation, passenger services or rolling stock purchase/maintenance. It does include heavy rail, light rail/trams, metro/subways and cable cars. It does include electric systems and those for diesel and other fuel types (e.g., hydrogen).
Transport		**Manufacture/Maintenance of Railway Locomotives & Rolling Stock**	The manufacture and/or maintenance of Railway locomotives and rolling stock. These activities can be for city-based rail services or provided for out-of-city clients and include all types of locomotive (electric, diesel, hydrogen etc)
Transport		**Manufacture/Maintenance of Other Equipment (Rail,**	The manufacture and/or maintenance of other equipment for railways, this includes the rail tracks, sleepers, pins, electrification equipment etc. These activities can be for city-based rail services or provided for out-of-city clients

		Electrification etc)	
Transport	Road Transport	**Bus Operation**	This involves administration (e.g., ticketing), operations management (including compliance for health & safety), bus purchase and maintenance scheduling and bus operations (e.g. operation of bus routes). They also include electric, diesel and other fuels (e.g. hydrogen). Services also include bus station + depot operations such as customer services and luggage re-direction, porter services etc.
Transport		**Manufacture/Maintenance of Buses**	The manufacture and/or maintenance of buses. These activities can be for city-based buses or services provided for out-of-city clients and include all types of buses (electric, hybrid, diesel, hydrogen etc)
Transport		**Operation/ Installation of EV Charge Points**	The supply, installation, maintenance and management of public EV Charge points. This includes any ancillary cabling, trenching and associated installation activities, along with apps and payment systems.
Transport		**Manufacture/Maintenance of Bicycles**	The manufacture and/or maintenance of Bicycles. These activities can be for city-based or out-of-city clients.
Transport	Maritime	**Passenger Maritime Transport**	This involves administration (e.g., ticketing), operations management (including compliance for health & safety), vessel purchase and maintenance and vessel operations (e.g. public transport ferry services)
Transport	Inland Waterways	**Passenger Inland Waterways Transport**	This involves administration (e.g., ticketing), operations management (including compliance for health & safety), vessel purchase and maintenance and vessel operations (e.g. public transport ferry services)
Transport	Training & Education	**Training (Transport)**	Training aims to develop specific, practical skills for jobs within the Transport sector and is usually specific and short-term. 'Green' training refers to those elements which are either within the Green sub-sectors (e.g., all passenger rail operation training including health and safety training), while 'Mixed' training refers to green training within sub-sectors not classified as 'Green' (e.g., sustainability training or energy reduction training in warehousing and storage).
Transport		**Education (Transport)**	Education refers to a broader understanding of a subject or field in Transport. 'Green' education refers to those elements which are either within the Green sub-sectors (e.g., further education courses in engineering and technology for the manufacture of new buses), while 'Mixed' refers to green education within sub-sectors not classified as 'Green' (e.g., Environmental Sciences used within the operation of ports)

Annex C. Occupations and Skill Levels in the Study (per ISCO)

Occupation	Definition	Skill Level Category
Elementary occupations	Elementary occupations involve the performance of simple and routine tasks which may require the use of hand-held tools and considerable physical effort. Most occupations in this major group require skills at the first ISCO skill level.	Low Skill
Clerical support workers	Clerical support workers record, organise, store, compute and retrieve information, and perform a number of clerical duties in connection with money-handling operations, travel arrangements, requests for information, and appointments. Competent performance in most occupations in this major group requires skills at the second ISCO skill level.	Medium Skill
Service and sales workers	Service and sales workers provide personal and protective services related to travel, housekeeping, catering, personal care, or protection against fire and unlawful acts, or demonstrate and sell goods in wholesale or retail shops and similar establishments, as well as at stalls and on markets. Competent performance in most occupations in this major group requires skills at the second ISCO skill level.	Medium Skill
Plant and machine operators	Plant and machine operators, and assemblers operate and monitor industrial and agricultural machinery and equipment on the spot or by remote control; drive and operate trains, motor vehicles and mobile machinery and equipment; or assemble products from component parts according to strict specifications and procedures. Competent performance in most occupations in this major group requires skills at the second ISCO skill level. The work mainly calls for experience with and an understanding of industrial and agricultural machinery and equipment as well as an ability to cope with machine-paced operations and to adapt to technological innovations.	Medium Skill

