GFP INTERNATIONAL

LANDSCAPE ANALYSIS

Building Africa's Industrial Future

Meeting the Growing Demand for Welding and Manufacturing Skills

A Landscape Analysis of Industry Demand, Training Capacity and Certification



SKILLS FOR INDUSTRIAL DEVELOPMENT

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1. Introduction

Africa is entering a period of industrial transformation driven by investments in energy infrastructure, mining, manufacturing, transportation, and construction. Across the continent, governments are increasingly pursuing policies that promote local value addition, industrial processing, manufacturing growth, and economic diversification. To succeed, these initiatives will require a skilled technical workforce capable of designing, constructing, operating, and maintaining modern industrial systems. In this dynamic context, industrial welding will be among the most important enabling skills for the manufacturing, fabrication, energy, mining, transportation, and construction sectors.

Africa's demand for industrial welders already far exceeds the continent's current supply. This report estimates that African economies will require close to three million qualified industrial welders, including about 2.16 million for manufacturing, and around 784,000 for mining, construction, fabrication, agriculture, and other sectors. Another 60,000 or more for major oil and gas projects, (with an assumption 30% of currently listed projects were to be completed simultaneously). African countries currently train only a small fraction of that number of welders to an internationally recognised standard. The unmet demand for welding skills is not a future challenge to be planned for, but a present constraint that is already delaying projects, inflating costs, and displacing local employment.

This landscape analysis estimates the supply of and demand for welding skills in Africa, revealing a substantial mismatch between the continent's existing training systems and the competencies required by employers. Drawing upon institutional surveys, facility assessments, industry consultations, reviews of technical standards, and strategic analyses, the study quantifies industrial demand for certified welders across sectors and evaluates the capacity of 37 established welding and fabrication training institutions in 13 African countries. While thousands of African welders are engaged in fabrication, repair, and metalworking, many operate informally and lack the formal training, certifications, and practical experience required for code-compliant industrial welding. The challenge is therefore not a shortage of workers who can weld, but a shortage of trained welders who possess the specific skills and recognised credentials necessary to work on pipelines, pressure vessels, refineries, power-generation facilities, mining operations, shipbuilding, heavy manufacturing, and large-scale infrastructure.

The institutional survey confirms that Africa's existing educational and training systems cannot close this gap. Across the 37 institutions assessed,[1] the median student receives approximately 30 hours of supervised arc time — far below the roughly 400 hours required to prepare a candidate for an internationally recognised welding qualification. Only one institution in the sample reported reaching the 400-hour threshold, and none reported issuing an internationally recognised welding certificate. Sixteen of the 37 institutions reported having no fabrication, cutting, or testing equipment of any kind, and only seven possessed bend-testing equipment, without which welder qualifications cannot be tested at all. These are not marginal deficiencies that can be corrected by incremental improvement; they represent a structural inability to produce the workforce that Africa's industrial sector requires.

Addressing this challenge will require a radical improvement to the continent's training systems. A coordinated strategy is needed to enhance practical training capacity, instructor development, certification readiness, quality assurance, and industry engagement. Establishing specialised Welding and

[1] Please refer to Annex B for a full list of participating institutions.

Manufacturing Centres of Excellence that can serve as regional hubs for advanced skills training, instructor certification, testing and qualification services, industry partnerships, and technology transfer would support surrounding technical and vocational education and training (TVET) institutions through a hub-and-spoke model. These centres would raise local training standards while expanding access to internationally aligned welding education.

Investments in welding and manufacturing skills should be viewed not only as workforce interventions but as strategic industrial development initiatives. Strengthening Africa's capacity to train, certify, and deploy internationally qualified welders will increase industrial competitiveness, boost local participation in infrastructure and manufacturing projects, improve employment opportunities for young people, and accelerate economic transformation across the continent.

1.1 Analytical Scope

This landscape analysis focuses on welding, fabrication, and manufacturing skills development in selected African countries. It examines the capacity of vocational training institutions, technical colleges, universities, industry academies, and specialised training centres to prepare learners for employment in industrial sectors requiring welding and fabrication competencies. The analysis considers multiple dimensions of workforce development — including training infrastructure, equipment availability, instructor capacity, practical training exposure, certification readiness, industry partnerships, and alignment with international welding standards — and compares them with emerging industrial demand across sectors such as manufacturing, energy, mining, construction, transportation, shipbuilding, and industrial processing. While the study draws upon examples and experiences from multiple countries and industrial sectors, it is not intended to provide a comprehensive assessment of all technical occupations or all TVET systems across Africa. Rather, it focuses on welding and manufacturing skills as a strategic case study and a starting point for examining broader challenges and opportunities in workforce development.

1.2 Intended Audience

This report serves a broad range of stakeholders involved in workforce development, industrialisation, manufacturing competitiveness, and technical education across Africa. The primary audience includes national governments — especially the ministries responsible for education, labour, industry, manufacturing, energy, mining, infrastructure, and economic planning — as well as TVET authorities, regulatory agencies, qualifications bodies, and public training institutions. Development partners, donor agencies, development finance institutions, foundations, and international organisations may draw on the report's findings to guide investments in workforce development, youth employment, industrialisation, and skills training. Industry stakeholders — including employers, manufacturers, engineering firms, construction companies, energy developers, mining companies, fabrication workshops, and industry associations — may also use the report to better understand current and future workforce requirements. In addition, the report provides relevant insights for TVET providers, universities, certification bodies, professional societies, workforce development practitioners, and investors interested in strengthening Africa's industrial skills ecosystem.

1.3 Objectives

The analysis is designed to:

1. Quantify current and emerging demand for certified welders and manufacturing technicians in key sectors such as manufacturing, mining, energy, construction, transportation, shipbuilding, and industrial processing.
2. Assess the current capacity of welding and manufacturing training institutions across selected African countries, including facilities, equipment, instructors, curricula, and practical training environments.
3. Evaluate the extent to which existing training programmes align with internationally recognised industrial standards, certification requirements, and employer expectations.
4. Identify key constraints affecting the production of skilled and certifiable welders, including infrastructure limitations, equipment shortages, instructor capacity gaps, funding challenges, and weak industry linkages.
5. Analyse gaps between training supply and industrial labour demand, with particular attention to the distinction between informal welding skills and industrial, code-compliant competencies.
6. Review international best practices in welding training, certification systems, instructor development, and workforce preparation that may be adapted to African contexts.
7. Explore practical strategies for strengthening welding and manufacturing skills ecosystems through improved training systems, industry partnerships, certification pathways, and technology transfer initiatives.
8. Assess the feasibility and potential impact of establishing regional Welding and Manufacturing Centres of Excellence to expand training quality, increase certification readiness, and promote industrial workforce competitiveness across Africa.
9. Provide evidence-based recommendations for governments, development partners, industry stakeholders, and training institutions seeking to accelerate industrial skills development and support long-term economic transformation.

1.4 Key Questions

The analysis aims to address the following questions:

- How rapidly is demand for certified welders expected to grow as industrialisation, manufacturing, energy, mining, and infrastructure investments expand?
- To what extent are existing welding and manufacturing training institutions capable of producing graduates who meet industrial workforce requirements?
- What gaps exist between current training systems and internationally recognised welding standards and certification frameworks?
- What are the principal constraints limiting the development of industrial welding and manufacturing skills across Africa?
- What explains the persistent gap between informal welding activity and industrial, code-compliant welding competence?

- What interventions are most likely to strengthen training quality, certification readiness, workforce competitiveness, and industrial productivity?
- How can Welding and Manufacturing Centres of Excellence contribute to the modernisation of TVET systems across Africa?

2. The Demand for Industrial Welding and Manufacturing Skills in Africa

The demand for skilled welders is closely linked to the pace of industrialisation, infrastructure development, manufacturing expansion, and technological advancement. Across Africa, governments are investing heavily in transport networks, energy infrastructure, mining operations, industrial parks, manufacturing facilities, affordable housing, and regional trade corridors. These investments are creating unprecedented demand for technically competent welders capable of working to internationally recognised quality and safety standards.

Welding is a foundational occupation that supports virtually every major industrial sector. From the construction of bridges, pipelines, power plants, and steel structures to the fabrication of pressure vessels, storage tanks, ships, rail systems, and manufacturing equipment, welding plays an essential role throughout the industrial value chain. As African economies continue to pursue industrialisation and local value addition, demand for qualified welding professionals is expected to increase significantly. This chapter establishes the scale of that demand; Chapters 3 and 4 then test whether the continent's existing training institutions are capable of meeting it.

2.1 Macroeconomic and Industrial Context

Many African countries have grown rapidly in recent decades, but this growth has not always translated into broad-based industrialisation, productivity improvements, or sufficient employment opportunities for rapidly expanding populations. Much of the continent remains heavily reliant on exports of raw materials, and unprocessed commodities account for about 70 percent of all African trade. In recent years, the largest export categories have been fuels and related products (about US$247 billion, or 35 percent of total exports), precious metals and stones (US$127 billion, 18 percent), other minerals and metals (US$107 billion, 15 percent), and agriculture and food products (US$84 billion, 12 percent).[2] Meanwhile, a large share of the manufactured goods, industrial equipment, and technical services consumed in Africa continues to be imported from outside the continent.

Demographic trends present an additional employment challenge, but effective training could transform the continent's large and growing workforce into an opportunity to accelerate growth. By 2050, Africa will be home to 25 percent of the global population and 40 percent of the world's labour force. Policymakers, development practitioners, and industry leaders increasingly recognise that long-term economic transformation requires more than social development interventions: sustainable industrialisation requires a skilled technical workforce capable of supporting manufacturing, construction, energy production, mining, transportation, and other productive sectors. TVET has therefore garnered renewed attention as a critical component of national development strategies across Africa, and industrial welding has emerged as a particularly important enabling skill.

African governments increasingly recognise the economic potential of expanding domestic value addition and are taking steps to support greater industrial development. For example, the Nigerian Senate recently passed a law requiring 30 percent processing of local raw materials before exportation.[3]

[2] Voronoi: https://www.voronoiapp.com/trade/-Raw-Materials-and-Commodities-Dominate-Africas-Exports-3621
[3] Vanguard, July 2025: https://www.vanguardngr.com/2025/07/senate-passes-bill-mandating-30-pre-export-processing-of-local-raw-materials/

These policies are driving demand for skilled industrial workers across the continent, and they cannot be implemented without those workers.

2.2 The Unmet Demand for Industrial Welding Skills

Across Africa, thousands of artisans operate successful welding and fabrication businesses serving local communities. These firms, which are often small and informal, manufacture and repair gates, doors, windows, furniture, agricultural equipment, and household products, and they contribute significantly to local economies and employment. However, industrial projects require an additional and quite different set of competencies, including welding procedure qualifications, quality integrated management systems (IMS), non-destructive testing (NDT), interpreting industrial engineering drawings, metal science and metallurgy, occupational health and safety (OHS), and internationally recognised certifications.

Africa does not lack people capable of welding; it lacks welders who are trained, assessed, and certified to internationally recognised industrial standards. This distinction is central to the analysis. Large-scale industrial facilities such as refineries, pipelines, power plants, and shipyards require specialised competencies including pressure-vessel welding, pipe welding in the 5G, 6G, and 6GR positions, alloy and stainless-steel welding, structural welding for heavy steel structures in 1G/F, 2G/F,3G/F, 4G/F and code-compliant welding to ASME, AWS, and ISO standards. Industrial welders must further understand welding procedure specifications (WPS), procedure qualification records (PQR), NDT, metallurgy and heat control management, standard safety procedures, and applicable welding codes. Because welding-related TVET provision is weak across most of the continent, many welders active in the market are simply not ready for large industrial projects.

The construction of the Dangote Refinery in Nigeria highlighted the extent of the shortage of qualified and certified welders. The project required thousands of certified welders capable of meeting strict international standards. The local supply of qualified welders proved very limited; many welders lacked certification for high-pressure pipe welding; and some required retraining before they could work on the project. As a result, contractors were obliged to bring in skilled welders from other countries, increasing project costs and extending timelines.

The shortage is now producing continent-wide competition for labour. In November 2023, a construction executive working on the East African Crude Oil Pipeline Project (EACOP), which will run from Uganda to the Tanzanian coast, noted that half of his skilled pipe welders had been recruited to work on the Dangote Refinery in Nigeria. Of the 300 East African welders who underwent skills testing for positions on EACOP, only 2 percent qualified. This single statistic illustrates both the intensity of demand for advanced welding expertise and the severity of the skills gap constraining large-scale industrial projects. When skilled welders are scarce, projects depend on foreign labour, costs increase significantly, technology transfer remains limited, and local job creation is reduced. These factors together constitute a structural bottleneck inhibiting Africa's industrialisation.

2.3 The Scale of the Opportunity

Implementing Africa's industrial development plans will require hundreds of thousands of skilled welders. Major planned projects include oil and gas infrastructure, refineries and pipelines, power plants, mining facilities, shipyards, railways, bridges, and other large steel structures. Moreover, the continued

growth of the manufacturing sector will drive a steady increase in demand for skilled welders, as approximately 60 percent of all manufactured goods require some amount of welding.

Industries that require skilled welders also carry a large job-multiplier effect. Manufacturing has an estimated multiplier effect of 9.0, meaning that every job created in the sector generates nine more jobs across the wider economy.[4] Beyond manufacturing, the sectors with the highest job multipliers are utilities, information technology, government services, and mining, oil, and gas production—most of which typically demand substantial industrial welding. Other sectors with smaller but still significant multiplier effects that also demand significant welding skills include transportation, construction, and agriculture.

Figure 1: Job-Multiplier Effects by Sector



Highlighted industries correspond to sectors emphasized in the landscape analysis.
Source: Emsi; Camoin Associates.

Demand for industrial welders in Africa already exceeds the available supply. Despite the employment of substantial numbers of expatriate welders, many from Asia, a persistent skills gap remains. The United States employs approximately 1,339 welders per million people, compared with 1,463 in Japan and 1,628 in China. If Africa were to achieve a broadly comparable density, it would require a total workforce of approximately 1.8 million qualified welders at current population levels. Based on the latest population projections, this requirement could rise to approximately 3 million by 2050. This is consistent with our detailed analysis contained in this report which predicts the need for 3,006,000 welders.

[4] Camoin Associates, "The Multiplier Effect: Which Industries Are the Biggest Job Creators?": https://camoinassociates.com/resources/the-multiplier-effect-which-industries-are-the-biggest-job-creators/

2.4 Demand for Welders by Sector

2.4.1 Oil, Gas, and Petrochemicals

Oil and gas developments require some of the highest levels of welding competency of any industry, owing to stringent quality, safety, and regulatory requirements. Pipelines, offshore facilities, storage terminals, refineries, liquefied natural gas (LNG) infrastructure, and petrochemical plants all depend on welders qualified to work in accordance with internationally recognised codes and standards. This sector is one of the strongest drivers of demand for certified industrial welders, particularly those with expertise in pipe welding, pressure systems, alloy materials, and quality-controlled fabrication.

