



NIW and Nigeria's National Welding Capability and their significance to the UN Sustainable Development Goals (SDGs)

Report by: Chris Smallbone, IIW President 2005-2008
 IIW Fellow, SAIW Fellow and Honorary Life Member
 Solomon Edebiri Ph.D., JP, MON, NIW President(2006-2022)
 Secretary, Board of Trustees, Nigerian Institute Of Welding
 Chairman, Nigeria Welding Sector Skills Council
 Member IIW Technical Management Board
 (2013-2015)



**NIGERIAN
 INSTITUTE OF
 WELDING**

Publisher

Nigerian Institute of Welding (NIW)
National Center of Excellence
For Welding Engineering and
Technology,
KM 26 Benin – Sapele Road
Obayantor, Benin City
Edo State, Nigeria.

Tel: +234 803 308 4842
+234 803 608 8492
Email: info@niw.ng
Website: www.niw.ng

DATE OF PUBLICATION: June 2022.

About Us

Nigerian Institute of Welding (NIW), a registered non-profit organization devoted to the promotion and implementation of best welding practices in Nigeria. Managed by representatives of different stake holding interests in the Nigerian welding industry. The focus of NIW centers on research and knowledge sharing on welding technology, education and training, qualification and certification across both private and public-sector interests.

NIW is the national awarding body for welding in the Nigerian skill qualification scheme (NSQ), authorized welding certification body for Nigeria's oil and gas skill development schemes and operates a mutual recognition agreement (MRA) with the Standards Organization of Nigeria (SON) covering the regulation of welding activities in Nigeria including development of standards and codes for the welding industry in Nigeria.

NIW enjoys a firm working relationship with NCDMB (Nigerian Content Development and Monitoring Board) being their recognised authority for the certification of welding personnel in the oil and gas industry.

NIW is a member of the International Institute of Welding (IIW), an Authorized Nominated Body (ANB) of the IIW-International Authorization Board and a pioneer member of The Welding Federation of Africa (TWF).

NIW implements IIW's guidelines on education, training and qualification of welding personnel leading to the award of the following IIW Diplomas: International Welding Engineer, International Welding Technologist, International Welding Inspector, International Welding Specialist, International Welding Practitioner and International Welder.

NIW implements the guidelines on skills qualification in Nigeria and is the sole awarding body for welding certifications under the National Skills Qualification Framework (NSQF) under the regulation of the National Board For Technical Education (NBTE).

The scope of practice covers the welder cadre, through the QA/QC to the Welding coordinators cadres. The certification covers levels 1 to 6 at the moment.

NIW has the approval of National Council for Science, Technology and Innovation for the development of National Welding Capability Plan for Nigeria.

NIW is the host Secretariat for the national welding skills sector council. This council is responsible for the development of occupational standards for Welding and related Skills.

Disclaimer

To the maximum extent permitted by applicable law, NIW will not be liable for any indirect, incidental, special, consequential, or punitive damages, or any loss of profits or revenues, whether incurred directly or indirectly, or any loss of data, use, goodwill, or other intangible losses, resulting from: (i) your access and use of the services and products of NIW; (ii) your implementation of any technical or other advice and/or information supplied by NIW (iii) your interaction with members of NIW.

Copyright

In accordance with the Nigerian Copyright Act of 1988, no part of this document/publication may be reproduced, stored or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording or by any information storage and retrieval system without the prior permission in writing from NIW.

REPORT: NIW and Nigeria's National Welding Capability (NWC) and its Significance to the UN Sustainable Development Goals (SDGs)

Introduction by Solomon Edebiri, Ph.D., JP, MON, President, Nigerian Institute of Welding (2006-2022) Secretary, Board of Trustees, Nigerian Institute of Welding, Chairman, Nigeria Welding Sector Skills Council, Member, IIW Technical Management Board, 2013-2015

The Nigerian Institute of Welding (NIW) recently took up the challenge to show how it and the Nigerian welding industry were both enhancing the country's national welding capability as well as contributing to Nigeria progressing the 17 United Nations Sustainable Development Goals (SDGs). This report co-authored by **Chris Smallbone**, International Institute of Welding (IIW) Fellow, and **Solomon Edebiri**, President, NIW, assesses how NIW and the welding industry have positively influenced the SDGs, and improved the quality of life of people and the environment in Nigeria.