Technicians and associate professionals	Technicians and associate professionals perform technical and related tasks connected with research and the application of scientific or artistic concepts and operational methods, and government or business regulations. Competent performance in most occupations in this major group requires skills at the third ISCO skill level.	Medium Skill
Craft and trade workers	Craft and related trades workers apply specific technical and practical knowledge and skills in the fields to construct and maintain buildings; form metal; erect metal structures; set machine tools or make, fit, maintain and repair machinery, equipment or tools; carry out printing work; and produce or process foodstuffs, textiles and wooden, metal and other articles, including handicraft goods. Competent performance in most occupations in this major group requires skills at the second ISCO skill level. The work is carried out by hand and by hand-powered and other tools which are used to reduce the amount of physical effort and time required for specific tasks, as well as to improve the quality of the products. The tasks call for an understanding of all stages of the production process, the materials and tools used, and the nature and purpose of the final product.	High Skill
Managers	Managers plan, direct, coordinate and evaluate the overall activities of enterprises, governments and other organizations, or of organizational units within them, and formulate and review their policies, laws, rules and regulations. Competent performance in most occupations in this major group requires skills at the fourth ISCO skill level, except for Sub-major group 14: Hospitality, Retail and Other Services Managers, for which skills at the third ISCO skill level are generally required.	High Skill
Professionals	Professionals increase the existing stock of knowledge; apply scientific or artistic concepts and theories; teach about the foregoing in a systematic manner; or engage in any combination of these activities. Competent performance in most occupations in this major group requires skills at the fourth ISCO skill level.	High Skill

Annex D: Detailed Workforce Development per Country

D.1 Workforce Development in Brazil

TVET in Brazil is well-established in terms of institutional structure, policy framework and reach, however there are challenges with regards to alignment (due to a coordination between providers and certification), funding and inclusion. TVET education programmes with professional qualifications are provided by the Ministry of Education and Ministry of Labour and Employment and includes:

- Programa Nacional de Acesso ao Ensino Técnico e Emprego (PRONATEC, est. 2011), targeted at the population participating in government income transfer programmes
- Mulheres Mil, targeted at women who are seriocomically vulnerable and/or prisoners
- Escola do Trabalhador, offered to the general population

In addition, Brazil recognises and certifies prior formal and non-formal learning, guided by public policies of Professional and Technological Education developed by the National Network of Professional Certification and Initial and Continuing Training (CERTIFIC). The framework allows the validation of professional knowledge acquired in the workplace including formal and non-formal studies and enable access to certification for the continuation of studies of professional practice. In this system, certification is conditional upon the individual being enrolled in continuing education obtained through the inter-institutional Programme of CERTIFIC (here).

Although the most important public vocational education institutions are universities and Federal Education Institutes, Science and Technology administered by the Federal government, there are two stream of TVET training in Brazil. The second stream comes from the private sector, through the "S System" of training institutions funded from private sector contributions based on a percentage of companies' payrolls. The "S System" is employer-aligned, has been in existence longer than PRONATEC and is comprised of:

- SENAI – The National Industrial Training Service (Serviço Nacional de Aprendizagem Industrial)
- SENAC – The National Commercial Training Service (Serviço Nacional de Aprendizagem Commercial)
- SENAT – The National Transportation Training Service (Serviço Nacional de Aprendizagem do Transporte)
- SENAR – The National Rural Training Service (Serviço Nacional de Aprendizagem Rural)

- SEBRAE – The Brazilian Support Service to Small and Medium Size Companies (Serviço Brasileiro de Atendimento às Pequenas e Médias Empresas)

SENAI and SENAC meet most of the demand for vocational education in industry and commerce, while SEBRAE develops activities to encourage "greening" entrepreneurship, supporting environmental courses and consulting, and environmental preservation, including the development of alternative renewable energy sources (here).

Note: The 2014-2024 education policy for Brazil has been used in this study, the new policy is due to be released in 2025 and is anticipated to include further development of TVET education, with 100 new campuses of Federal Institutes of Education. There are currently 685 units in the Federal Network of Professional, Scientific and Technological Education (some of which are federal institutes), serving 1.6 million students (here).

Brazil is investing heavily in the renewable energy market, particularly in Wind, Solar and Energy Efficiency, however the Brazilian TVET systems do not yet produce enough graduates to service existing and expected demand. As such, SENAI is implementing new training courses, producing specialised technicians, e.g., a new training centre for training Wind technicians in Fortaleza (here).