According to UK-based consulting firm Wood Mackenzie, Africa is entering an US$800 billion investment cycle in the oil and gas sector.[5] Based on the number of welding jobs per dollar invested in recent LNG projects, Africa's planned oil and gas investments could directly create demand for 80,000 or more trained and qualified welders. GFP International has reviewed publicly available sources to produce a project-level breakdown of the demand for skilled labour implied by its US$800 billion forecast. The preliminary findings of that analysis are presented in Tables 1, 1.1 and 2 below which contain select publicly announced projects.

Table 1: Demand for Construction Workers at Select Oil Refinery Projects[6] [7]

Refinery project	Barrels per day	Cost (US$ bn)	Workers	Welders	Workers per US$ bn	Cost per BPD (US$)
Ghana Energy Hub	900,000	60	200,000	n.a	3333	66667
Dangote refinery expansion (Nigeria)	750,000	14	95,000	n.a	6643	19067
Dangote Phase 1 (Nigeria)	650,000	20	39,650	11,000	1983	30769
Dangote East Africa (Kenya)	650,000	17	50,000	11000 [8]	2941	2615
Abia State Modular Refinery (Nigeria)	650,000	20	39,650	n.a	1983	30769
Jomoro Refinery (Ghana)	300,000	12	30,000	n.a	2500	40000
Lobito Refinery (Angola)	200,000	7	8,000	n.a	1212	33000
Soyo Refinery (Angola)	100,000	4	10,000	n.a	2857	35000
Namibia / Botswana	80,000	4	15,000	n.a	3750	50000
Second Refinery (Selegal)	80,000	5	15,000	n.a	3000	62500
Gode Oil Refinery (Ethiopia)	70,000	3	10,000	n.a	4000	35714
Ndola Refinery (Zambia)	60,000	1	2,200	n.a	2000	18333
Kabaale, Hoima District (Uganda)	60,000	4	6,000	n.a	1500	66667
Abia State Modular Refinery (Nigeria)	30,000	0	3,000	n.a	10000	10000
Cabina Refinery Phase 2 (Angola)	30,000	1	4,500	n.a	9000	16666
Tanga Energy Hub (Tanzania)	700,000	20	50,000	n.a	2500	2857
Total	5,310,000	191	578,000		59202	517,767
Weighted average					3,029	35,932

[5] Wood Mackenzie press release: https://www.woodmac.com/press-releases/africas-$800bn-upstream-investment-cycle-underlines-the-central-role-of-oil-and-gas-in-the-continents-energy-future/

[6] https://constructionreviewonline.com/major-oil-refinery-projects-in-development-in-africa/

[7] Various public information sources

[8] The East Africa refinery is planned to be a duplicate of the Dangote refinery in Nigeria, where 11,000 of the workers were welders.

Table 1.1: Other Reported Refinery Projects with Limited Reliable Public Information

Refinery project	Barrels per day	Cost (US$ bn)	Workers	Welders	Workers per US$ bn	Cost per BPD (US$)
Ogun Refinery (Nigeria)	100,000	5	n.a	n.a		50000
Tharjiath field oil refinery (South Sudan)	300,000	3	n.a	n.a		10000
Eghudu Refinery Limited	100,000	3	n.a	n.a		30000
Ondo Refinery (Nigeria)	500,000	50	n.a	n.a		100000
Total	**1,000,000**	**61**				

The percentage of construction workers on refinery projects who are welders can reach 20–25% during peak piping and mechanical installation.[9] For comparison and validation purposes, welders constituted 28 percent of the Dangote Refinery project's total workforce of 39,650.[10] If we apply 25 percent as the welder peak demand on the projects in Table 1, 25% of the 578,000 workers will be welders if all the peak demands were additive, the resultant peak demand for welders would 144,000 welders. A more detailed analysis of the African peak demand would result from a deeper view of the of the schedules for these projects.

The projects in Table 1.1 have a total reported value of $61 billion USD. We can see from Table 1 that there are 3,029 workers per $USD billion in construction value. Applying this benchmark to the projects in Table 1.1 results in a total of 184,769 workers. If 25% of these workers are welders at peak demand, the welders needed at peak would be 46,192 welders.

Note: Welder counts are reported only for projects where a figure was available. Ratios in the total row are computed from column totals rather than summed across rows. Source: GFP International analysis of project data; Wood Mackenzie.

Table 2: Demand for Skilled Welders by LNG Projects

LNG project	MTPA	Cost (US$ bn)	Cost per MTPA (US$ bn)	Workers	Welders	Welders (%)	Workers per US$ bn
TotalEnergies Mozambique LNG	13.0	24.50	1.88	7,000	n.a.	n.a.	286
Coral North FLNG, Eni (Mozambique)	3.6	7.20	2.00	1,400	n.a.	n.a.	194
NLNG Train 7 (Nigeria)	8.0	10.00	1.25	10,000	n.a.	n.a.	1,000
Bioko Island LNG Plant Expansion	2.4	1.00	0.42	1,400	n.a.	n.a.	1,400
Tanzania LNG Project	10.0	42.00	4.20	30,000	n.a.	n.a.	714
Rovuma LNG (Mozambique)	7.6	30.00	3.95	30,000	n.a.	n.a.	1,000
Greater Tortue Ahmeyim, Phase 2	3.0	5.00	1.67	3,775	n.a.	n.a.	755
Congo LNG, Phase 2	3.0	4.00	1.33	3,020	n.a.	n.a.	755
Total / weighted average (African projects)	50.6	123.70	2.44	86,595	—	—	700
Benchmark: Papua New Guinea LNG (2014)	6.9	19.00	2.75	21,200	5,000	23.6%	1,116

Note: The Papua New Guinea LNG project is included as an international benchmark and is excluded from the African totals. Totals are computed from the underlying project figures. Source: GFP International analysis; Wood Mackenzie.

[9] U.S. Petroleum Refining, A Report by the National Petroleum Council, June 2000.

[10] Reported workforce figures for the Dangote Refinery construction programme; see also Leadership, "Nigeria loses $10bn annually from importation of certified welders": https://leadership.ng/nigeria-loses-10bn-annually-from-importation-of-certified-welders/

During peak construction, **welders typically make up about 20% of the on-site workforce on an LNG project**.[11] A major LNG project in Papua New Guinea employed 5,000 welders out of 21,000 total workers, or 24 percent of the workforce.[12] **If 20% of the 86,595 workers for the projects in table 2 are welders, the total number of welder jobs on these projects would be 17,319.**

If all projects listed in Tables 1, 1.1 and 3 were constructed simultaneously, they could require as many as 207,511 industrial welders.

Table 1	144,000 industrial welders
Table 1.1	46,192 industrial welders
Table 2	17,319 industrial welders
TOTAL:	**207,511 industrial welders at peak project demand**

These figures are indicative only: in practice, each project's demand is influenced by a range of factors, especially the extent of local fabrication versus prefabrication, which is common in coastal LNG projects. Overall demand is also affected by project sequencing, since demand for welders tends to increase through the project cycle and often peaks just after the midpoint. Because industrial welders are highly mobile and frequently relocate from one project to the next, whether project implementation is simultaneous or staggered will materially affect how many welders are required in total. The languages of the host countries may affect where welders are able and willing to be assigned.

A calculation based on sectoral investment trends in the oil and gas sector underscores the rising demand for welders. Investment in Africa's oil and gas sector is projected to total US$800 billion over the next decade.[13] If 20 percent of goes to exploration, the remaining US$640 billion would mainly fund the construction of physical assets.[14]

If we applied an average of 3,029 workers per billion USD investment, the total number of jobs created would be 1,938,560 construction workers. If we conservatively assume that 20% of those workers will be welders, there will be a total of **387,712 project welder positions** to meet this demand. Clearly, all the eventual projects are not listed in tables 1, 1.1 and 2. And surely, many of these jobs will be filled by travelling welders who work from project to project.

Again, the total demand for trained welders in the energy sector will depend on the concurrency of the projects. Many of the projects identified in tables 1, 1.1 and 2 will be performed concurrently. It we just consider four of the projects listed: the Dangote refinery in Nigeria; the construction of the East Africa refinery in Kenya; the energy hub refinery in Tanzania; and the energy hub in Ghana – in the scenario where these four projects were constructed simultaneously, the demand for welders on these four projects could easily exceed 40,000 at one time. If 30% of the projects in tables 1, 1.1 and 2 were constructed simultaneously, an assumption that seems reasonable, **the total peak demand for these projects would be 62.253 thousand welders, (207,511 x 30% = 62,253)**

[11] Exploring LNG in Canada, Report by the Petroleum Labor Market Information (PLMI) division of Enform.

[12] Development Policy Centre, "PNG LNG and skills development": https://devpolicy.org/png-lng-and-skills-development-20190327/

[13] https://www.woodmac.com/press-releases/africas-$800bn-upstream-investment-cycle-underlines-the-central-role-of-oil-and-gas-in-the-continents-energy-future/

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Case Study 1: Demand for Certified Welders at the Dangote Refinery

Increasingly sophisticated industrial facilities are driving demand for certified welders, and where domestic certification capacity is insufficient that demand is met by imported labour. Nigeria's US$20 billion Dangote Refinery commenced operations in October 2024. For 80 years, foreign energy companies had been extracting oil from Nigeria, exporting it to foreign refineries, and shipping refined fuels and petroleum products back to Nigeria and other markets. The opening of the refinery marked a major shift in the Nigerian oil sector. With capacity to process 650,000 barrels of crude oil per day, it is positioned to meet a substantial portion of domestic fuel demand while also making the country a potential exporter of refined petroleum products.

The refinery demonstrates the scale of technical workforce required for modern industrial facilities. Constructing one of the world's largest single-train refineries required tens of thousands of skilled tradespeople, including approximately 11,000 welders — some 16 percent of the total workforce. The demand for these workers illustrates the distinction between general fabrication skills and industrial welding competence: while many welders operate successfully in informal fabrication markets across Africa, major industrial projects require personnel capable of working in accordance with internationally recognised welding procedures, inspection requirements, and quality management systems. Because that capability was not available locally at the required scale, contractors imported welders from other countries.

2.4.2 Electricity and Power Infrastructure

Africa's rapidly expanding energy sector represents one of the largest future markets for industrial welding. Hydroelectric power stations, geothermal developments, thermal power plants, transmission infrastructure, renewable energy projects, and regional power interconnections all require extensive welding during construction, commissioning, maintenance, and rehabilitation. Large-scale energy systems involve extensive fabrication of structural frames, pressure components, piping networks, and storage vessels. The transition toward cleaner energy technologies — including solar, wind, hydrogen, and battery manufacturing — will further increase demand for specialised fabrication and welding skills.

Seventeen African nations have recently pledged to develop actionable strategies to enhance electricity access as part of Mission 300. As of 2025, the electrification rate was about 57 percent, leaving 600 million people without access to electricity. Mission 300, spearheaded by the World Bank Group and the African Development Bank Group, aims to halve the share of Africans without electricity access by 2030.[15] In early 2026, Chad, Côte d'Ivoire, the Democratic Republic of Congo, Liberia, Madagascar, Malawi, Mauritania, Niger, Nigeria, Senegal, Tanzania, and Zambia established energy compacts collectively involving over 400 policy measures aimed at enhancing utility operations, minimising investor risk, and removing obstacles to investment in electricity.

Africa's total installed electricity generation capacity is approximately 250 gigawatts, although a significant portion is often unavailable due to maintenance or infrastructure limitations. Africa's electric generation mix is diverse, with natural gas leading at 43% (112 GW), followed by coal at 20% (52

[15]African Development Bank, "17 countries commit concrete plans to scale electricity access as Mission 300 expands": https://www.afdb.org/en/news-and-events/press-releases/17-countries-commit-concrete-plans-scale-electricity-access-mission-300-expands-87112

GW), hydropower at 15% (39 GW), oil at 10% (25 GW), and solar photovoltaic at 5% (14 GW). The cost to develop 1,000 MW of generating capacity is about US$1-1.5 billion for a natural gas combined-cycle plant, US$3-5 billion for a coal-fired plant, US$1-3 billion for a hydropower plant, US$1-3 billion for an oil-fired plant, and US$1-3 billion for a solar photovoltaic plant. If the generation mix remained constant, achieving the Mission 300 goal of supplying 300 million more people with electricity would require about US$150 billion in new generation investment.

Multiple gas-fired power plants are expected to be commissioned within the next few years. Morocco is developing three power stations at Ain Beni Mathar, Kenitra, and Mohammedia, each with a capacity of about 150 MW; expressions of interest have been invited by Morocco's National Office for Electricity and Drinking Water, with commissioning expected by 2026. Nigeria has launched the US$10 billion LNG Train 7 expansion project, which will add around 8 million tonnes per annum (mtpa) of liquefaction capacity and was about 80 percent complete as of mid-2025. Mozambique's Temane Thermal Power Station, currently under construction, will have a capacity of 450 MW serving local and regional needs. Kenya has proposed the construction of several natural gas power plants aimed at diversifying its energy mix and reducing reliance on hydroelectric power.

Case Study 2: Technical Skills Required for Hydropower Development

Expanding renewable energy increases long-term demand for highly skilled industrial welders, both for construction and infrastructure maintenance. Large hydropower projects across Africa illustrate the scale of the welding and fabrication competencies required to support modern energy infrastructure. The construction of dams, spillways, penstocks, turbines, powerhouse structures, gates, and transmission infrastructure depends on qualified welders working under strict engineering specifications.

Beyond construction, long-term operations and maintenance require specialised welding skills for inspection, repair, rehabilitation, and the replacement of critical infrastructure throughout the project lifecycle. The continued expansion of renewable energy systems across Africa therefore presents considerable and durable employment opportunities for welders, underscoring the need for technical institutions capable of producing graduates whose competencies align with international engineering standards.

2.4.3 Mining and Mineral Processing

Mining continues to be a major driver of industrial activity throughout Africa. Mining operations rely on welding expertise for plant construction, equipment maintenance, mineral processing facilities, structural steel fabrication, heavy machinery repair, pipeline construction, and industrial maintenance. As African countries increasingly seek to process minerals locally, additional demand will emerge for fabrication workshops, manufacturing plants, refineries, and industrial processing facilities, all of which require skilled welding personnel.

Africa's mining sector holds an estimated US$29.5 trillion in untapped mineral resources. In 2024, an estimated 10 percent of global exploration investment was allocated to the continent. As of early 2026, over 2,000 active and planned mining projects were being developed across Africa, targeting 33 different minerals, with a focus on battery-related minerals and materials vital to the green energy transition. The

pipeline of near-term projects is valued at US$83.3 billion. International corporations and state-supported entities are driving this investment, with China playing an especially significant role. Global demand for minerals and metals — particularly for renewable energy technologies and electric vehicles — is rising rapidly, and Africa possesses rich deposits of lithium, cobalt, and other essential commodities.