The report will also give NIW members the opportunity to assess their companies against the SDGs and their commitments to sustainability.

For the future, it is the intention of NIW to draw up mutually beneficial strategies and action plans with the support of the Nigerian Government, industry and aid agencies for implementation to achieve significant progress in UN SDGs for which it and its members and the welding industry have the expertise.

NIW's National Welding Capability Project

NIW, together with its members and networks, has worked for many years to improve the nation's National Welding Capability (NWC).

<https://www.scielo.br/j/si/a/tDWHcwCpMB3tFYY4xTXWZWt/?lang=en>

Improving a country's National Welding Capability can make a significant contribution to, and have a very positive effect on, many national and international programmes including the SDGs.

Such initiatives include, amongst others, education, training, qualification and certification of personnel to both national and international standards, assisting companies to meet exacting standards of customers, R&D and technology transfer. NIW also assists in improving education and training to increase self-sufficiency and diversity in skilled personnel in Nigeria and other regional countries.

NIW's excellent national, regional and international networks of individuals and organisations, including the International Institute of Welding (IIW) and its members, universities, colleges, research organisations and companies involved in welding enables it to cooperate and collaborate with them and leverage many of the activities, including technologies, required to progress the NWC and various SDGs.

What are the UN Sustainable Development Goals (SDGs)

The United Nations (UN), has 193 countries as members and with the challenges of improving the quality of life in countries, in 2015, world leaders agreed for the UN to implement 17 Sustainable Development Goals (SDGs) aimed at low and middle income countries.

Each UN country is supposed to measure its progress on an annual basis against the targets and indicators set against each SDG to achieve the UN 2030 Agenda.

https://en.wikipedia.org/wiki/Sustainable_Development_Goals

In July 2017, Nigeria presented its first Voluntary National Review (VNR) on the implementation of the SDGs to the United Nations High-Level Political Forum in New York. In mid-2016, Nigeria suffered an economic recession which resulted in the development of Nigeria's Economic Recovery & Growth Plan (ERGP) (2017-2020) to cope with the recession. The ERGP's focus on

economic, social and environmental dimensions of development makes it consistent with the aspirations of the UN 2030 Agenda and SDGs.

Nigeria currently ranks 160 out of 165 countries reporting <https://sustainabledevelopment.un.org>documents>nigeria>

The 2020 VNR focused on SDGs 1,3,4,5,8,16 and 17 which focused on the current development priorities, as captured in the ERGP and the three cardinal objectives of the economy, security and fighting against corruption. It had a 'whole of society' approach by ensuring the active participation of state and non-state actors in the review and reporting processes.

Progress on the SDGs was mixed with challenges remaining in the achievement of many of the



goals. The COVID-19 pandemic and the health and socioeconomic impacts have slowed down progress as well as the collapse in oil prices for an economy still getting 86% of public revenue from oil and gas. The Government is committed however to lifting 100 million Nigerians out of poverty by 2030.

The Way Forward

It is hoped that this report will stimulate ideas amongst the Nigerian welding community for feedback to Solomon Edebiri, NIW President, president@niw.ng as well as for dissemination into regional countries to improve their SDGs.

The link https://asr.ro/documents/C.Smallbone2021.pdf?_t=1639211760 contains many examples and references to various initiatives across welding-related fields, which have been, or could be, introduced for all 17 UN SDGs.

LINK TO DOWNLOAD THE REPORT

Introduction

The Nigerian Institute of Welding (NIW) and the Nigerian Government are supporters of the United Nations (UN) project to continuously improve, both locally and globally, the 17 UN Sustainable Development Goals (SDGs) agreed to by world leaders in 2015. https://en.wikipedia.org/wiki/Sustainable_Development_Goals

The UN has 193 countries as members and the aim is to improve the quality of life particularly in low and medium income countries. Each UN country is encouraged to measure its progress on an annual basis against the targets and indicators set against each SDG.