D.2 Workforce Development in Colombia

The Ministry of National Education (MEN) is the main body responsible for education in Colombia. There is a National Qualifications Framework (MNC) which acts as an instrument to classify and structure qualifications in a scheme of 8 levels ordered and expressed in terms of knowledge, skills and aptitudes. The National Learning Service (SENA) was created in 1957 to lead the National System of Education for Work (SNFT) and is responsible for public, private, technical secondary, professional technical, technological and non-formal education (now education for work and human development) (here).

SENA provides free comprehensive training, with an extensive infrastructure of laboratories and workshops aimed at companies of all technological levels and involving employers and trade unions in training centres. It monitors labour market trends and renews its offer of training in consultation with industry. It is the largest training institution in Colombia and the second largest in South America (after SENAI in Colombia). It includes 117 training centres, over 3,000 training venues and 180 mobile classrooms, covering over 98% of Colombian territory (here). It offers continuing vocational training and training programmes in social, economic and technological

fields, it is state funded through grants and company contributions and employs over 32,800 people making it the largest employer in the country (here).

SENA is providing certification for labour skills useful for usable waste collection (here).

D.3 Workforce Development in Italy

note: This passage is only lightly edited from here)

Vocational education and training (VET) involves multilevel governance by national, regional and local stakeholders:

- Ministries of education and labour lay down general rules and common principles for the system
- VET schools are in charge of upper secondary VET school pathways (EQF 4-ISCED 354)
- Regions and autonomous provinces are in charge of VET programmes and most apprenticeship-type schemes
- Social partners contribute to defining and creating active employment policies relevant to VET and lifelong learning.

At age 14 learners make a choice between general education, secondary VET school pathways and regional IVET pathways (*Istruzione e Formazione Professionale,* IeFP). They have the 'right/duty' to stay in education until age 18 to accomplish 12 years of education and/or vocational qualification. At upper secondary level, 3-year to 5-year VET programmes are offered, with all upper secondary education programmes being either school based or delivered as apprenticeships.

There is mobility across VET programmes and the general education system, e.g. on completion of a 3-year regional IVET path, it is possible to attend 1 additional year leading to an EQF level 4 vocational diploma; this allows enrolling in the fifth year of the State education system and sitting the State exam for an upper secondary technical or vocational education diploma (EQF level 4).

At post-secondary level, graduates of 5-year upper secondary programmes or 4-year IeFP programmes who passed entrance exams may enrol in:

- higher technical education and training courses (*istruzione e formazione tecnica superiore,* IFTS): 1-year post-secondary non-academic programmes leading to a high technical specialisation certificate (*certificato di specializzazione tecnica superiore,* EQF level 4).

- higher technological institute programmes (*istituti tecnologici superiori;* ITS academy): 2- year tertiary non-academic programmes which lead to a high-level technical diploma (*diploma di specializzazione per le tecnologie applicate* - EQF level 5 Implementation of the recently (2022) reformed system of higher technological institutes is ongoing in 2023; it foresees introduction of 3-year programmes leading to an applied technologies qualification (EQF level 6).

VET for adults is offered by a range of different public and private providers. It includes programmes leading to upper secondary VET qualifications to ensure progression opportunities (upskilling) for the low-skilled; these are provided by provincial centres for adult education (*centri provinciali per l'istruzione degli adulti,* CPIA) under the remit of the education ministry.

Continuing vocational training (CVT) to meet enterprise, sectoral and regional needs is:

- supported by the ESF and is managed by regions and autonomous provinces
- directly funded by the regions and autonomous provinces
- financed by joint inter-professional funds, managed by the social partners

Apprenticeship is available at all levels and programmes and is defined as an open-ended employment contract.

D.4 Workforce Development in Kenya

note: This passage is only lightly edited from here

There has been a significant increase in the number of TVET providers in Kenya over the last decade, from 701 TVET providers in 2012, to 2,396 in 2021. TVET training is delivered through public vocational training centres; private vocational training centres; public technical and vocational colleges; private technical vocational centres; national polytechnics and the Kenya school of TVET.

The Kenya National Qualifications Framework is a learning outcome-based qualifications framework, covering all education and training, in all sectors and both formal and informal training. It includes a central register of qualifications which sets out clear criteria for the achievements of awards and details the knowledge and skills required in each case. The system is aimed at equipping learners with practical and technical skills for the labour market, self-employment, and entrepreneurship.

Public TVET institutions are funded through the National Treasury but can receive additional funding through public-private partnerships. They are also funded through a Training Levy under the National Industrial Training Authority, which is collected from the employers of certified trainees.