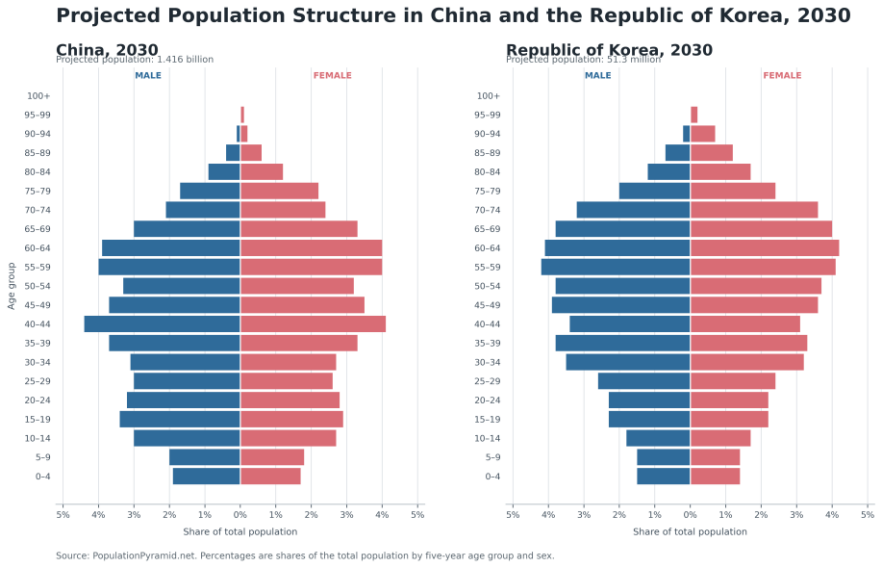
In Sub-Saharan Africa, mining contributed US$108 billion to total economic output in 2023. In the 15 most mineral-rich African countries, mining represents 10 percent of GDP and 8 percent of government revenue on average, and the sector is a primary target of foreign direct investment. Africa holds over 50 percent of the world's cobalt and manganese reserves and over 20 percent of all aluminium and copper. In 2020, the value of copper and battery-metal extraction alone reached US$20 billion.

Every mine operation has a maintenance shop where machinists and welders work to maintain mechanised equipment. The manufacture of such equipment also requires skilled welders, as does the construction and maintenance of supporting infrastructure. The available data do not yet allow a precise estimate of welder demand in the mining industry, and GFP International is working to obtain the information necessary to support a thorough analysis.

2.4.4 Shipbuilding and Seaports

The global shipbuilding industry faces a large and growing shortage of skilled welders. The U.S. shipbuilding sector is already experiencing a significant crisis, and while China and South Korea remain dominant players in global shipbuilding, demographic ageing is eroding their workforces. By contrast, Africa offers a growing workforce and low labour costs. Research conducted for this analysis indicates that employing a skilled welder in Africa costs approximately one-fourth to one-third of the cost of employing a welder in South Korea. This combination of global shortage and African cost advantage represents one of the clearest strategic opportunities identified in this report — but it can only be captured by a workforce holding internationally recognised qualifications.

Figure 2:



Major port projects across Africa are focusing on deep-sea infrastructure, increased capacity, and regional trade corridors. There are at least 61 existing or planned port projects in Africa involving Chinese investment alone. Chinese firms hold stakes in 78 ports across 32 countries and aim to boost trade capacity

from 265 million tons to over 2 billion tons by 2040.[16] The Lekki Deep Sea Port is a US$1.5 billion container terminal designed to deepen Nigeria's integration with global markets. Dakhla Atlantic Port aims to boost trade in West Africa. Kenya's Funzi Port Project is a new US$4.8 billion development designed as a specialised, high-capacity port to increase regional trade, and Lamu Port is expanding into a key logistics hub with associated transport corridors. Bagamoyo Port in Tanzania is a US$10 billion project intended to compete with established hubs such as Dar es Salaam and Mombasa. Hobyo Port in Somalia is designed to support regional trade and provide sea access for Ethiopia. The Coast Barge Project in Côte d'Ivoire is intended to improve lagoon access and container terminal capacity.

2.4.5 Transportation and Infrastructure Development

Major investments in roads, bridges, railways, airports, ports, water supply systems, public buildings, and urban development continue to increase demand for structural steel fabrication and welding services. These projects require welders capable of working with structural steel, reinforcing systems, heavy equipment, transport infrastructure, and large-scale construction. Regional integration initiatives and trade corridor development are further expanding investment in railway systems, bridges, and heavy transport structures. Such assets require welders trained to meet fatigue resistance, load-bearing integrity, and inspection compliance requirements, and the scale of these projects implies consistent, long-term demand.

Nigeria is developing a US$60 billion, 4,000 km high-speed rail network designed to link key economic hubs in Lagos, Abuja, Kano, and Port Harcourt using gas-powered trains. Nigeria is also partnering with Ethiopia on a proposed US$400 billion to US$1 trillion "gas-by-rail" initiative that would transport LNG across 40 Sub-Saharan African countries via a 73,500 km rail network.

Figure 3: Illustration of a Gas-by-Rail System



The development of transport infrastructure will require large numbers of skilled welders. Building Nigeria's Train 7 LNG expansion project, for example, will demand an estimated 12,000 total workers, of whom about 20 percent will likely be welders. Train 7 will increase output capacity by 35 percent, from 22 mtpa to 30 mtpa, implying an employment ratio of 240 welders for each 1 mtpa increase in capacity.

[16]UNCTAD, "UN project powering smart, sustainable ports in Africa": https://unctad.org/news/un-project-powering-smart-sustainable-ports-africa

Case Study 3: Standard Gauge Railway Projects and Local Skills Development

Infrastructure investment creates domestic opportunity only when the national workforce possesses sufficient industrial skills to capture it. Railway construction projects undertaken in several African countries demonstrate the importance of developing domestic technical capacity. Modern railway systems require extensive fabrication and welding during the construction of bridges, stations, steel structures, maintenance depots, rolling stock facilities, and associated infrastructure.

Where sufficient local technical capacity exists, countries are better positioned to maximise local employment, technology transfer, and domestic value addition. Conversely, shortages of certified technical personnel result in greater reliance on expatriate labour and imported expertise. Investments in welding education therefore contribute directly to strengthening local participation in national infrastructure programmes and increasing their economic multiplier effect.

2.4.6 Manufacturing and Industrialisation

Manufacturing remains one of the largest consumers of welding and fabrication services. Production of machinery, vehicles, agricultural equipment, construction materials, fabricated steel products, consumer goods, and industrial components depends on a workforce with diverse welding competencies. Manufacturers increasingly require welders who can interpret engineering drawings, follow welding procedures, maintain quality standards, and operate modern fabrication equipment. Employers also emphasise the importance of productivity, precision, documentation, and teamwork within contemporary manufacturing environments.

Many African economies continue to export raw or semi-processed materials while importing finished consumer and capital goods. This imbalance limits domestic industrial growth and constrains skilled employment creation. Welding skills are central to the problem: countries that lack certified welders cannot produce pressure vessels, process skids, storage tanks, industrial piping systems, heavy machinery structures, motor vehicles, or sophisticated manufactured goods. Value that could be retained locally is instead transferred abroad. National and multilateral industrialisation strategies increasingly emphasise local content requirements, regional manufacturing hubs, technology transfer, and skills development — and the success of these efforts hinges on the availability of competent technical labour, particularly in welding and fabrication.

Industrialisation policies will drive further demand for skilled welders in manufacturing and related sectors.[17] The Nigerian Senate has passed legislation requiring that all raw materials undergo local processing to at least 30 percent before being eligible for export, with non-compliance incurring a 15 percent levy on the value of the exported goods.[18] Ugandan President Yoweri Museveni has issued a directive banning the exportation of raw minerals. The ban is expected to increase revenue for Uganda through domestic processing: a tonne of unprocessed vermiculite sells for about US$25, while processed vermiculite can fetch up to US$410. Local processing is also expected to create jobs in mining and manufacturing — the Abyssinia Group's new steel factory in Jinja, for example, is expected to employ 280

[17]Institute for Security Studies, African Futures — Manufacturing: https://futures.issafrica.org/thematic/07-manufacturing/
[18]ThisDay, July 2025: https://www.thisdaylive.com/2025/07/08/senate-passes-landmark-law-mandating-30-local-processing-of-raw-materials-before-export/

people directly and benefit over 1,000 indirectly, producing 75,000 tons of steel annually from locally mined iron ore.[19]

Table 3: Welders as a Share of Manufacturing Sector Workers, Cross-Country Comparison

Country	Population (millions)	Welders	Welders per million pop.	Manufacturing workers	Mfg. workers per million pop.	Welders in manufacturing	Welders as % of mfg. workers
United States	342.0	457,300	1,330	12,590,000	36,813	278,453	2.21%
China	1,421.0	2,300,000	1,628	110,000,000	77,410	3,000,000	2.73%
Germany	83.6	n.a.	n.a.	6,670,000	79,785	417,000	6.25%
Japan	122.7	179,501	1,463	10,200,000	83,130	n.a.	n.a.
Kenya	58.6	50,000	853	358,000	6,109	50,000	13.97%
Nigeria	242.0	808	n.a.	7,000,000	28,926	n.a.	n.a.
Africa (today)	1,570.0	n.a.	n.a.	20,000,000	12,739	n.a.	n.a.
Africa (2045 forecast)	2,280.0	see below	see below	54,000,000	see below	see below	see below

Note: Compiled from a range of online sources and AI-assisted searches. Figures are assumed to refer to qualified industrial welders and to exclude welders working in the informal economy.

While data constraints prevent a precise estimate of demand for welders in the African manufacturing sector, international experience provides a reasonable benchmark. Welders will likely make up about 3.5 percent of the manufacturing workforce, placing Africa in the middle of the global range (Table 3). Combining that metric with the forecast of 34.6 million new manufacturing jobs across the continent implies that the growth of **the manufacturing sector alone will create demand for 1.21 million new qualified industrial welders**

2.4.7 Construction and Urbanisation

Rapid urbanisation across Africa is driving continuous demand for structural steel fabrication, commercial construction, housing frameworks, and public infrastructure. Modern construction increasingly relies on prefabricated steel components, modular assemblies, and engineered joints, all of which depend on reliable welding quality. Where domestic welding competence is limited, construction sectors revert to conservative material choices, imported prefabricated components, and slower project delivery timelines. Strengthening welding capabilities therefore contributes not only to employment but also to construction efficiency and cost reduction.

2.4.8 Emerging Industrial Opportunities

Industrial growth across Africa is creating opportunities not only for employment but also for technology transfer, local manufacturing, and value addition. Beyond the sectors examined above, the analysis reveals expanding opportunities in defence manufacturing, automotive assembly, aerospace support industries, agricultural mechanisation, modular construction, steel manufacturing, and advanced fabrication. Many of these industries are adopting digital technologies, automation, robotics, and advanced welding systems that require new technical competencies beyond traditional manual welding. Preparing the

[19]The Voice of Africa, "Uganda bans raw mineral exports: what it means for the mining sector": https://thevoiceofafrica.com/2025/07/11/uganda-bans-raw-mineral-exports-what-it-means-for-the-mining-sector/

future workforce for these industries will require continuous modernisation of training systems and stronger collaboration between education providers and industrial employers.

2.5 The Competencies the Market Requires

Energy infrastructure and manufacturing remain the most significant drivers of high-skill welding demand. Pipeline construction, refinery development, gas-processing facilities, and storage systems all rely on welders capable of executing precision welds subject to strict inspection regimes. Such projects typically require adherence to qualified welding procedures, performance certification of individual welders, traceability of materials and weld records, and compliance with international pressure and safety codes. Because these requirements exceed the competence level produced by congested or under-equipped training environments, energy projects frequently depend on imported technical labour, foreign fabrication yards, and externally certified welding teams. This reliance represents both a skills deficit and a lost economic opportunity. While industrial projects, pipelines, refineries, power plants, and modular skids require high-standard welders, African value capture is currently limited by the import of prefabricated industrial kits; building local welding capacity supports the localisation of fabrication and retains value on the continent.

Highly qualified welders require training against international standards. ISO 14731 defines welding coordination and quality traceability responsibilities; training centres lacking exposure to welding coordination tasks are likely to produce technicians who cannot operate in regulated EPCC projects. The PQR, WPS, and welder performance qualification (WPQ) form the operational triad that underpins industry acceptance of welding outputs. Training must therefore go beyond bead practice to teach process variables, documentation, and traceable test records. Integrating these competencies into trainer curricula enables graduates to operate within industrial quality-assurance frameworks. Contemporary welding simulators can additionally reduce consumable costs and provide rapid feedback loops, and formal recognition of simulation hours can enable welders to maintain their qualifications during short periods of inactivity. Simulator integration could therefore be a critical enabler of skills development, especially where consumables and electricity are constrained.

2.6 The Cost of Unmet Demand for Welding Skills

Where local training systems cannot produce enough capable welders, industries compensate in predictable and costly ways. They recruit foreign technical labour, outsource fabrication to external facilities, or delay and scale down projects. Employers also face increased costs associated with additional in-house training and extended probationary periods. The rejection of locally trained applicants weakens trust between training institutions and industry, further complicating workforce development.

The uneven distribution of training resources produces regional disparities in welding competence. Some areas benefit from relatively well-equipped institutions capable of producing employable graduates, while others remain dependent on under-resourced training environments. Unequal training capacity limits labour mobility, equitable employment opportunities, and balanced regional industrial growth. Addressing the welding skills gap therefore requires not only overall capacity expansion but also a more equitable distribution of effective training infrastructure.

Closing the welding skills gap would generate substantial social and economic benefits by driving job creation, accelerating economic activity, boosting tax revenue, and providing employment opportunities for Africa's young and rapidly growing population. Given the multiplier effects described

in Section 2.3, the returns on investment in industrial welding capacity extend well beyond the welders themselves. To assess the precise nature of the gap between Africa's existing training systems and the workforce necessary to support industrialisation at scale, GFP International surveyed 37 established welding and fabrication training institutions across 13 African countries. Chapter 3 describes the survey, and Chapter 4 presents its findings.

3. Assessing Supply: Survey of Existing Training Institutions

3.1 Purpose of the Institutional Survey

The preceding chapter established that Africa requires approximately three million qualified industrial welders. This chapter and the next address a single, deliberately narrow question: can the continent's existing welding schools produce them?

To answer it, GFP International surveyed 37 established welding, fabrication, and manufacturing training institutions across 13 African countries. It is important to be clear about what this survey is and what it is not. It is not a study of institutions that might one day be built, nor an assessment of proposals or plans. Every institution in the sample is an operating school, college, university department, or industry training centre that is enrolling students and delivering welding instruction today. Several are among the better-regarded technical institutions in their respective countries. They represent, in other words, the supply side of the African welding labour market as it currently exists.

The survey was designed as a capacity test, benchmarked against the requirements of industrial certification. Rather than ranking institutions or evaluating their administration, it measured a small number of variables that determine whether a graduate can realistically qualify to internationally recognised welding standards: the quantity and condition of welding machines, the number of formal welding booths, supervised arc time per student, student-to-machine ratios, the availability of fabrication and testing equipment, instructor qualifications, curriculum alignment, and the type of certificate the institution is able to award. These are objective, verifiable measures, and each maps directly onto a precondition of industrial employability.

The purpose of the exercise, therefore, is diagnostic rather than evaluative. Participating institutions volunteered for the assessment, provided documentation, and hosted verification visits, and their willingness to expose their constraints to external scrutiny deserves recognition. The findings that follow are not a criticism of those institutions or of the instructors who work in them. They are a measurement of a system-level deficit. What the data demonstrate is that the existing network of welding schools — operating as it currently does, with the equipment, arc time, and certification pathways currently available to it — cannot meet the demand quantified in Chapter 2, and cannot be brought to that standard by incremental improvement alone. That conclusion is the evidential basis for the intervention proposed in Chapter 5.