In July 2017, Nigeria presented its first Voluntary National Review (VNR) on the implementation of the SDGs to the United Nations High-Level Political Forum in New York. In mid-2016, Nigeria suffered an economic recession which resulted in the development of Nigeria's Economic Recovery & Growth Plan (ERGP) (2017-2020) to cope with the recession. The ERGP's focus on economic, social and environmental dimensions of development makes it consistent with the aspirations of the UN 2030 Agenda and SDGs [1].

The 2020 VNR focused on SDGs 1,3,4,5,8,16 and 17 which focused on the current development priorities, as captured in the ERGP and the three cardinal objectives of the economy, security and fighting against corruption. It had a 'whole of society' approach by ensuring the active participation of state and non-state actors in the review and reporting processes [1].

Progress on the SDGs was mixed with challenges remaining in the achievement of many of the goals. The COVID-19 pandemic and the health and socioeconomic impacts have slowed down progress as well as the collapse in oil prices for an economy still getting 86% of public revenue from oil and gas. The Government is committed however to lifting 100 million Nigerians out of poverty by 2030 [1].

The progress does however reflect on the partnerships which have been built and strengthened and how collaborative initiatives can result in better outcomes and greater impacts.

Many of the Nigerian Government's flagship programmes such as the Nigeria Integrated Sustainable Development Goals (ISDG) Model and the re-alignment of the National Statistic System (NSS) have been put in place to guide effective implementation of the SDGs in Nigeria. Nigeria is also committed to the African Union (AU) Agenda 2063-"The Africa we want".

The SDG Nigeria Index report can be accessed with the full Sustainable Development Report 2021 giving the Global SDG Index and country reports on <https://dashboards.sdqindex.org/downloads> and [Sustainable Development Report 2021 \(sdqindex.org\)](https://dashboards.sdqindex.org/downloads)

Established in 1980, the Nigerian Institute of Welding (NIW) is a not-for-profit organisation incorporated under the incorporated trustee's act of the Corporate Affairs Commission (CAC). It has 119 company members, 484 individual members, 22 graduate members and 1152 Student Members. It is the Nigerian Responsible Member of the 50 Member Country International Institute of Welding (IIW). NIW is working in line with the Nigerian Government's national initiatives, to help Nigeria to achieve the United Nations Sustainable Development Goals (SDGs) by 2030.

NIW has been working with the **Federal Ministry of Science and Technology** to establish a **National Welding Capability Development Plan** and implementation strategies. This will enhance the operation of the Executive Order No 5 to augment sustainable growth and will also support the progress of the UN SDGs [2].

NIW's excellent national and international networks of individuals and organisations, including the International Institute of Welding (IIW), enable it to cooperate and collaborate with them and leverage many of the activities, including technologies, required to progress the various SDGs.

As part of the global community, NIW also embraces collective international action, cooperating where applicable to apply global solutions to global challenges.

A key objective of this report therefore is to act as a catalyst to create a quantum leap in the amount of projects within each SDG which NIW and its welding Industry networks could do in cooperation and collaboration with the Nigerian Government, industry and aid agencies to achieve the UN SDGs by 2030.

The link to a paper titled "Your Country's National Welding Capability (NWC) and its significance to the UN Sustainable Development Goals (SDGs)" by Chris Smallbone, International Institute of Welding (IIW) Past President, allbones@iinet.net.au contains many examples and references to various initiatives across welding-related fields which have been, or could be, introduced for all 17 UN SDGs [3].

If you wish to discuss such ideas further, including you and your organisation's possible contributions to NIW's initiatives on the SDGs, contact Solomon Edebiri, NIW President, president@niw.ng

The Importance of NIW's work on Nigeria's National Welding Capability (NWC) and Links to the UN SDGs

Welding technology is an enabling technology used across almost all industries in Nigeria and a wide range of applications, from micro-joining of medical devices, electronics and photonics, to larger scale applications such as bridges, buildings, ships, rail, road transport, pressure equipment and pipelines. The importance of welding to national economic performance can be shown in numerous ways [4].