A number of ministries offer non-formal TVET programmes, including the ministry of Labour, East Africa Affairs and Social Protection; Ministry of Trade and Industry; ministry of Water; ministry of Tourism and the Ministry of Public Service, Youth and Gender Affairs.

Overall, the State Department of Vocational and Technical Training, under the Ministry of Education is responsible for the development of TVET and related policies. Alongside this are:

- TVET Authority is responsible for accreditation of institutions, programmes and trainers, ensuring standards and licensing, regulating and coordinating training
- Curriculum Development, Assessment and Certification Council, responsible for TVET curricula development and certification
- National Qualifications Authority, responsible for qualifications and establishment of a national qualifications framework

Other contributors include:

- Religious institutions
- Private industries
- Micro and Small Enterprise Authority (MSEA) - regulates and coordinates the sector and its growth and trains entrepreneurs on business, managerial and leadership skills, as well as facilitating their access to market
- National Industrial Training Authority (NITA) - deals with industrial training, assessment and collecting industrial training levy and fees, and regulating trainers. It is tasked with curriculum development, integrating labour market information, equivalence of certificates, accreditation of institutions assessing industrial training, evaluating occupational skills, and awarding certifications

The National Industrial Training Authority (NITA) operates five Industrial Training Centres: NITA-Nairobi, NITA-Textile Training Institute (Nairobi), NITA-Kisumu, NITA-Athi River and NITA-Mombasa. Together, the centres have the capacity to cater for over 5,000 trainees. In addition to these centres, NITA has registered/accredited more than 400 training providers and has accredited more than 600 assessment centres.

D.5 Workforce Development in Mexico

note: This passage is only lightly edited from (here)

The Mexican qualifications framework (MMC) is a comprehensive framework developed by the General Directorate of Accreditation, Authorisation and Recognition (DGAIR), within the Secretariat of Public Education. The MMC has eight levels and is similar in design to the European Qualifications Framework. Competences are evaluated through the NSCS, which, in addition to providing for technical and professional education, includes five levels dedicated to vocational qualifications.

Non-formal programmes tend to consist of courses aimed at training adults in order to improve their performance at work. These courses do not always require a school background and are given through the industrial training institutes, training programmes offered by regional governments with federal government support (ODE), and technical secondary and agricultural technology education.

The recognition of competences for workforce development and employability is based on the National System of Competency Standards (NSCS) which has been developed by CONOCER. The NSCS is also the framework under which the recognition of non-formal and informal learning is organized, regulated, and implemented in accordance with Agreement 286 of the Ministry of Education.

A number of government and nongovernmental actors offer non-formal TVET, such as the National Institute for Adult Education (INEA), under the supervision of the Ministry of Public Education (SEP) and promotes and develops literacy courses as well as primary and secondary education programmes for youth and adults. Those over 16 years can choose the vocational track or continue with adult education. Vocational training programmes under the INEA are one to four years (depending on occupation) and are implemented by the SEP as well as by public and private institutions. The SEP also identifies targets for recognition of prior learning across different industries and regions. Employers and trade unions play a significant role in this process, both in the design of training programmes and in the evaluation and certification of workers' competences according to the NSCS framework. The Ministry of Labour and Social Welfare (STPS) also offers non-formal TVET programmes.

While the SEP is responsible for formal TVET in Mexico on the federal level, the education system in Mexico is decentralized and the SEP shares the responsibility with various national and regional bodies. For example, each state has its own Secretariat of Education in charge of the education system and schools. State governments are responsible for administering State Centres for Scientific and Technological Studies (CECyTE) and Institutes of Training for Work (ICAT). Municipalities also provide education services at all levels.

Other institutions involved in the governance of TVET include:

The Directorate General of Higher Technological Education (DGEST) is responsible for the National System of Technical Institutes (SNIT) consisting of 263 institutions: 126 federal technological institutes; 131 decentralized technological institutes, four Regional Centres for Optimization and Development, an Interdisciplinary Centre for Research and Teaching Technical Education, and a National Centre for Research and Technological Development. The SNIT aims to improve TVET services, enhance access to TVET programmes, promote the use of Information and Communications Technology in TVET programmes and enhance school and institution management structures.

The Directorate General of Industrial Technological Education (DGETI) aims to train people with technological expertise in the industrial, commercial and service sectors. DGETI has 433 campuses distributed throughout Mexico: 168 Industrial Technology Research Centres and Services and 265 Centres offering Bachiller Tecnico and Profesional Técnico – Bachiller.