3.2 Research Design

This study adopted a mixed-methods research design integrating qualitative and quantitative approaches. The research team collected detailed statistics on institutional capacity, equipment inventories, student enrolment, instructor availability, and training infrastructure, alongside qualitative information generated through interviews, field observations, curriculum reviews, and stakeholder consultations.

The assessment focused on vocational training institutions, technical colleges, universities, and specialised training centres offering programmes in welding, fabrication, machining, manufacturing, and related engineering disciplines. The institutions surveyed represent both public and private providers across different geographic regions, levels of industrial development, and vocational training systems. They were selected on the basis of their interest in participating in the proposed African Welding School and

Training Program, their potential for institutional development, and their strategic importance in supporting national and regional industrial workforce development.

The study team engaged directly with institutional leadership and technical staff. Information was obtained from principals, institutional administrators, heads of department, welding instructors, engineering faculty, workshop technicians, and curriculum developers. Beyond these institutions, additional information was collected from employers, engineers, project managers, manufacturing companies, industry representatives, and technical experts in order to obtain the demand-side perspective on workforce requirements, certification standards, and industry expectations.

3.3 Data-Collection Procedures

Data collection was undertaken through a structured multi-stage process that began with institutional engagement through a formal Letter of Interest. Institutions wishing to participate submitted a Letter of Interest expressing their willingness to take part in the assessment and confirming their institutional commitment to strengthening welding and manufacturing training capacity. This served as an initial screening mechanism before detailed institutional assessments were undertaken.

Following receipt of the Letter of Interest, participating institutions completed a comprehensive Welding School Survey developed by GFP International. The survey collected standardised information on institutional infrastructure, workshop facilities, equipment inventories, instructor capacity, student enrolment, welding laboratories, curriculum content, practical training hours, certification readiness, safety systems, and industry partnerships. Supporting documentation — including photographs of equipment, workshop layouts, welding booths, facility floor plans, and curriculum materials — was also requested to facilitate verification.

After reviewing the completed surveys, GFP assessment teams conducted field visits to selected institutions. These visits validated the information submitted, inspected workshop facilities, observed training activities, verified equipment inventories, assessed training environments, and included interviews with institutional leadership, instructors, and technical staff. Direct observation enabled the team to identify constraints that could not be captured through questionnaires alone.

The institutional findings were further supplemented through consultations with employers, engineers, manufacturing companies, project managers, industry associations, and technical experts. Secondary data from government publications, labour market studies, development agency reports, industry reports, and international technical standards were also reviewed to provide broader context.

3.4 Data-Collection Tools

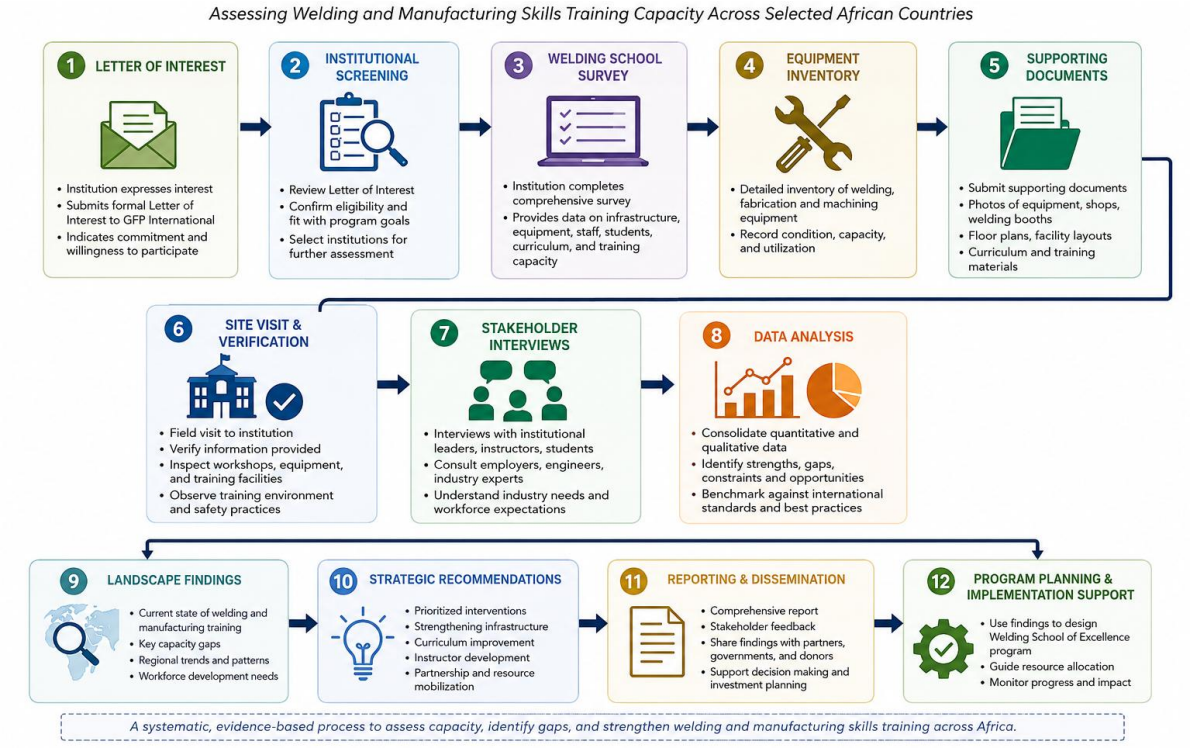
Multiple data-collection instruments were employed to improve the reliability and completeness of the assessment. The primary tool was the GFP Welding School Survey, a comprehensive institutional assessment covering institutional profiles, equipment inventories, welding machines, machining equipment, workshop infrastructure, instructor capacity, student enrolment, curriculum content, practical welding hours, laboratory facilities, safety systems, and certification readiness.

A detailed Equipment Inventory Survey documented the availability and condition of industrial training equipment, including welding machines, machine tools, testing equipment, fabrication equipment, and workshop infrastructure. Institutional capacity was benchmarked directly against

internationally accepted training requirements. Additional instruments included semi-structured interview guides used during discussions with institutional leaders, instructors, employers, and industry representatives; observation checklists employed during site visits to assess workshop conditions, equipment utilisation, safety practices, and training environments; and document-review checklists used to evaluate curricula, institutional reports, and training manuals.

The complete quantitative dataset generated by these two instruments is reproduced without amendment in Annex C. Table C1 presents the institutional capacity data, and Table C2 shows the equipment inventory data as returned by the participating institutions. The findings presented in Chapter 4 are drawn from those tables and can be verified against them.

Figure 4: Research Process Flow



3.5 Ethical Considerations

The study was conducted in accordance with accepted principles of professional research and institutional engagement. Participation was voluntary and commenced only after formal expression of interest through the Letter of Interest process. Institutional leadership granted permission for site visits, facility inspections, interviews, photography, and collection of institutional information. Participants were informed of the purpose of the assessment and the intended use of the information collected.

Information obtained during interviews and institutional assessments was used solely for research, planning, and programme development purposes. Institutional data were analysed objectively, and findings are presented in aggregate form to identify regional trends, capacity gaps, and strategic opportunities rather than to evaluate or rank individual institutions. Throughout the study, the assessment team sought to maintain professional integrity, respect institutional confidentiality where appropriate, and ensure that all observations and conclusions were supported by evidence obtained through surveys, field verification, stakeholder consultations, and document reviews.

3.6 Participating Institutions

A total of 37 institutions across 13 countries participated in the inventory survey. The distribution reflects both the concentration of industrial activity across the continent and the geographic reach of GFP International's partner network. Nigeria, Cameroon, and Kenya together account for 22 of the 37 institutions surveyed.

Table 4: Participating Institutions by Country

Country	Institutions	Country	Institutions
Nigeria	10	Ghana	1
Cameroon	6	Malawi	1
Kenya	6	Namibia	1
Senegal	3	Republic of Congo	1
South Africa	2	Tunisia	1
Tanzania	2	Uganda	1
Zimbabwe	2		
Total			**37**

The full list of participating institutions is provided in Annex B. Complete survey returns are reproduced in Annex C.

The sample spans the full range of provider types found in African welding education. It includes national polytechnics and technical universities (e.g., Kaduna Polytechnic, Koforidua Technical University, the Technical University of Kenya, and Harare Institute of Technology); public vocational and technical colleges (Lilongwe Technical College, Kushinga Phikelela Polytechnic, Lycée Seydina Limamou Laye); faith-based and non-governmental training providers (the Don Bosco institutes in Nigeria and Tanzania); specialised private welding institutes (Kaduna Welding Institute, SEB Institute of Welding and Technology, Harmattan City Institute of Welding and Fabrication); and industry-linked training and inspection companies (Inspections and Testing Limited, Icon Lifting and Rigging Inspections Limited, HOMIK Oil and Gas Facility Engineering School, Morendat Institute of Oil and Gas). Because the sample includes well-established public universities and industry-operated training providers alongside smaller vocational centres, the constraints identified in Chapter 4 cannot be attributed to the weakness of any single category of institution but are present, in varying degrees, across the entire spectrum of welding training providers on the continent.

4. Findings: The Capacity of Existing Institutions

The assessment reveals considerable variation in the capacity of the assessed training institutions, but they consistently fall short of the requirements of industrial certification. Some institutions have established welding programmes supported by dedicated workshops and experienced instructors; many others struggle to produce graduates capable of meeting the competency requirements of modern industry. On the measures that determine industrial employability — supervised arc time, equipment availability, testing capability, and certification pathways — deficiencies are evident across the entire sample.

4.1 Headline Findings

Table 5 summarises the survey findings against the requirements of internationally recognised welder qualification. Each indicator is a precondition for industrial certification rather than a measure of institutional quality. A school may perform well overall and yet still fail to satisfy any of the specified requirements.

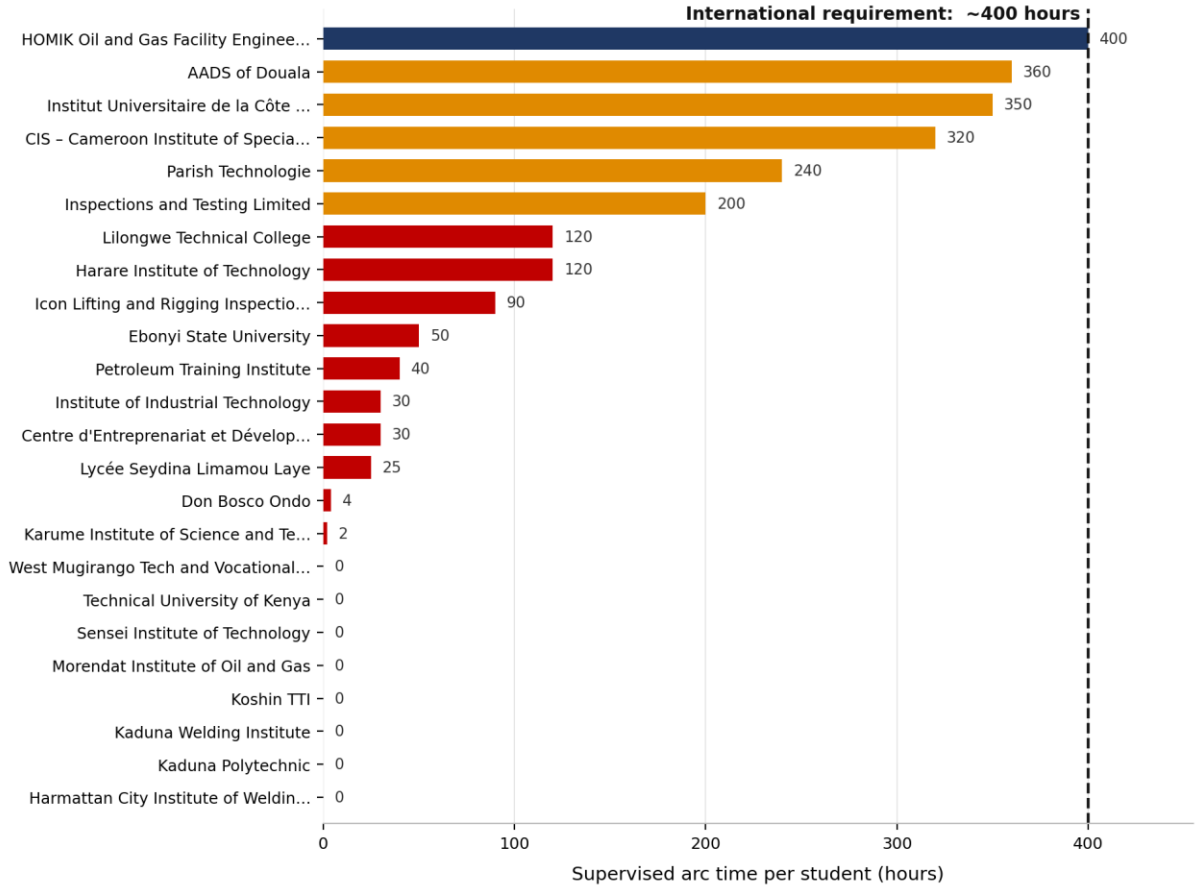
Table 5: Institutional Capacity Measured against International Qualification Requirements

Indicator	International requirement	Survey finding (37 institutions)
Supervised arc time per student	Approx. 400 hours for an introductory certifiable programme	Median 30 hours. Of 24 institutions reporting, 18 fall below 150 hours and 8 report no hours at all. Only one, HOMIK Oil and Gas Facility Engineering School, satisfies the 400-hour requirement.
Certification awarded to graduates	Internationally recognised qualification (IIW, AWS, ASME, ISO)	None. All institutions award local certificates, national awards, or none at all.
Curriculum alignment	Mapped to international welding codes and standards	34 of 37 only deliver a locally developed curriculum; 3 reported no formal curriculum.
Bend-testing equipment	Essential — welder qualification testing cannot be performed without it	7 of 37.
Formal welding booths	Essential for supervised, safe practical instruction	14 of 37.
Welding machines	Approx. one machine per 2–3 students	149 machines in total across the 22 institutions reporting; 5 report none.
Fabrication, cutting, and testing equipment	Required to support code-compliant practice	16 of 37 reported no such equipment of any kind.
Student-to-machine ratio	Approx. 2–3 : 1	Aggregate ratio of 7.3 : 1 among reporting institutions; individual ratios reach 100 : 1.

Source: GFP Welding School Survey and Equipment Inventory Survey. Complete returns are reproduced in Annex C.

The most consequential figure in the table is arc time. Welding is a psychomotor skill: competence is acquired through repetition under supervision, and no amount of classroom instruction substitutes for hours spent under the hood. A candidate presenting for an internationally recognised qualification test is expected to have accumulated approximately 400 hours of supervised practice. The median institution in this survey provides 30. That difference is of an order of magnitude, and it indicates that the overwhelming majority of graduates emerging from these institutions are not merely uncertified but uncertifiable without substantial further training.