It encompasses the total life cycle of welded products/structures including design, manufacture, conformity assessment, inspection and testing, operation, maintenance,

repair and decommissioning including recycling and other environmental conditions. It is critical to the infrastructure of any country.

The welding industry is defined as those organisations and people:

- involved with the total life cycle of welded products/structures including design, manufacture, conformity assessment, inspection and testing, operation, maintenance, repair and decommissioning including recycling and other environmental conditions
- engaged in, or employing, any of the organisations or people involved above;
- supplying welding equipment or consumables or materials to be welded; and /or
- involved with education, training, qualification, certification, research and development, work health and safety (WHS), standards and industrial relations aspects of welding.

NIW, together with its members and networks, has worked for many years on improving the nation's National Welding Capability (NWC) [5]. NIW also has many examples of NWC initiatives it has implemented to significantly progress the UN Sustainable Development Goals (SDGs) and improve the quality of life of people and the environment in Nigeria and other African countries [6].

Such initiatives include amongst others, education, training, qualification and certification of personnel to both national and international standards, assisting companies to meet exacting standards of customers, R&D and technology transfer. NIW also assists in improving education and training to increase self-sufficiency and diversity in skilled personnel in Nigeria and other African countries.

NIW has also been a great supporter of the International Institute of Welding (IIW) and its initiatives to improve the global quality of life [7].

Examples of some initiatives are shown below for each SDG although many SDGs are also interlinked. Hopefully, the examples given under each SDG will lead to mutually beneficial projects between NIW, the different tiers of government in Nigeria, the welding industry and aid agencies.



SDG 1 End poverty in all its forms everywhere.

The challenges facing Nigeria including from geo-political and socio-economic viewpoints are immense. Even though Nigeria is now the largest economy in Africa, with a GDP of US\$ 397 billion and accounting for 17% of the continent's GDP, 40.1% of Nigerians (about 83 million people) live in poverty and growth per capita has been negative [1].

The poor health and education services for those who cannot afford to pay is also a driver of poverty. Key to Nigeria's efforts at addressing poverty is to recognise the centrality of women in producing healthy children if they can do so when they choose, contributing to productive households if they have access to essential services, such as water and sanitation, and agricultural support [1].

NIW, its members, the welding industry and networks could assist in finding solutions to meet some of these challenges through the implementation of welding and related technologies.

The vast majority of people in Nigeria simply want a decent job, food, education, health, safety and security and a roof over their heads for their family as well as a decent environment to bring up their children. The NIW initiatives help progress such aspirations.

Over the years, NIW has been able to show the value and benefits of its work and outcomes of that work to Nigeria and Africa. Many of the examples and initiatives developed by NIW over the years contribute to ending poverty and improving the quality of life.

Industrialisation through manufacturing and construction can lead to economic growth – and most importantly – with the creation of quality jobs with a high labour absorption rate. In metals manufacturing and construction, welding is the enabling technology that allows these activities to take place. Welding, as a career choice, is able to absorb unskilled, poorly educated people and give them in-demand, well-paid, high quality jobs as well as through further education and training, give them career paths to even better opportunities in the welding industry.

Unfortunately, the Nigerian industrial sector is weak due to its low contribution to the nations GDP and employment. It utilises low technology with poor research and development activities and operates under weak infrastructure and poor industrial environment and therefore remains uncompetitive. To introduce new concepts such as Industry 4.0 requires innovative labour equipped with relevant skills and technology which NIW is introducing [8].

Although there are still problems with the adoption and impact of Industry 4.0 in Nigeria, NIW is also now focusing on the introduction of Industry 4.0 which if successful is anticipated to give unprecedented transformation to the Nigerian welding and manufacturing industry. The introduction of new and appropriate technologies besides saving time, will boost productivity, reduce waste, expand business models and be more responsive to fast changing environmental and consumer demands which will all contribute to the improvement of the quality of life.



SDG 2 End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.

This SDG is critical for the country since astoundingly cheap investments made today in better nutrition for children can lead to better education and more productive adult lives. Research in Ghana and Malawi has shown that with this approach, it can cost as little as \$US5 per mother and yet save lives and transform lifelong prospects so that each dollar spent delivers \$US36 of social returns [9].