The National College of Technical Professional Education (CONALEP) is one of the leading TVET institutions and provides TVET programmes according to the Mexican dual system. CONALEP's objectives are to:

- Develop new programmes according to the demands of the labour market.
- Update the curriculum and teaching equipment.
- Reduce the school drop-out rate.
- Implement strategies to develop scholarship programmes for students.
- Strengthen CONALEP's international cooperation in the field of TVET.
- Implement strategies to expand the number of opportunities for students to attend schools.
- Promote links with the industrial sector to reduce the unemployment rate.

Dual training: The dual vocational education and training model initiated in Estado de México is of three years' duration and comprises 75 percent practical training in the company and 25 percent theory. Because in Mexico the vocational schools are often a long way away from the companies providing training, the country has found an innovative solution to deal with vocational school content via the use of a learning software. The theoretical part of dual training is imparted via an e-learning platform. The dual training model in Mexico is founded on three main pillars of company-based training, augmented by regular inter-company short courses and training via multimedia e-learning platform.

D.6 Workforce Development in South Africa

note: This passage (to changes in 2024) is only lightly edited from (here)

The government's primary responsibility is to develop policy, norms and standards. Other responsibilities include the development of a national curriculum, staff development, student and programme targeting, funding and updating policy implementation. The National Skills Fund is also established to support priority skills and innovative research in high-level occupationally directed programmes from universities to the workplace. The Professional, Vocational, Technical and Academic Learning (PIVOTAL) grant functions similarly, but with a focus on providing access to professional placements, work-integrated learning, apprenticeships, learnerships, internships, skills programs and work-experience placements.

The Sector Education and Training Authority (SETA) currently act as the primary source for providing credible information on the supply and demand for skills. SETA also distributes discretionary funds for purposes of upgrading skills in the workforce. Alongside SETA, large corporate employers and state-owned enterprises cooperate with the relevant education and training institutions to provide training and staff to address educational needs. Partnerships between the DHET, SETA, employers, private provider and public TVET colleges are able to meet the industry needs throughout the country. SETA act as the bridge between students and workplaces by creating interventions and shaping solutions on skill demands within a given sector.

TVET institutions practice a tripartite governance structure consisting of a council, an academic board and a student representative council. Each institution enjoys strong stakeholder representation. Their primary role is to govern, develop a strategic plan for the mission, goals, vision and funding plans for the college, and exist as a suitable advisory structure. Partnerships are developing between government, organized business, labour and communities. In addition to these partnerships, the DHET adopts the Occupational Qualifications sub framework of the NQF and cooperates with the UMALUSI and Quality Council for Trades and Occupations (QCTO) in order to maintain credible standards for the workplace.

There are four kinds of funding: formula funding of TVET training programmes, funding for special purposes, student financial aid and private funding. Each provincial education department uses the budgetary principles of the Medium-Term Expenditure Framework (MTEF) to fund TVET colleges. South Africa introduced a compulsory levy scheme in 2000, through the Skills Development Levies Act. The Department of Higher Education and Training, in conjunction with the various sector education and training authorities (SETAs), is

responsible for administering the Act. The skills levy in South Africa is used to finance 21 SETA-run sector training funds to encourage levy-paying enterprises to train their employees as well as a single National Skills Fund to fund skills not covered by the SETAs.

Changes in 2024: The National Skills Development Plan 2030 (NSDP 2030) transferred responsibility for accreditation of skills development providers from Sector Education and Training Authorities (SETAs) to the Quality Council for Trades and Occupations (QCTO). The last date for SETA enrolment was June 30 2024 (here). While SETAs continue to play a role in skills development, particularly in relation to specific industries and qualifications, the QCTO is now the primary body responsible for accrediting skills development providers and ensuring the quality of occupational qualifications. The change has been introduced in an attempt to address the misalignment being qualifications and industrial need. SETA organisations will still teach educational programmes, developed and accredited by QCTO (here). The transition has not been seamless, but the ambition is to move away from training for numbers towards employment-driven outcomes, ensuring learners secure jobs or start businesses (here).