Figure 5: Supervised Arc Time per Student, by Institution



Institutions reporting an arc-time figure (24 of 37). Institutions shown in red fall below 150 hours; the dashed line marks the approximate international requirement.

The absence of any certification pathway is also a critical finding. Not one of the 37 institutions surveyed reported the ability to issue an internationally recognised welding certificate. Only seven possess bend-testing equipment, without which welder qualification testing cannot be conducted at all. An institution that cannot test to code cannot certify to code, and a graduate without a recognised certificate cannot be engaged on a refinery, pipeline, pressure-vessel, or shipyard project regardless of actual skill. The certification gap therefore severs the link between the training system and precisely those sectors identified in Chapter 2 as the sources of greatest demand.

4.2 Overall Institutional Readiness

Most institutions demonstrated a strong commitment to expanding technical and vocational education and recognised the growing importance of welding and manufacturing skills in supporting national industrialisation agendas. Institutional leadership consistently expressed interest in modernising training facilities, strengthening practical instruction, improving curriculum delivery, and establishing stronger partnerships with industry. This commitment was reflected in the willingness of participating institutions to submit Letters of Interest, complete institutional inventory surveys, provide supporting documentation, and participate in detailed field assessments.

Despite this broad commitment to modernisation, the assessment identifies substantial disparities in institutional readiness. Several institutions operated purpose-built engineering workshops with dedicated welding laboratories, fabrication areas, and machining facilities. Others relied on ageing infrastructure, multipurpose workshops, or facilities originally designed for smaller student populations and less sophisticated training programmes. In many cases, workshop space had become inadequate to accommodate increasing enrolment, resulting in overcrowding and reduced opportunities for practical instruction.

The assessment also finds considerable differences in programme diversity. While some institutions offered training across multiple welding processes, as well as fabrication, machining, and manufacturing technologies, others were limited to basic welding instruction with minimal exposure to modern industrial applications. This variation directly affects the ability of institutions to prepare graduates for employment in manufacturing, mining, energy, construction, transportation, and industrial fabrication.

A recurring finding was the gap between institutional ambition and institutional capacity. Many colleges had developed strategic plans to expand engineering programmes and establish centres of excellence, yet progress was constrained by limited financial resources, outdated infrastructure, shortages of modern equipment, and insufficient access to industry-standard technologies. These constraints reduce opportunities for learners to acquire the practical competencies and certification readiness expected by employers.

4.3 Facilities and Equipment

4.3.1 Training Facilities

Practical welding is a competency-based discipline in which technical proficiency is developed through supervised hands-on experience using industry-standard equipment under controlled workshop conditions. Institutional capacity is therefore directly determined by the availability, condition, utilisation, and diversity of training equipment. The Equipment Inventory Survey documented workshop infrastructure, welding equipment, fabrication machinery, machining facilities, testing equipment, workshop utilities, safety systems, classroom resources, and supporting training facilities, with returns verified during institutional visits.

The assessment highlights the uneven quality and capacity of workshop infrastructure across participating institutions. While several institutions possessed purpose-built welding laboratories capable of supporting structured practical instruction, many operated in facilities originally designed for general engineering education rather than industrial welding training. Common limitations included inadequate workshop floor space, insufficient welding booths, poor ventilation, limited fume extraction, ageing electrical installations, inadequate compressed air systems, insufficient material storage, and limited classroom space dedicated to welding theory and quality control. Only 14 of the 37 institutions reported having formal welding booths at all. In several institutions, large student populations shared relatively small workshop spaces, significantly reducing opportunities for individual practical training and increasing competition for available equipment.

The assessment also identifies weaknesses in workshop safety infrastructure. Several institutions lacked adequate welding curtains, fire protection systems, personal protective equipment storage, emergency response facilities, and appropriate segregation of welding processes. Such deficiencies adversely affect training quality while exposing students and instructors to significant occupational health

and safety risks. Many institutions will require substantial infrastructure modernisation before they can consistently deliver industrial-grade welding training aligned with internationally recognised safety and quality standards.

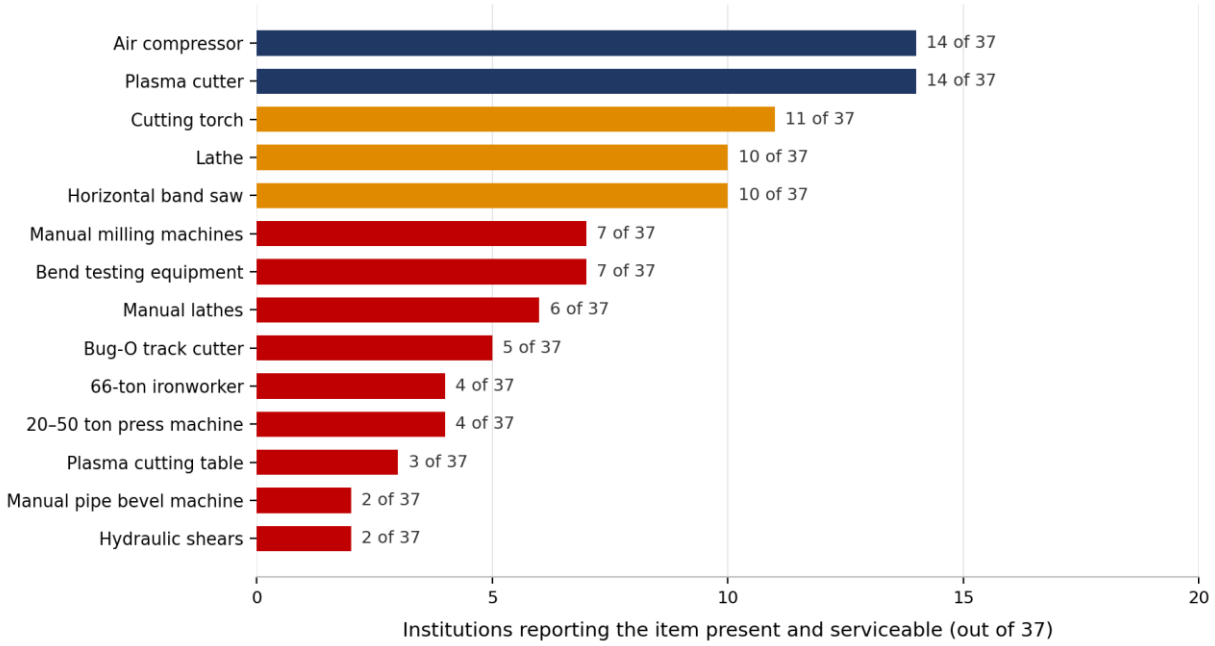
4.3.2 Welding, Fabrication, and Machining Equipment

The Equipment Inventory Survey shows considerable variation in both the quantity and quality of welding equipment available for training. Across the 22 institutions reporting a machine count, a total of 149 welding machines were recorded — an average of under seven machines per institution, and five institutions reported none at all. Shielded Metal Arc Welding (SMAW) equipment was the most common technology, reflecting its continued importance within vocational education. However, many machines were ageing, heavily utilised, or outdated, limiting opportunities for students to gain experience with equipment currently used in modern manufacturing industries.

Equipment for Gas Metal Arc Welding (GMAW/MIG), Gas Tungsten Arc Welding (GTAW/TIG), Flux-Cored Arc Welding (FCAW), submerged arc welding, plasma cutting, and mechanised welding systems was considerably less common. Where such equipment existed, it was frequently available in limited quantities, resulting in high student-to-machine ratios and reduced practical training time. This shortage presents a significant obstacle for institutions seeking to prepare graduates for employment in oil and gas, power generation, mining, shipbuilding, heavy manufacturing, and pressure-vessel fabrication, where multiple welding processes and advanced technologies are routinely employed.

Industrial welding training also requires supporting competencies in fabrication, machining, measurement, inspection, and material preparation. The assessment therefore examined the availability of fabrication and machine shop equipment, including lathes, milling machines, band saws, presses, plate rollers, guillotines, pipe-preparation equipment, cutting equipment, and testing apparatus. The results are set out in Figure 6.

Figure 6: Availability of Fabrication, Cutting, and Testing Equipment



Where returns were incomplete or ambiguous, the item has been counted as not present. Source: GFP Equipment Inventory Survey (Annex C, Table C2).

The pattern is consistent and severe. Sixteen of the 37 institutions — including several national universities and a specialised welding institute — reported no fabrication, cutting, or testing equipment of any kind. Pipe-bevelling machines and hydraulic shears were each present at two institutions; plasma cutting tables at three. Bend-testing equipment, the single most important item for welder qualification, was available at seven. Computer Numerical Control (CNC) machinery, robotic welding systems, automated cutting technologies, and digital fabrication equipment were effectively absent across the entire sample.

The consequence is that students graduate with limited exposure to the technologies increasingly used in modern industrial production. This gap between training technology and industry practice reduces graduates' competitiveness in precisely those sectors undergoing the most rapid technological transformation — and it cannot be closed by curriculum reform alone, because the equipment on which the curriculum depends does not exist in the workshops.

4.3.3 Equipment Utilisation and Practical Training Capacity

Equipment shortages translate directly into high student-to-machine ratios, limiting individual practice time and reducing opportunities for the repetitive skills development on which welding competence depends. Among institutions reporting both enrolment and machine counts, the aggregate ratio stands at approximately 7.3 students per machine, against an international norm of roughly two to three. Individual institutions perform far worse: one national university reported 300 students sharing three welding machines, a ratio of 100 : 1, and another reported 167 students sharing five machines.

In several institutions, practical sessions required students to rotate between machines, reducing actual arc time and preventing the development of the procedural consistency required for industrial certification. Many institutions additionally reported shortages of welding consumables, including electrodes, shielding gases, filler metals, grinding discs, cutting equipment, and base materials. Even where equipment was available, limited operating budgets often constrained its regular use, further reducing the supervised practical experience available to learners. Equipment counts alone therefore overstate real training capacity.

4.3.4 Workshop Infrastructure Priorities

Modernising welding education in Africa will demand far more than the procurement of additional equipment. Effective training systems require integrated investments in workshop design, electrical infrastructure, ventilation systems, safety facilities, modern welding technologies, fabrication equipment, inspection laboratories, digital learning resources, and ongoing maintenance programmes. The institutions demonstrating the greatest readiness for industrial workforce development were those that combined adequate infrastructure with strong institutional leadership, qualified instructors, active industry partnerships, and a clear commitment to continuous programme improvement. These institutions provide a practical foundation upon which future Welding and Manufacturing Centres of Excellence can be established.

The equipment inventory assessment demonstrates that efforts to increase the number of welding schools must be paired with measures to improve the quality, diversity, and industrial relevance of existing training infrastructure. Many institutions have established basic welding programmes capable of supporting introductory technical education. However, the transition from basic vocational instruction

to internationally competitive industrial workforce preparation requires significant investment in modern equipment, practical training environments, quality assurance systems, and supporting manufacturing technologies. Without these investments, graduates will remain concentrated within informal fabrication and repair markets, while large-scale industrial projects continue to depend on imported technical labour.

4.4 Instructor Capacity and Human Capital

The quality of any technical and vocational education system depends on the competence, experience, and continuous professional development of its instructors. In welding education, instructors transfer technical knowledge, demonstrate practical skills, enforce safety standards, cultivate professional attitudes, and prepare trainees for industrial employment. The availability of qualified and industry-experienced instructors is therefore one of the most important determinants of training quality and graduate competence.

The institutional assessments found that participating institutions were supported by committed instructors demonstrating a strong commitment to student learning and technical skills development. Many possessed formal qualifications in welding, fabrication, mechanical engineering, manufacturing, or related technical disciplines, and had accumulated years of teaching experience. Their commitment was evident in their willingness to participate in the assessment, share institutional information, and engage in discussions regarding programme improvement.

However, the study also identified significant disparities in instructor capacity. While some institutions employed experienced welding professionals with extensive practical backgrounds, others relied on instructors whose industrial exposure had been limited or who had spent most of their careers in academic environments. As industrial technologies continue to evolve, instructors require regular exposure to current manufacturing practices, advanced welding processes, modern fabrication techniques, automation technologies, and internationally recognised quality management systems.

A recurring challenge was the limited availability of structured professional development. In many institutions, instructors had few opportunities to participate in refresher training, industrial attachments, international certification programmes, or exposure visits to modern manufacturing facilities. Knowledge of emerging welding technologies, digital manufacturing systems, robotic welding, advanced inspection techniques, and international welding codes consequently varied considerably between institutions.

The assessment also highlighted the importance of instructor certification. While many instructors possessed academic qualifications and extensive teaching experience, relatively few had access to internationally recognised professional certifications validating competency against global industrial standards. As industries increasingly demand compliance with internationally accepted welding procedures and quality assurance systems, instructor competency must extend beyond classroom teaching to include familiarity with industrial codes, welding procedure specifications, inspection requirements, and welder qualification testing.

The Instructor Baseline: Evidence from the SAIW Programme

In 2024, GFP International, together with four members of its technical team from the United States and South Africa, interviewed approximately 50 welding instructors in East Africa. From this group, four instructors were selected to participate in a 12-week introductory SMAW training course at the

South African Institute of Welding (SAIW), an institution accredited by the International Institute of Welding (IIW) to issue IIW certificates to students meeting the required skill standards.

Over the 12 weeks, the four instructors acquired the practical skills and theoretical knowledge that a novice student would typically gain at a reputable welding training institution. In other words, the instructors responsible for training the next generation of African welders arrived at the program possessing only beginner-level understanding and abilities. Subsequent interviews with welding instructors in 10 African nations confirmed the pattern and underscored the necessity of an advanced train-the-trainer programme. GFP International has responded by forming a dedicated team of highly skilled welding professionals, comprising both American and African experts, with competencies suited to the specific training requirements of the African context.

Implication: *The capacity deficit is not confined to equipment but extends to instructor competencies, indicating that investment alone would not produce certifiable graduates.*

Instructor development should therefore be viewed as a long-term strategic investment rather than a one-time training activity. Modern welding technologies, manufacturing processes, quality standards, and industrial equipment continue to evolve rapidly. Maintaining instructional excellence requires continuous learning, regular engagement with industry, and lifelong professional development. Investments in instructor certification, industrial attachments, continuous professional development, international collaboration, and structured train-the-trainer programmes generate long-term improvements that extend well beyond individual institutions. By strengthening the competencies of instructors, countries can enhance curriculum delivery, improve graduate employability, support technology transfer, and increase workforce competitiveness. Developing highly qualified instructors is among the most cost-effective and sustainable approaches to improving the quality of welding and manufacturing education across Africa.

4.5 Curriculum and Training Delivery

The effectiveness of welding and manufacturing education is determined not only by infrastructure, equipment, and qualified instructors, but also by the relevance of the curriculum and the quality of training delivery. A well-designed curriculum should equip learners with the theoretical knowledge, practical competencies, safety awareness, problem-solving skills, and professional attitudes required to perform successfully in modern industrial environments.