Although there are many factors which can produce hunger in the population in a country, if one considers some of the elements required to assist a country to be able to grow, harvest, store, process and distribute food, welding can assist at each stage in ensuring success and add value to a country's food production needs and hence reduce the probability of hunger.

At the planting, growing, irrigating and harvesting stages there will always be a need to assemble, install and repair equipment such as tractors, tilling equipment, planters, balers,

combines, ploughs, mowers, harvesters, grain and feed handling, dams, sprayers and irrigation equipment. Similarly, with storage and distribution, storage and drying equipment, boiler and boiler components, scrubbers, fans, pumps, conveyors, gear boxes and turbines as well as forklift trucks, pallets, lorries.

Even if one is in a region of subsistence farming, collective farming or individual large farms, access to skilled people and equipment is essential both to make components and perform repair and maintenance using welding.

The welding industry can supply significant support to farmers of all categories through the provision of facilities, equipment and consumables for the maintenance and repair of agricultural equipment and plant.

A key objective therefore should be to train as many people as possible in the area in the appropriate welding skills and knowledge for any eventuality which may arise. In many developing countries however, opportunities to attend such colleges are often not readily available. The challenge, therefore, is to assist farmers often in remote rural areas to be able to access such training and obtain the necessary skills.

Some innovative ideas over the past four decades in countries such as Australia and the US have involved mobile welder training centres which can be driven to all areas accessible by road. The availability of welding supply companies to offer technical advice and welding supplies to such farmers is also critical. Timing is very important since the farmer cannot wait in the middle of planting or harvesting to fix machinery. Transfer of appropriate technology to farmers is much easier today due to the more acceptable forms of communication such as the latest welding news, blogs, podcasts, virtual conferences, online courses, and digital tools designed to help people grow and succeed

Such people can also use the skills and knowledge for non-agricultural purposes as well and develop other businesses in the rural areas as well as increase the opportunities for employment in various industries. There could be many opportunities at the micro-enterprise level to develop true entrepreneurial cultures which the Nigerian Government is keen on promoting.

Nigeria has excellent opportunities for promoting “start-ups” in many areas both urban and rural. In the welding field this could include youth starting with acquiring basic skills in welding through to engineering personnel with degrees and diplomas. The resources required to train such people to operate a Micro, Small and Medium Enterprises (MSMEs) are readily available and can be incorporated into the welding training courses at the different levels.

With respect to food processing the hygienic requirements of for example, the food and beverage industry place high demands on the welds that hold tanks, pipes and vessels together.

The requirements specified in codes and standards for a high-quality weld and weld surface finish are paramount in the dairy and other food and beverage industries, as the consequences of poor surface and weld quality can be costly and dangerous.

Nigerian fabricators therefore need to make significant efforts to ensure that both the weld integrity is adequate and that the surface finish meets the specified requirement for hygiene.

Collaborating with aluminum and stainless steel associations in its networks in Nigeria as well as those such as the Southern Africa Stainless Steel Development Association (Sassda) and the Aluminium Federation of South Africa (AFSA) elsewhere, NIW can also help ensure a competent industry is available using appropriate technologies to be able to build, repair and maintain the relevant plant and equipment for such food processing and food transportation as well as agricultural equipment and facilities.

NIW has many examples of how the technologies developed over the years in their networks will help ensure the reliability of plant and equipment for processing food as well as the reliability and integrity of the food itself thus contributing to food security.

A key objective therefore should be to train as many people as possible in the appropriate welding skills and knowledge and ensure appropriate technology transfer takes place for any eventuality which may arise.



SDG 3 Ensure healthy lives and promote well-being for all at all ages.

To ensure the continuous well-being of people in a country and continued accessibility to health systems to increase life expectancy, welding and joining technology transfers are needed and contribute to meeting various medical objectives including examples such as those developed and implemented by IIW Members in the NIW networks, for example, related to medical devices, implants, prosthetics [10],[11],[12].