D.7 Workforce Development in the USA

TVET in the USA is commonly referred to as Career and Technical Education (CTE) and is headed by the U.S. Department of Education, Office of Career, Technical, and Adult Education (OCTAE), along with the U.S. Department of Labour (USDOL) through apprenticeship and workforce programs. Funding is delivered by federal legislation under the Carl D. Perkins Career and Technical Education Act (Perkins V): The primary federal funding source for CTE (Individual states administer Perkins funds through state CTE plans that align with local labour market needs). CTE is delivered in all states in K-12 schools. Some states operate structured dual-enrolment or apprenticeship systems (dual-system). Others are beginning to pilot such systems with federal/state/industry support.

Vocational training is aided by the Workforce Innovation and Opportunity Act (WIOA) which Coordinates workforce training and employment services and encourages partnerships between education providers, employers, and workforce boards. Employers partner with public institutions to design curricula, provide training sites, and hire graduates. Trade unions also operate apprenticeship programs (especially in construction and manufacturing).

There are multiple Private Education Providers, both For-profit technical/trade schools, and Non-profit organizations. The private sector actively provides input into curricula, provides work based learning and direct training. Public-private partnerships (PPPs) are actively encouraged to bridge skills gaps, providing apprenticeships with a growing focus on non-traditional sectors beyond construction, such

as IT, logistics, and clean energy. Many programs remain reactive rather than proactive, and there are gaps in industry-specific alignment, especially in newer or less visible sectors such as waste management and green logistics.

Transportation Sector: There are several Transportation-focused CTE programs in high schools and community colleges such as the Federal Motor Carrier Safety Administration (FMCSA) actively promoting "Commercial Driver's Licence" training within Perkins-funded schools to address a national shortage. Additionally, Logistics and Supply Chain Management pathways are increasingly offered although they are under "Business/Marketing" or "Industrial Tech" CTE categories.

Construction Sector: There is a Robust apprenticeship system supported by Perkins-funded high school trades programs as well as Union programs and Community college certifications.

Waste Management Sector: CTE programs relating to waste management typically fall under Environmental Technology or Industrial Maintenance categories. Programs include certifications for Hazardous Waste Operations and Emergency Response, Occupational Safety and Health Administration, Environmental Monitoring, additionally some community colleges offer recycling and resource recovery tech programs.

Annex E. kMatrix Data Triangulation Methodology

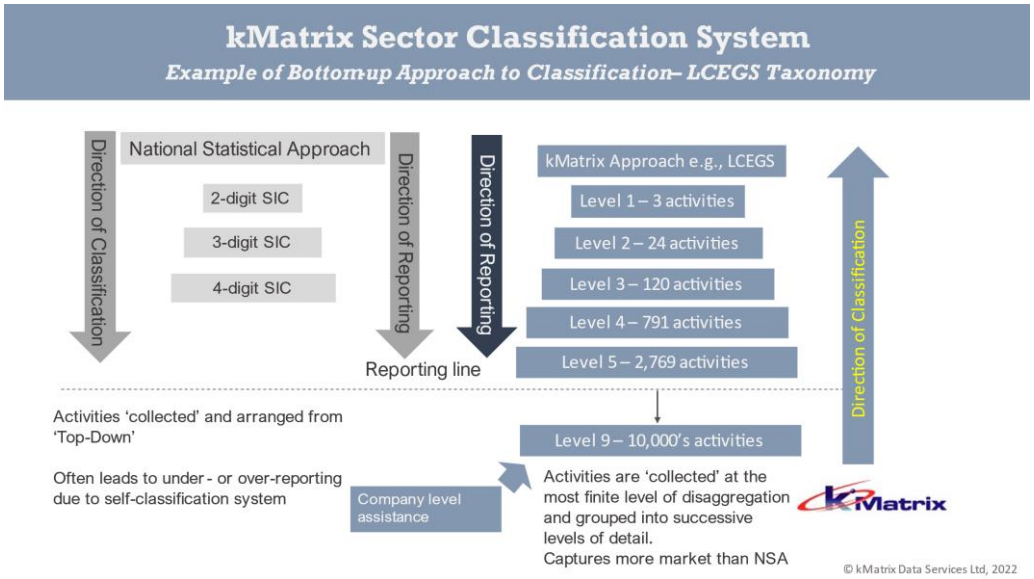
E.1. Verifying the Geographical Area for each City

The C40 Cities team has provided detail on the population numbers for each city, which has been used to determine, through desk-research, whether the reported population numbers indicate the city or metropolitan city.

E.2. Brief General Methodology for kMatrix Data Production

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.