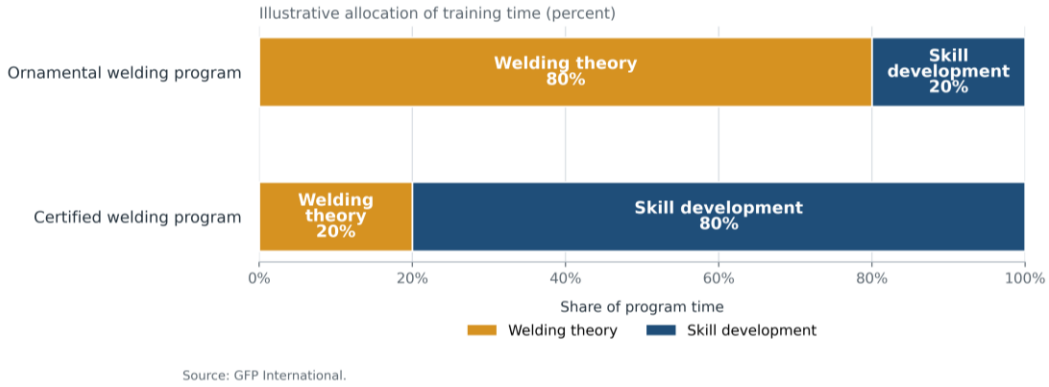
The survey found that all 37 institutions deliver a locally developed curriculum, and none reported a curriculum mapped to international welding codes or certification frameworks. Three institutions reported no formal welding curriculum at all. Institutional programmes generally covered fundamental principles of metallurgy, engineering drawing, fabrication techniques, welding theory, workshop practice, occupational health and safety, and basic quality control. These programmes provide an important foundation for technical education and have contributed significantly to the development of skilled artisans serving local industries. However, considerable variation was observed in curriculum content, programme duration, practical training requirements, and alignment with industrial expectations. While some institutions had revised their curricula to incorporate emerging technologies and competency-based approaches, others continued to rely on programmes that had undergone limited revision despite significant technological change within the manufacturing sector.

4.5.1 The Arc-Time Deficit

A welding school preparing students to become internationally certifiable welders requires approximately 400 hours of arc time, or "stick time", within a 12-week introductory programme. The institutions participating in this analysis offer a median of 30 hours, and many deliver approximately 150 hours spread across three years of training. Only one institution in the sample reaches the 400-hour benchmark.

This shortfall is structural rather than pedagogical. The typical African welding school curriculum directs students to spend approximately 85 to 90 percent of their time on welding theory and only 10 to 15 percent on actual skills practice. That allocation is not primarily a curriculum design choice; it is a rational response to resource constraints, and it is consistent with the fact that welding schools typically operate with approximately one welding machine for every 15 students. Where machines and consumables are scarce, theory expands to fill the timetable. Curriculum reform that is not accompanied by investment in machines, consumables, booths, and instructor capacity will therefore not change the ratio.

Figure 7: Theoretical Instruction and Skills Development in Welding Programmes



Source: GFP International.

4.5.2 Welding Processes and Technical Competencies

SMAW remains the dominant welding process taught across most participating institutions, owing to its affordability, versatility, and widespread application within local fabrication industries. However, opportunities for students to develop competencies in GMAW/MIG, GTAW/TIG, FCAW, submerged arc welding, pipe welding, and advanced fabrication techniques were often limited by equipment availability and instructor expertise. As industrial sectors increasingly adopt automated manufacturing systems and specialised welding processes, graduates require proficiency in multiple welding techniques rather than reliance on a single process. The limited exposure to advanced welding technologies observed across the sample therefore represents a significant constraint on graduate employability within high-value industrial sectors.

Competency in welding cannot be achieved through classroom instruction alone; it requires repeated hands-on practice under realistic workshop conditions. While practical training formed a substantial component of most programmes, the quantity and quality of practical exposure varied considerably. Limited workshop capacity, shortages of welding machines, insufficient consumables, high student-to-equipment ratios, and constrained institutional budgets frequently reduced the amount of actual welding practice available to individual learners. Institutions providing greater opportunities for repetitive practice, multiple welding positions, diverse joint configurations, and project-based learning were consistently better positioned to produce graduates capable of meeting industrial performance standards.

4.5.3 Curriculum Alignment with Industry Requirements

The study finds varying degrees of alignment between institutional curricula and the competency requirements of modern industry. While many programmes successfully prepared learners for general fabrication and maintenance activities, few provided comprehensive preparation for oil and gas, mining, power generation, pressure-vessel fabrication, shipbuilding, structural steel construction, or advanced manufacturing. Modern industrial employers increasingly require competencies extending well beyond welding technique: graduates are expected to understand welding procedure specifications, quality assurance systems, engineering drawings, dimensional tolerances, inspection procedures, welding metallurgy, material traceability, and workplace documentation. These competencies were incorporated only to varying and generally limited degrees. Strengthening collaboration between training institutions and industry will be essential to ensure that curricula remain responsive to technological advances, changing workforce demands, and internationally recognised industrial standards.

4.5.4 Work-Based Learning and Industry Exposure

Work-based learning provides students with opportunities to apply classroom knowledge within real industrial environments. The assessment found that many institutions recognised the importance of industrial attachment programmes; however, access to structured placements varied considerably depending on institutional partnerships and the availability of host industries. Where strong relationships existed between institutions and employers, students benefited from exposure to industrial equipment, production systems, quality management practices, workplace safety standards, and professional work environments. Such experiences enhanced graduate employability while enabling employers to participate directly in workforce development. Expanding partnerships between training institutions and manufacturing industries should be considered a strategic priority.

4.5.5 Emerging Curriculum Priorities

The assessment identified several emerging areas warranting greater emphasis within welding and manufacturing curricula. These include digital manufacturing technologies, Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), Computer Numerical Control (CNC) systems, welding automation, robotic welding, NDT, quality assurance and quality control (QA/QC), additive manufacturing, sustainable manufacturing practices, and Industry 4.0 technologies. Integrating these subjects into existing programmes would better prepare graduates for employment within increasingly technology-driven industrial environments and support Africa's broader industrial transformation agenda.

Modern welding education should move beyond teaching students how to join metal components and instead prepare them to operate within highly regulated industrial environments where quality assurance, safety, precision, productivity, and continuous improvement are fundamental expectations. Achieving this transition will require sustained collaboration among governments, training institutions, employers, professional bodies, and development partners.

4.6 Certification Readiness and Alignment with International Standards

Industrial welding is among the few technical trades in which competency is routinely verified through practical qualification tests conducted in accordance with internationally recognised codes and standards. Unlike many occupations, in which academic qualifications alone suffice, industrial

welders are generally required to demonstrate competence through standardised welding qualification tests before being authorised to perform work on critical infrastructure and industrial facilities.

Modern industrial projects require welding activities to comply with internationally accepted engineering standards that ensure structural integrity, public safety, environmental protection, and long-term asset performance. Oil and gas, mining, power generation, petrochemical processing, shipbuilding, transportation, heavy manufacturing, and infrastructure construction all rely upon welders who have demonstrated competence through recognised qualification procedures. These standards govern not only the quality of completed welds but also welding procedures, material selection, inspection requirements, documentation, welder qualification, and quality management systems throughout the fabrication process. For African industries seeking to compete globally and participate in international supply chains, alignment with these standards is not optional.

4.6.1 Current Institutional Readiness

Although many participating institutions successfully prepare students for entry-level employment in fabrication and general engineering, none possesses the facilities, equipment, procedures, or institutional capacity required to prepare graduates for internationally recognised industrial welding certification. Common limitations identified during the assessment included:

- Limited exposure to internationally recognised welding codes and standards;
- Inadequate access to welding qualification testing facilities — only 7 of 37 institutions possess bend-testing equipment;
- Insufficient equipment for advanced welding processes;
- Limited availability of calibrated testing and inspection equipment;
- Inadequate training in welding documentation and quality assurance;
- Minimal integration of welding procedure specifications into practical instruction; and
- Limited instructor exposure to industrial certification systems.

These constraints substantially reduce graduates' ability to compete for employment within highly regulated industrial sectors where certification is mandatory.

4.6.2 Welding Procedure Specifications and Quality Assurance

Modern welding extends well beyond producing visually acceptable welds. Industrial fabrication requires strict adherence to documented WPS supported by PQR, inspection procedures, material traceability systems, and quality assurance protocols. The assessment finds that while basic welding techniques were commonly taught, few institutions incorporated comprehensive instruction in industrial quality systems, welding documentation, procedure qualification, or inspection methodologies. Graduates may therefore possess practical welding ability while lacking familiarity with the documentation and quality control processes expected in industrial environments.

Industrial welding also requires systematic inspection throughout fabrication to verify compliance with engineering specifications. Employers increasingly expect welders to understand dimensional inspection, visual examination, weld discontinuities, destructive testing, and the principles of non-destructive testing. Many institutions provided introductory instruction in weld inspection; however, access to specialised inspection equipment, testing laboratories, and practical exposure to industrial quality

assurance procedures remained very limited. Expanding institutional capacity in inspection and testing would significantly strengthen graduate preparedness for employment within quality-sensitive industries.

4.6.3 Pathways to International Certification

Strengthening Africa's welding workforce requires the development of structured certification pathways that extend beyond institutional graduation. Such pathways should enable learners to progress from foundational welding education to internationally recognised industrial qualifications through practical experience, supervised workplace learning, competency assessment, and professional certification. This progression requires stronger collaboration between training institutions, certification bodies, employers, professional associations, and government agencies to establish nationally coordinated systems aligned with international best practice while remaining responsive to local industrial needs.

A key challenge facing African welding institutions is not a lack of training programmes but the absence of a path from training to internationally recognised industrial certification. Certification readiness should be viewed as a strategic investment in industrial competitiveness: employers gain access to a more competent workforce, governments strengthen local participation in major infrastructure projects, training institutions enhance graduate employability, and graduates improve their prospects in both domestic and international labour markets. Alignment with internationally recognised standards would also increase confidence among investors and engineering firms seeking reliable local technical capacity.

4.7 Cost and Quality Challenges

Training welders to internationally recognised industrial standards entails a substantial cost. The foundational 12-week SMAW course offered by the South African Institute of Welding is priced at approximately US$4,000. More than half of this cost is consumable materials — steel plates, pipes, welding rods, gases, and other essential supplies. In return, the course delivers over 400 hours of hands-on welding practice. Nairobi's Morendat Institute of Oil and Gas offers an introductory welding course for approximately US$2,000, but training is partially subsidised by the institute's parent organisation, the Kenya Pipeline Company.

The cost of internationally certified welding programmes is prohibitively high for many students and their families, and this economic reality shapes institutional behaviour. Because the cost of consumables is directly linked to the number of skills-practice hours, a curriculum comprising 150 hours over a three-year programme costs far less to deliver than a 400-hour course. In the absence of scholarship funding, the most financially viable route for expanding welding training is therefore to concentrate on traditional ornamental welding with minimal arc time. This makes programmes more accessible and keeps enrolment numbers high, but it delivers far less value than internationally certified training — and it explains why the arc-time deficit documented in Section 4.5.1 persists even at institutions that understand the problem clearly.

Although many training institutions enroll substantial numbers of students, only a fraction can realistically achieve industry-ready competence given restricted machine access and limited practical exposure. While graduate numbers may appear healthy, the effective supply of qualified welders remains very low. From a labour-market perspective this is a capacity bottleneck rather than a participation deficit: industries are confronted not with a shortage of trainees, but with a shortage of competent, certifiable practitioners. As technology advances and productive systems become more complex, welding is evolving

toward higher precision, stricter quality assurance, and integration with digital fabrication, which makes strengthening training systems now the only way to avoid a wider gap later.

4.8 Lessons from the International Experience with Welding Training

The international experience shows that investments in welding training achieve stronger results when financing, modern equipment, curriculum reform, instructor development, and internationally recognised certification pathways are addressed together. Recent initiatives offer several useful lessons to guide implementation:

- In 2019, a Korean development agency supported the establishment of a modern vocational welding school in Mozambique. The facility was equipped with advanced welding machines, appropriate ventilation and lighting, and essential workshop tools. The curriculum currently provides approximately 100 hours of practical welding experience—about one-quarter of the supervised practice generally considered necessary to prepare candidates for an internationally recognised certification examination. This experience highlights the importance of aligning investments in facilities and equipment with sufficient practical training time.
- A European development agency recently provided approximately US$10 million to support improvements to national TVET programmes in an East African country. The initiative illustrates the value of complementing financial assistance and institutional leadership with specialised welding expertise to ensure that curricula, equipment, instructor preparation, and assessment systems are aligned with international standards.
- The World Bank is supporting major skills-development initiatives across several African countries. These investments provide an important opportunity to strengthen industrial trades. Their impact on welding training could be further enhanced by incorporating specialised technical expertise alongside the broader policy, institutional, and educational capabilities of national ministries and implementing agencies.
- An international energy company is working with a nonprofit institution in Tanzania to strengthen welder training. This partnership demonstrates the potential value of private-sector engagement and could be reinforced through additional technical support focused on international standards, instructor development, qualification testing, and certification..

Collectively, these experiences suggest that funding is essential but may not be sufficient to achieve the intended results. Effective investment in welding training requires access to credible technical advisory capacity throughout programme design and implementation. This includes expertise in workshop planning, equipment selection, curriculum development, instructor preparation, supervised practical training, quality assurance, qualification testing, and certification.

Over three years, GFP International assessed welding training provision through visits to approximately 50 vocational schools and universities in 10 African countries. The assessment identified limited access to specialised advisory services capable of helping institutions modernise their facilities, curricula, and training programmes. In response, GFP International has assembled a team of technical specialists and developed partnerships with organisations including the American Welding Society, the International Institute of Welding, and the Canadian Welding Bureau. Through these partnerships, GFP International seeks to support qualification testing and certification while assessing the results of investments in welding laboratories, equipment, instructor development, and student scholarships.

4.9 The Multidimensional Capacity Gap

The gaps identified across the preceding sections are interconcted and must be addressed simultaneously. These gaps extend beyond technical welding ability to encompass infrastructure, equipment, curriculum relevance, instructor competency, certification systems, industry engagement, institutional governance, and investment in modern manufacturing technologies.

4.9.1 Training-Facility Gap

Africa's challenge is not a shortage of vocational institutions but a mismatch between the competencies those institutions develop and those required by modern industrial economies. Many operate in facilities originally designed for basic vocational education rather than advanced industrial skills development. Inadequate workshop space, ageing infrastructure, insufficient welding booths, poor ventilation, limited electrical capacity, and inadequate safety facilities reduce the effectiveness of practical training and constrain institutional growth. Modern industrial training requires purpose-built workshops that replicate workplace conditions while supporting safe, efficient, competency-based learning.

4.9.2 Equipment and Technology Gap

The overwhelming majority of the schools assessed lack the equipment required for code-compliant industrial training, and shortages of modern industrial technologies are widespread. Advanced welding processes, automated systems, fabrication equipment, inspection technologies, and digital manufacturing tools were unavailable or available only in limited quantities. The resulting gap between institutional equipment and industrial technology restricts learners' exposure to the tools and processes increasingly used in manufacturing, mining, energy, and infrastructure. Graduates consequently require substantial additional training before becoming fully productive in industrial workplaces.

4.9.3 Instructor-Competency Gap

Instructors are highly committed to technical education but frequently have limited opportunities for continuous professional development and industrial exposure. Many institutions reported insufficient access to structured refresher training, international certification programmes, industry attachments, and advanced technical training. Without regular engagement with industry and emerging technologies, instructors cannot prepare learners for modern industrial environments.