Such technological improvements lead to cheaper and more efficient components, better recovery, reduced surgery times and greater access to the wider population and could be introduced into Nigeria.

The integrity and reliability of the plant and equipment to produce pharmaceuticals and medical gases relies on the availability of competent welding personnel and companies as well as appropriate welding related technologies. A number of NIW company members produce medical gases and are involved in installing them into the national networks of hospitals and medical facilities. The criticality of this industry was shown recently by the reported massive needs for oxygen during the Covid-19 crisis.

NIW has also played a key role in ensuring that people involved in welding are protected from a health and safety viewpoint. Its involvement with many other organisations from industry, government, standards organisations and IIW among others, has enabled the appropriate standards, guidance notes and educational materials to be used throughout the country to continuously improve the well-being of people.

4 QUALITY EDUCATION



SDG 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

With a population of 206 million people, regional disparities are significant in Nigeria with 78% of south-western children able to read full or part sentences, while only 17% of north-eastern children can. Much of this is attributed to poor attendance levels at school. The participation rate of youth and adults in formal and non-formal education and training is meager [1].

A major challenge is to improve participation in education at all levels substantially. With only 1.6% of GDP devoted to education, the country needs to increase the resources to provide quality education. This also becomes prevalent for the successful introduction of Industry 4.0

NIW has created and implemented a number of programmes and opportunities both in its own right and within the International Institute of Welding (IIW) for lifelong learning to take place. It has helped establish closer partnerships with government as well as between higher education institutions and industry and the development of effective, affordable training qualification and certification systems to contribute to national economic development, international competitiveness and the attainment of social goals.

Besides having conducted a national gap analysis in the welding capacity and capability of tertiary institutions in Nigeria, NIW is also the host **Secretariat for the National Council for Welding Skills Sector**.

NIW has been very active working with government and industry to improve this SDG. NIW enjoys the full authorisation of the Federal Government under the supervision of the **National Board for Technical Education (NBTE)** as the sole awarding body for welding and related skills qualifications. Together with the NBTE, NIW supports capacity building in welding and related skills for Nigerian Polytechnics and Monotechnics.

Similarly, NIW is the sole authorised body recognised by the **Nigerian Content Development and Monitoring Board (NCDMB)** to certify and regulate welding personnel in the oil and gas industry leading to a harmonised welding personnel qualification scheme.

Working with the **Petroleum Technology Development Fund (PTDF)** over the past 12 years, NIW has been able to develop over 30 welding training centres each available to train 40 to 200 people at a time in multiple welding processes. Working with the **Niger Delta Development Commission (NDDC)**, over 20 training centres have been established across nine states in the region.

Persuading governments, industry and aid agencies to support the upliftment of disadvantaged people through improved skills and knowledge of welding and Non-Destructive Testing (NDT) can also be a positive approach to be adopted in a NWC Project in a developing country.

For example, International Institute of Welding, IIW WGRA/COM, Success Story No 1 illustrates how the Canadian, Dutch and South African Governments were persuaded to provide the funding to train and qualify 65 disadvantaged people in NDT at the Southern

African Institute of Welding (SAIW). As the Success Story states “This wonderful team effort, between three national governments, industry bodies, national welding institutes and South African industry resulted in an outstanding outcome in improving the quality of life and ongoing opportunities for young people” [13].

A major training project involving over 20 countries in Africa was initiated and supported by the **International Atomic Energy Agency (IAEA)** through the promotion of radiation based Non-Destructive Testing Techniques [14] with South Africa and Tunisia playing very effective coordination and implementation roles in this very successful project. This project led to the formation of the **African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology (AFRA)** established by African member states [15]. Projects still continue to this day.

NIW has been involved with an initiative with the **United Nations Office for Projects (UNOPS)** to develop a plan for welding training centres to undertake welder training in accordance with NIW/IIW guidelines.

The development of the International Institute of Welding (IIW) Education, Training, Qualification and Certification programmes and their implementation including the IIW Manufacturers Certification Scheme According to ISO 3834 (IIW MCS ISO 3834) in 47 countries worldwide, illustrates the importance and need for world class personnel and companies to be available in the welding industry in a country.