This diagram provides an example of the depth of detail possible, using the Low Carbon Environmental Goods and Services (LCEGS) sector as an example:



This is quite different to the National Statistical Approach (or other country equivalents), 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 82,000 for some studies, 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.

kMatrix is also published in the House of Lords for the Security sector and provide the European Commission with Cybersecurity data across Europe.

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

- Domestic Energy Retrofit in the North East: here
- Low carbon environmental goods and services sector: here and here
- The green Economy: here and here
- Adaptation economy: here
- Carbon Finance: here
- Weather and Climate: here
- Climate Services: here

E.3. Data Triangulation – the Cornerstone of kMatrix

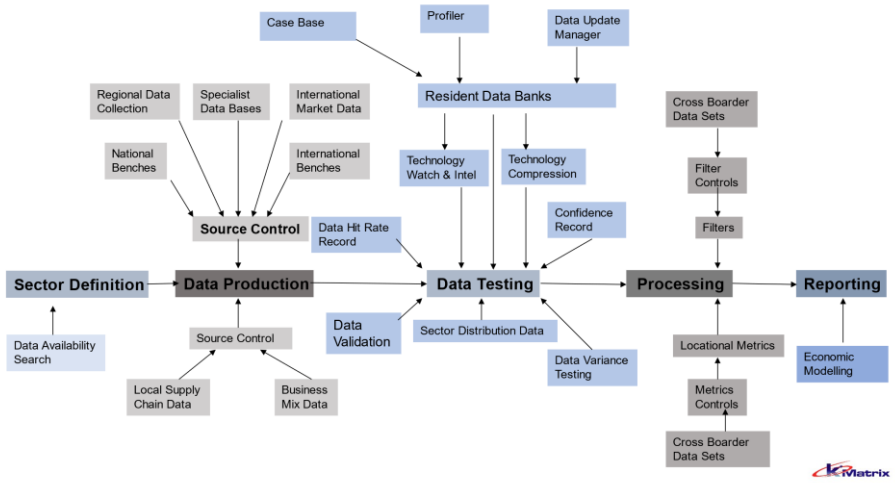
kMatrix uses a propriety data triangulation methodology to calculate over 100 metrics for many sectors including Domestic Retrofit, Space, Climate Services, Green Economy, Marine, Security, Cybersecurity, Adaptation & Resilience, Water, Design and others.

The 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.

Figure E.1: Sector Research Model



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

E.4. Calculating Employment – Triangulation of Skills

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 (or other country equivalents). This allows the development of a detailed market segmentation model, with in-depth skills measurement and analysis, which is specific to the sector being measured, 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 for those within all identified measures. 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.

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

Terminology for jobs within industry is often varied, e.g. 'technician' and 'engineer', particularly within the Green Economy, 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.

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.