4.9.4 Industry-Engagement Gap

Effective vocational education relies on strong partnerships between training institutions and employers. Although many institutions maintain relationships with local industries, these vary considerably in depth and effectiveness. Opportunities for apprenticeships, industrial attachments, curriculum review, joint research, equipment sharing, and instructor exchange remain limited. Strengthening collaboration would improve curriculum relevance, enhance graduate employability, and facilitate the transfer of emerging technologies.

4.9.5 Policy and Investment Gap

In many countries, investment in TVET has focused primarily on expanding access to education rather than strengthening the quality and industrial relevance of technical training. Sustainable modernisation will require coordinated investment in infrastructure, equipment, instructor development, curriculum reform,

certification systems, and institutional governance, demanding collaboration among governments, development partners, industry, professional associations, and vocational education providers.

4.10 The Existing Training System Cannot Meet the Demand for Welders

The gaps documented in this chapter are mutually reinforcing, and none can be addressed in isolation. Modern infrastructure cannot improve training outcomes without qualified instructors. Updated curricula cannot enhance learning quality without access to appropriate equipment and opportunities for practical application. Graduates cannot compete in international labour markets without recognised certification pathways and meaningful exposure to industrial work environments. An institution that acquires welding machines but has no bend-testing equipment still cannot certify, and an institution that certifies but provides only 30 hours of arc time cannot meet a standard industry will accept.

Africa requires approximately three million qualified industrial welders, yet even under generous assumptions the existing system produces internationally certifiable welders at a rate approaching zero. The 37 institutions surveyed — a group that includes national universities, established polytechnics, and industry-operated training providers across 13 countries — collectively operate 149 welding machines, provide a median of 30 hours of supervised arc time, hold bend-testing equipment at seven sites, and issue no internationally recognised certificates. This structural deficit cannot be corrected by expanding enrolment, revising syllabi, or building additional schools of the same type. Training institutions lack the necessary equipment to practice on, the instructors to teach to standard, the testing capability to qualify candidates, and the accreditation to make those qualifications meaningful. Incremental or isolated interventions have repeatedly failed to change these outcomes — as the examples in Section 4.8 demonstrate — because each addresses only one element of a system in which all elements are binding constraints simultaneously. To succeed, an intervention must address all of these constraints at once and it must enhance the capability of surrounding institutions rather than serving only its own students.

5. The Solution: Welding and Manufacturing Centres of Excellence

Establishing Centres of Excellence (CoEs) in welding and related skills is the most effective way to address the widening gap between existing training systems and the growing demands of African economies. The analysis presented in Chapter 2 estimates that about three million qualified industrial welders will be required to support Africa's industrial development, while the evidence shown in Chapter 4 demonstrates that the continent's existing welding schools cannot meet this demand through incremental improvements in their training capacity. Alleviating the constraints imposed by a lack of qualified welders will require a radical intervention designed to transform the continent's TVET systems.

The key functions of a CoE are to centralise expertise, standardise processes, and drive innovation, ensuring consistency and efficiency across an industry. By pooling specialised knowledge and resources, a CoE can accelerate skills transformation, reduce operational costs, and foster collaboration between training institutions and the private sector. A CoE also accelerates innovation by facilitating the rapid adoption of new technologies and acting as an incubator for new systems and business models. Moreover, by developing reusable components, curricula, and templates, a CoE can reduce operational costs for other training facilities and rapidly disseminate proven techniques.[20]

5.1 How Centres of Excellence Address the Identified Constraints

The case for the CoE model rests directly on the structure of the deficit documented in Chapter 4. That deficit includes four related constraints—equipment, instructor competence, testing capability, and accreditation—each of which is binding. Relieving any one constraint in isolation produces no certifiable welders, which helps explain why the donor-funded interventions reviewed in Section 4.8 achieved limited progress toward internationally recognised certification outcomes despite substantial investment. A well-equipped school that can offer only 100 hours of practical training is unlikely to prepare welders for certification, while an internationally aligned curriculum cannot be delivered effectively without adequate equipment, consumables, and testing facilities.

A CoE resolves this challenge by supplying all four elements as an integrated package. The model also concentrates the most capital-intensive components—advanced equipment, calibrated testing laboratories, and internationally certified instructors—in a small number of regional sites rather than attempting to replicate them at every institution. This is both technically necessary and economically realistic: the survey found bend-testing equipment at seven of 37 institutions, and equipping all 37 to full qualification-testing standard would be prohibitively expensive and largely redundant, since qualification testing is periodic rather than continuous.

Table 6: How the Centre of Excellence Model Addresses Each Identified Constraint

Constraint identified in Chapter 4	Centre of Excellence response
Median 30 hours of supervised arc time against a 400-hour requirement	Concentrated arc-time capacity at the hub, with intensive block-release programmes for students from spoke institutions and simulator integration to extend effective practice hours at lower consumable cost.

[20] "Center of Excellence: key to successful business transformation": https://www.linkedin.com/pulse/center-excellence-key-successful-business-transformation/

Constraint identified in Chapter 4	Centre of Excellence response
149 welding machines across 37 institutions; 5 with none	Hub equipped to industrial specification across SMAW, GMAW/MIG, GTAW/TIG, FCAW, and pipe welding, with a structured equipment upgrade pathway for spoke institutions.
Bend-testing equipment at 7 of 37 institutions	A calibrated testing and qualification laboratory at the hub, serving surrounding institutions and industry as a shared regional facility.
No institution able to issue internationally recognised certification	Accreditation through partnerships with the International Institute of Welding, the American Welding Society, and the Canadian Welding Bureau, enabling qualification testing and certification to internationally accepted codes.
Instructors entering advanced training at beginner competence level	Structured train-the-trainer programmes, instructor certification, and industrial attachments delivered at the hub for instructors drawn from spoke institutions.
Curricula developed locally, unmapped to international codes	Reference curricula mapped to ASME, AWS, and ISO requirements, developed once at the hub and disseminated across the network.
Weak and uneven industry linkages	Industry partnership, work-based learning placement, and technology transfer coordinated at regional scale, giving employers a single credible counterparty.

5.2 The Hub-and-Spoke Model

The CoEs are designed to raise the capability of surrounding institutions rather than to replace or compete with them. Each CoE operates as a regional hub supporting a network of technical and vocational education and training institutions, industry academies, universities, and private training providers as spokes. The hub concentrates advanced equipment, certified instructors, testing laboratories, and accreditation relationships; the spokes retain responsibility for foundational instruction, recruitment, and community reach. This structure enables the CoEs to deliver:

- **Advanced skills training** to internationally recognised standards, including the welding processes, positions, and materials required by the oil and gas, power, mining, shipbuilding, and heavy manufacturing sectors identified in Chapter 2;
- **Instructor certification and train-the-trainer programmes**, addressing the instructor-competency gap that would otherwise limit the return on every other investment;
- **Testing and qualification services**, providing the region with the calibrated bend-testing, inspection, and non-destructive testing capability that the survey found almost entirely absent;
- **Industry partnerships**, including structured work-based learning, employer-led curriculum review, and direct placement pathways into major industrial projects;
- **Technology transfer**, introducing CNC systems, welding automation, robotic welding, digital fabrication, and simulator-based training into the regional training ecosystem; and
- **Curriculum and quality-assurance support** to spoke institutions, including reference curricula, welding procedure specifications, documentation templates, and safety systems.

The model is deliberately designed for leverage rather than scale at a single site. A Centre that trains only its own intake would make a marginal contribution against a three-million-welder requirement. A Centre that certifies the instructors of twenty surrounding institutions, provides their qualification testing, and supplies their curricula changes the output of the entire regional network. This is the mechanism by which a small number of well-resourced facilities can shift a system-level deficit.

5.3 Building on Existing Institutional Foundations

The survey findings also identify where such CoEs can most effectively be established. The institutions demonstrating the greatest readiness were those combining adequate infrastructure with strong institutional leadership, qualified instructors, active industry partnerships, and a clear commitment to continuous programme improvement. Several participating institutions — particularly the industry-linked training providers and the better-equipped technical universities — already possess a foundation on which a CoE could be built. A few had already independently developed strategic plans but lacked the financial resources, technical advisory capacity, and accreditation relationships to execute them.

GFP International has assembled the technical capacity that these institutions lack. Following a three-year assessment of welding training across the continent, the organisation has formed a team of specialists drawn from the United States, South Africa, and across Africa, and has established partnerships with the American Welding Society, the International Institute of Welding, and the Canadian Welding Bureau to provide qualification testing and certification. Section 4.8 highlights instances in which substantial donor investment achieved limited improvements in training outcomes because funding was not consistently complemented by the specialised technical expertise required for effective implementation. The CoE model is explicitly designed to address this gap by integrating such expertise with the requisite funding.

5.4 Investment Rationale

The manufacturing sector has an employment multiplier of about 9.0, meaning that each new manufacturing job supports the creation of around nine additional jobs across the wider economy. As described above, Africa's planned oil and gas investment cycle implies annual peak demand for at least 20,500 and as many as 40,000 welders, and the growth of manufacturing, fabricated steel products, consumer goods, and industrial components will call for a further 2.16 million. Failing to meet that demand locally would represent a massive loss through foregone employment, technology transfer, and value capture. Conversely, building a supply capacity that exceeds African demand would enable African welders to help meet the global welder shortage which offers enormous potential for remittances and the accumulation of expertise abroad.

Strengthening institutional capacity is therefore a strategic investment not only in education, but in industrial productivity, local content development, workforce competitiveness, and long-term economic transformation across Africa. Strengthening the alignment between workforce supply and industrial demand will enhance local participation in major infrastructure projects, reduce dependence on imported technical labour, support local content policies, and contribute to Africa's long-term industrial transformation. The evidence presented in this report indicates that the intervention required is neither incremental nor conventional, and that the cost of continued inaction is already being paid — in imported labour, delayed projects, inflated costs, and a generation of trained but uncertifiable graduates. Investing in welding skills now will accelerate economic growth and lower project costs while enabling African workers to reap the full benefits of the continent's ongoing industrialisation.

A shifting industrial landscape coupled with demographic ageing, especially in China, South Korea, and high-income economies worldwide, is driving an almost limitless demand for welders. Although difficult to estimate, post-war reconstruction in Russia, Ukraine, and the Middle East is likely to further increase demand for industrial welding. According to UN estimates, the cost of reconstruction in Ukraine

will be US$588 billion over ten years.[21] Syria's post-conflict reconstruction costs are estimated at US$216 billion.[22] In April 2026, Iran claimed war damages had reached US$270 billion. These and other conflict-affected countries are likely to attract large numbers of foreign welders by offering high pay and benefits. Building Africa's capacity to train welders to an international standard would enable African workers to reap considerable benefits while contributing to the reconstruction of war-torn communities abroad.

[21] https://news.un.org/en/story/2026/02/1167016

[22] https://www.worldbank.org/en/news/press-release/2025/10/21/syria-s-post-conflict-reconstruction-costs-estimated-at-216-billion

10 Initial Steps to Transform African Welder Training

No	Action	Status
1	**Conduct comprehensive facility and training assessments.** Evaluate workshop space and layout, equipment, trainer competence, curricula, practical training hours, testing practices, and certification procedures against national, international, and industry-specific standards.	100% complete at 47 schools in ten African countries.
2	**Engage employers and validate industry demand.** Consult existing and prospective employers across the manufacturing, construction, infrastructure, energy, mining, and transport sectors to identify current and projected workforce needs, required process knowledge, in-demand technical skills, and certification requirements.	Employer demand study completed by GFP International.
3	**Train welding trainers.** Provide structured training-of-trainers programmes led by qualified experts to ensure that instructors possess the technical competence, practical experience, pedagogical tools, and familiarity with relevant standards necessary to deliver high-quality training.	Training-of-trainers curriculum has been prepared.
4	**Modernise workshop infrastructure.** Prepare schematic, architectural, and engineering designs to remodel, expand, or construct new training facilities. Field visits by GPF International to approximately 40 facilities found that all required some degree of workshop improvement or expansion.	Schematic designs have been completed for eight schools.
5	**Procure appropriate industrial-grade equipment.** Equip training facilities with modern equipment of appropriate capacity and duty cycle for intensive multi-process training that reflects industrial practice.	Competitive quotations have been received by GFP International.
6	**Establish testing, tools and materials infrastructure.** Establish weld-testing facilities, secure tool rooms, storage for steel and consumables, and supporting systems for effective practical training, assessment, safety and equipment management.	Project funding is pending.
7	**Implement industry-aligned curricula and practical training.** Combine relevant theory with sufficient hands-on training to produce graduates capable of meeting internationally compliant industrial requirements. Periodically review curricula with employers to maintain alignment with demand.	Global curricula have been evaluated, and best practices have been identified.
8	**Train students in application-specific welding procedures.** Provide practical training relevant to specific industries, processes, and major projects. Where appropriate, tailor training to identified employment opportunities, including refinery-related welding requirements.	School upgrades and training-of-trainers activities are pending.
9	**Establish independent assessment and recognised certification pathways.** Engage qualified examiners and certification bodies associated with the American Welding Society (AWS), the International Institute of Welding (IIW), and the Canadian Welding Bureau (CWB), as appropriate, to assess graduating welders against recognised standards and award relevant qualifications or certifications.	Evaluators with professional ties to the American Welding Society, the International Institute of Welding, and the Canadian Welding Bureau have been identified.

10	**Connect graduates with employers and track employment outcomes.** Create structured agreements with industry partners for internships, apprenticeships, recruitment, and job placements. Track employment, employer satisfaction, wage dynamics, and the continued relevance of training to industry needs.	GFP International tracks industrial project plans and schedules, and its newsletter reaches over 6,000 executives across the public and private sectors.

Annex A. GFP and International Welding Professional and Certification Organisations

GFP International

GFP International is a registered 501(c)(3) non-profit organisation based in the United States. Established in 2005, GFP International focuses on enhancing Africa's industrial capabilities by improving vocational training programmes, including specialised training in certified welding, high-voltage electrical systems, and instrumentation. With an office in Nairobi, Kenya, GFP International has brought together a team of world-class experts dedicated to assisting existing educational institutions in establishing Centres of Excellence to address skills gap in critical sectors such as mining, oil and gas, electric power development, agricultural mechanisation, and manufacturing.

GFP International's work has evolved from community-development initiatives to a broader focus on skills training and workforce capacity-building across Africa. The organisation traces its origins to partnerships established between faith communities in Minnesota and Tanzania, where early efforts focused on supporting educational opportunities and community projects. One of these initiatives involved mobilising resources to support the establishment of a primary school in Matamba, Tanzania, with the objective of improving access to quality education and strengthening opportunities for young people within the region.

Through its engagement with communities, educational institutions, and development partners, GFP gained increasing exposure to the structural challenges affecting economic development across many African countries. While significant progress had been made in expanding access to primary and secondary education, persistent shortages of technical and vocational skills continued to constrain industrial growth, job creation, and local participation in large-scale infrastructure and manufacturing projects. Welding, fabrication, machining, and manufacturing repeatedly emerged as critical skills gaps across multiple sectors. Discussions with educators, industry representatives, engineers, and vocational institutions highlighted a common concern: although demand for skilled industrial trades was growing, many training institutions lacked the equipment, facilities, instructor capacity, and industry linkages necessary to prepare graduates for modern industrial employment.