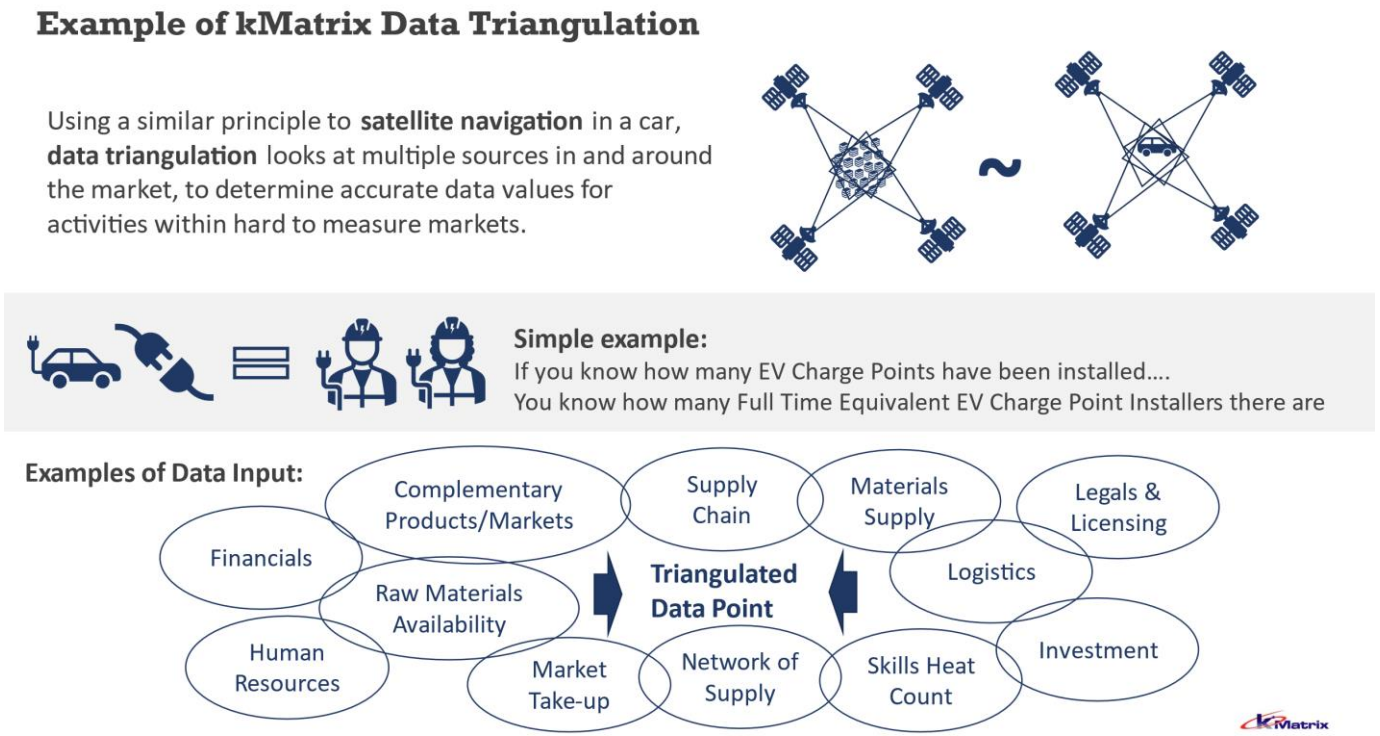
The benefit of this form of measurement is it provides a clear indication of how many hours of work are undertaken and how this varies between sub-sectors. It also gives an indication of how many people are working within the sector, without double-counting people who are multi-skilled.

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. Another example is education, where a lecturer teaching 1 hour a week for 6 weeks is counted in the total FTE.

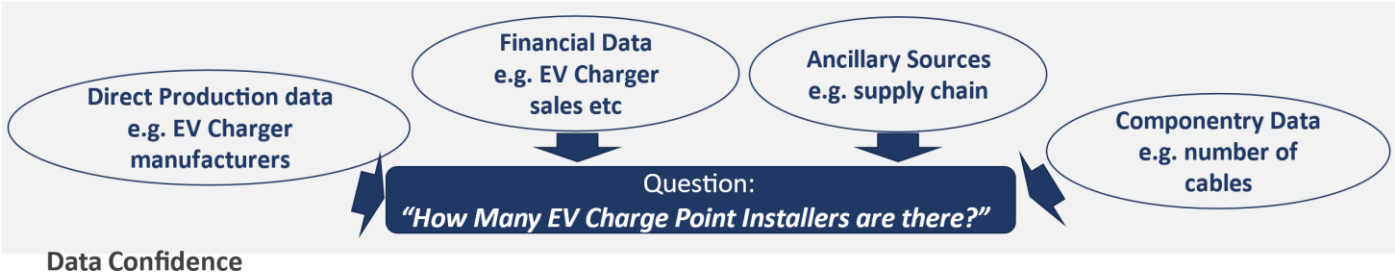
By using the FTE system of measurement, with the advantages and limitations clearly stated, the absolute time worked can be used for skills analysis.

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.



EV Charge Point Installer Example in Further Detail

- Where available, direct installer employment data provides an indicative figure
- This is then reality-checked by multiple data sources (never less than 20), who have a proven track record of reliability for that metric and market, these can be:
  - Financial data e.g., reported sales/installation of EV Charge Points and/or related products, and/or supply chain
  - Componentry e.g., cables
  - Ancillary sources e.g., supply chain data, HR etc.
- Where installation data is unavailable, a 'pure' triangulation value is produced, tracking EV production and installation through chains and networks of supply to indicate the likely installation volumes and therefore number of installers



Data Confidence

- Data source reliability is tracked over time (up to 35 years), with each source having a 'confidence hit rate' within the kMatrix system, for each metric and market. Confidence hit rates of sources are combined to provide a 'confidence level', which is an indication of the accuracy of the data sources that sit behind each triangulated data point.

In summary, kMatrix never uses a single source for data, each datapoint is created using multiple sources to mitigate against single source reporting errors.

By looking at the chains and networks of supply, consensus can be achieved as to the likely 'true' value of a datapoint, as per the EV Charge point Installers above.