These findings prompted GFP to broaden its focus beyond traditional education support toward technical and vocational workforce development. The organisation initiated a multi-year effort to better understand the state of TVET across Africa, with a specific focus on industrial welding and manufacturing skills. Since 2022, GFP and its partners have conducted assessments of vocational schools, technical colleges, universities, and industry training centres across multiple African countries. These engagements included facility visits, equipment inventories, consultations with instructors and administrators, discussions with employers, and reviews of international training standards and certification systems.

The findings from these assessments revealed a significant mismatch between the competencies required by modern industries and the capabilities of existing training systems, even as major investments in energy, mining, manufacturing, transportation, and industrial infrastructure generated growing demand for skilled welders, fabricators, and manufacturing technicians. This study was therefore undertaken to provide an evidence-based assessment of welding and manufacturing training capacity in Africa, to identify the key constraints affecting workforce development, to examine emerging industrial

demand for certified welders, and to explore practical strategies for strengthening technical training systems. In addition to contributing to the literature on industrial development in Africa, this analysis informs GFP's vision for establishing regional Welding and Manufacturing Centres of Excellence designed to support workforce competitiveness, industrialisation, and long-term economic transformation across the continent.

The International Institute of Welding

The International Institute of Welding (IIW) is a global organisation dedicated to the advancement of welding technology and education. Established in 1948, the IIW promotes collaboration among experts in the welding field. Its primary goals are to enhance the quality and safety of welding, foster international cooperation, and facilitate the exchange of knowledge. The IIW comprises national welding institutes and individual members from many countries, creating a worldwide network of professionals. The organisation develops international standards and certification programmes to ensure high-quality welding practices, offers training programmes, conferences, and workshops supporting the professional development of welders and engineers, and promotes research in welding technology and its applications across industries.

American Welding Society (AWS)

AWS is a nonprofit organisation dedicated to advancing the science, technology, and application of welding and related joining processes. Established in 1919, AWS supports the welding profession through the development of widely recognised technical codes, standards, certification programmes, education, and professional development. Its standards are extensively used across industries such as construction, manufacturing, energy, transportation, aerospace, and infrastructure. AWS administers internationally recognised personnel certification programmes, including the Certified Welding Inspector credential and certifications for welding educators, supervisors, engineers, and other professionals. The organisation also provides training courses, technical publications, conferences, industry events, and educational resources designed to strengthen welding quality, safety, competence, and productivity. Through its standards, qualifications, and professional network, AWS plays an important role in promoting consistent and internationally recognised welding practices.

Canadian Welding Bureau (CWB)

CWB specialises in welding certification, qualification, education, inspection, and quality assurance. Established in 1947, CWB has played a central role in supporting the implementation of Canadian welding standards and ensuring that companies, personnel, and welding procedures meet recognised quality and safety requirements. CWB provides certification of welding companies and qualification of welders, welding supervisors, engineers, inspectors, and other welding professionals in accordance with applicable Canadian standards and industry requirements. Through the broader CWB Group, the organisation also provides training, technical services, consulting, inspection, and professional development programmes. Its certification systems are widely recognised across sectors including structural steel, construction, manufacturing, transportation, energy, and infrastructure. CWB also works internationally to support organisations seeking to strengthen welding quality-management systems, workforce competence, and compliance with recognised welding standards.

Annex B. List of Participating Institutions

The following 37 institutions across 13 African countries participated in the GFP Welding School Survey and Equipment Inventory Survey. All are established, operating institutions delivering welding, fabrication, or related technical instruction at the time of assessment. Their complete survey returns are reproduced in Annex C.

Table B1: Participating Institutions

#	Name of institution	Country
1	AADS of Douala	Cameroon
2	Boolumbal Fabrication	Senegal
3	Centre d'Entreprenariat et Développement Technique (CEDT G15)	Senegal
4	CIS – Cameroon Institute of Specialisation	Cameroon
5	Don Bosco Ondo	Nigeria
6	Don Bosco Oyster Bay Technical Training Institute	Tanzania
7	Ebonyi State University	Nigeria
8	ENSET of the University of Douala	Cameroon
9	Forek Institute of Technology	South Africa
10	Harare Institute of Technology	Zimbabwe
11	Harmattan City Institute of Welding and Fabrication	Nigeria
12	HOMIK Oil and Gas Facility Engineering School	Nigeria
13	Icon Lifting and Rigging Inspections Limited	Nigeria
14	Inspections and Testing Limited	Nigeria
15	Institut Universitaire de la Côte (IUC)	Cameroon
16	Institute of Industrial Technology	Nigeria
17	Jacky Felly Nafack Hightech University Institute (JFN-HUI)	Cameroon
18	Kaduna Polytechnic	Nigeria
19	Kaduna Welding Institute	Nigeria
20	Karume Institute of Science and Technology	Tanzania
21	Kenyatta University	Kenya
22	Koforidua Technical University	Ghana
23	Koshin TTI	Kenya
24	Kushinga Phikelela Polytechnic	Zimbabwe
25	Lilongwe Technical College	Malawi
26	Lycée Seydina Limamou Laye	Senegal
27	Morendat Institute of Oil and Gas	Kenya
28	Mpumelelo Artisan Centre	South Africa
29	Namibia Welding Institute	Namibia

#	Name of institution	Country
30	Parish Technologie	Republic of Congo
31	Petrocertif Computer Based Welding Training & Testing	Cameroon
32	Petroleum Training Institute	Nigeria
33	SEB Institute of Welding and Technology	Uganda
34	Sensei Institute of Technology	Kenya
35	Technical University of Kenya	Kenya
36	West Mugirango Tech and Vocational College	Kenya
37	Wiki Academy	Tunisia

Source: GFP Welding School Survey, inventory returns.

Annex C. Raw Data from the Inventory Survey Forms

This annex reproduces the complete quantitative dataset collected through the GFP Welding School Survey and Equipment Inventory Survey. The data are presented as returned by the participating institutions, without adjustment, interpolation, or exclusion, so that the analysis presented in Chapters 3 and 4 can be verified directly against the underlying returns.

Two conventions apply throughout. Entries marked "n.r." indicate that no response was recorded for that field; these are distinct from returns of "None reported", "None", or zero, which represent a positive response that the item is absent. In Table C2, equipment condition is recorded as reported by the institution (Good, Fair, or Poor), an em dash indicates that the item was reported as absent, and "Present" indicates that availability was confirmed without a condition rating. Where a return was internally inconsistent or a value appeared in an unrelated field, the entry has been reproduced as received and treated as "not present" for the purposes of the counts reported in Chapter 4.

Table C1: Institutional Capacity Data — GFP Welding School Survey

Name of institution	Country	Welding machines	Students	Instructors	Formal booths	Arc time (hours)	Teaching curriculum	Certificate samples
AADS of Douala	Cameroon	8	32	2	Yes	360	Local	Local
Boolumbal Fabrication	Senegal	0	None reported	None reported	None reported	None reported	Local	None reported
Centre d'Entreprenariat et Développement Technique (CEDT G15)	Senegal	11	30	3	Yes	30	Local	Yes
CIS – Cameroon Institute of Specialisation	Cameroon	5	25	2	None reported	320	Local	None reported
Don Bosco Ondo	Nigeria	3	20	1	Yes	4	Local	Yes
Don Bosco Oyster Bay Technical Training Institute	Tanzania	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Ebonyi State University	Nigeria	3	300	8	None reported	50	Local	Yes
ENSET of the University of Douala	Cameroon	n.r.	None reported	n.r.	n.r.	n.r.	n.r.	n.r.
Forek Institute of Technology	South Africa	n.r.	n.r.	n.r.	n.r.	n.r.	Local	n.r.
Harare Institute of Technology	Zimbabwe	8	40	4	Yes	120	Local	None reported
Harmattan City Institute of Welding and Fabrication	Nigeria	0	0	0	None reported	0	Local	None reported
HOMIK Oil and Gas Facility Engineering School	Nigeria	17	20	2	Yes	400	Local	Yes
Icon Lifting and Rigging Inspections Limited	Nigeria	15	35	4	Yes	90 hours	Local	Yes
Inspections and Testing Limited	Nigeria	24	20	6	Yes	200 hours	Local	Yes

Name of institution	Country	Welding machines	Students	Instructors	Formal booths	Arc time (hours)	Teaching curriculum	Certificate samples
Institut Universitaire de la Côte (IUC)	Cameroon	5	167	9	Yes	350	Local	Yes
Institute of Industrial Technology	Nigeria	6	24	1	Yes	30 hours	Local	Yes
Jacky Felly Nafack Hightech University Institute (JFN-HUI)	Cameroon	n.r.	None reported	n.r.	n.r.	None reported	Local	None reported
Kaduna Polytechnic	Nigeria	n.r.	0	n.r.	n.r.	0	Local	None reported
Kaduna Welding Institute	Nigeria	0	0	0	None reported	0	Local	None reported
Karume Institute of Science and Technology	Tanzania	n.r.	20	n.r.	n.r.	2HOURS	Local	VETA
Kenyatta University	Kenya	n.r.	None reported	n.r.	n.r.	n.r.	Local	None reported
Koforidua Technical University	Ghana	10	47	7	Yes	n.r.	Local	Yes
Koshin TTI	Kenya	0	0	0	None reported	0	Local	None reported
Kushinga Phikelela Polytechnic	Zimbabwe	n.r.	None reported	n.r.	n.r.	None reported	Local	None reported
Lilongwe Technical College	Malawi	12	60	2	Yes	120	Local	Yes
Lycée Seydina Limamou Laye	Senegal	3	25	5	Yes	25 hours	Local	None reported
Morendat Institute of Oil and Gas	Kenya	n.r.	None reported	n.r.	n.r.	0	Local	None reported
Mpumelelo Artisan Centre	South Africa	n.r.	n.r.	n.r.	n.r.	n.r.	Local	n.r.
Namibia Welding Institute	Namibia	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Parish Technologie	Republic of Congo	7	20	1	Yes	240	Local	Yes
Petrocertif Computer Based Welding Training & Testing	Cameroon	4	0	4	None reported	None reported	Local	Yes
Petroleum Training Institute	Nigeria	8	220	16	Yes	40 hours	Local	Yes
SEB Institute of Welding and Technology	Uganda	n.r.	Yes	n.r.	n.r.	Yes	Local	Yes
Sensei Institute of Technology	Kenya	n.r.	None reported	n.r.	n.r.	0	Local	None reported
Technical University of Kenya	Kenya	n.r.	None reported	n.r.	n.r.	0	Local	None reported
West Mugirango Tech and Vocational College	Kenya	0	0	0	None reported	0	Local	None reported
Wiki Academy	Tunisia	n.r.	None reported	n.r.	n.r.	None reported	Local	None reported

n.r. = no response recorded. Source: GFP Welding School Survey, inventory returns.

Table C2: Equipment Inventory Data — GFP Equipment Inventory Survey

Institution	Plasma cutting table	Plasma cutter	Horiz. band saw	Lathe	Bend testing equip.	Bug-O track cutter	20–50 t press	Cutting torch	Air comp.	Pipe bevel machine	Hydraulic shears	Manual lathes	Manual milling	66 t iron-worker
AADS of Douala	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Boolumbal Fabrication	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Centre d'Entreprenariat et Développement Technique (CEDT G15)	—	—	—	—	Fair	Good	—	Poor	Good	—	—	—	—	Fair
CIS – Cameroon Institute of Specialisation	—	Good	—	—	Fair	—	320	Good	Good	—	—	—	—	—
Don Bosco Ondo	—	—	Fair	Fair	—	—	Good	—	Good	—	—	Good	Good	—
Don Bosco Oyster Bay Technical Training Institute	n.r.	—	—	—	—	n.r.	—	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Ebonyi State University	—	—	—	Fair	—	—	—	Fair	—	—	—	—	—	—
ENSET of the University of Douala	—	—	Poor	Good	—	—	—	—	Poor	—	—	Good	—	Fair
Forek Institute of Technology	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Harare Institute of Technology	—	—	Good	Good	—	—	Good	Good	Good	—	—	Good	Good	—
Harmattan City Institute of Welding and Fabrication	n.r.	Present	—	—	—	n.r.	—	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
HOMIK Oil and Gas Facility Engineering School	—	Good	—	—	—	—	—	Good	Good	Good	Good	Good	Good	Good
Icon Lifting and Rigging Inspections Limited	—	Good	—	—	—	—	90 hours	Good	Good	—	—	—	—	—
Inspections and Testing Limited	Good	Good	Good	Good	Good	Good	Good	Good	Good	—	—	—	Good	—
Institut Universitaire de la Côte (IUC)	—	Fair	Fair	Good	Good	—	—	Fair	Good	Good	Poor	n.r.	Good	—
Institute of Industrial Technology	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Jacky Felly Nafack Hightech University Institute (JFN-HUI)	n.r.	Present	—	—	—	n.r.	—	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Kaduna Polytechnic	n.r.	—	—	—	—	n.r.	—	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Kaduna Welding Institute	n.r.	Present	—	—	—	n.r.	—	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Karume Institute of Science and Technology	n.r.	Present	VETA	VETA	20	n.r.	2HOURS	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Kenyatta University	n.r.	—	—	—	—	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Koforidua Technical University	present poor	Good	Good	Good	—	Good	—	Good	Good	—	—	Good	Poor	—
Koshin TTI	n.r.	—	—	—	—	n.r.	—	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Kushinga Phikelela Polytechnic	n.r.	—	—	—	—	n.r.	—	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Lilongwe Technical College	—	Poor	Good	—	—	—	—	—	Good	—	—	—	—	—

Institution	Plasma cutting table	Plasma cutter	Horiz. band saw	Lathe	Bend testing equip.	Bug-O track cutter	20–50 t press	Cutting torch	Air comp.	Pipe bevel machine	Hydraulic shears	Manual lathes	Manual milling	66 t iron-worker
Lycée Seydina Limamou Laye	—	—	—	—	—	—	—	—	Poor	—	—	—	—	—
Morendat Institute of Oil and Gas	n.r.	—	—	—	—	n.r.	—	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Mpumelelo Artisan Centre	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Namibia Welding Institute	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Parish Technologie	—	—	—	—	Fair	Good	—	Poor	Good	—	—	—	—	Fair
Petrocertif Computer Based Welding Training & Testing	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Petroleum Training Institute	Fair	Poor	Poor	Poor	Good	Poor	—	Good	Good	—	—	Good	Poor	—
SEB Institute of Welding and Technology	n.r.	Present	Present	Present	Present	n.r.	Present	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Sensei Institute of Technology	n.r.	—	—	—	—	n.r.	—	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Technical University of Kenya	n.r.	—	—	—	—	n.r.	—	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
West Mugirango Tech and Vocational College	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Wiki Academy	n.r.	Present	—	—	—	n.r.	—	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.

Condition as reported by the institution. — = reported absent; n.r. = no response recorded; Present = availability confirmed without a condition rating. Source: GFP Equipment Inventory Survey.

Annex D. References