Since the introduction of the IIW programmes in 2000, 57009 International Welding Engineers (IWEs) have been trained and qualified worldwide, 12341 International Welding Technologists (IWTs), 46067 International Welding Specialists (IWSs), 4087 International Welding Practitioners (IWPs), 29839 International Welders, 15211 International Welding Inspectors and 230 International Welded Structures Designers and 2740 companies have been certified to the IIW MCS ISO 3834 programme [16].

To ensure that it complies with the appropriate accreditations, NIW was approved as an IIW Authorised Nominated Body. Since the introduction of the IIW programmes in 2010, 30 International Welding Engineers (IWEs), 8 International Welding Technologists (IWTs), 4 International Welding Specialists (IWSs), and over 5000 International Welders have been trained and qualified at NIW.

NIW also had 20 IIW international Welding Practitioners and 10 International Welding Specialists trained at the Southern African Institute of Welding (SAIW) as trainers. Similarly, 11 International Welding Engineers, 40 International Welding Inspectors – Comprehensive were also trained by the German (GSI-SLV) in Turkey while 12 underwater welding technicians were trained in Marseille, France.

In Nigeria, NIW has also trained 500 people under the WTCP phase one programme and 700 under phase two. 130 people also received training in multi-welding processes and 20 have been trained to the American Society for Non-destructive Testing (ASNT) SNT-TC-1A level 2 standard. Opportunities also exist to expand the IIW qualification and certification programmes throughout Nigeria.

To engage youth from elementary and secondary ages across the country, NIW is working on introducing a new welding simulator program which will use virtual and

augmented reality to allow students to try welding in a safe, controlled environment while learning about career opportunities in welding and related skilled trades. This may also be included in NIW **Train-the-Trainer** programmes.

NIW has also implemented many projects on a voluntary basis including improving the image of welding projects. Through the holding or supporting of welding skill competitions, welded art exhibitions and competitions, NIW is encouraging as many people as possible to take up the art, trade or profession of welding. For example, NIW organised a National Welding Competition in collaboration with Samsung Heavy Industries Nigeria and the Federal Ministry of Science and Technology.

NIW is conducting national welding competitions to encourage young people in their welding careers as well as participating in international skill competitions and the IIW Welded Art Photographic Exhibition.

All this has contributed to improving SDG 4 in welding related fields in Nigeria and with appropriate support can be expanded significantly in many regions of the country.



SDG 5 Achieve gender equality and empower all women and girls.

During the Second World War (WWII), in some countries such as the US, Canada, USSR and UK, due to sheer necessity, women and girls were employed in a wide range of employment situations normally fulfilled by men. Similarly, in many developed countries today, due to women and girls showing that they are competent to fulfil the employment roles, they are employed on an equal basis to men.

Unfortunately, there may be countries where due to a variety of reasons, this does not apply. There may therefore be a need to change a number of cultures in a country to achieve equality and empowerment for women and girls.

One of the best ways to enable women and girls to show that they are competent to perform any type of work is to show that they have achieved the required qualification and certification criteria specified for a particular type of work or application. At the same time, if one can change the culture which might be having a negative effect on this approach, then it might achieve positive results.

This becomes easier to achieve when a country has developed and implemented a number of cultures including a skills respect culture [17].

NIW has always been involved in programmes in Nigeria promoting such cultures and enabling women and girls to enter the welding related fields at various levels and areas such as education, training, research, development and technology transfer accompanied by the appropriate career paths.

The implementation of scholarships and support for Science, Technology, Engineering and Mathematics (STEM) initiatives, are examples of how NIW is working towards gender equality and greater diversity to progress this SDG.



SDG 6 Ensure availability and sustainability management of water and sanitation for all.

The Nigerian Government has launched an emergency response to the country's water and sanitation crisis through the implementation of a **National Plan of Action**. Declining water services included a fall in the percentage of the population with piped water services (32% in 1990 to 7% in 2015) and a fall in the percentage of people with access to improved sanitation (from 38% in 1990 to 29% in 2015) [18].

Clean Water Management is a key issue in any Government's strategic policy. A sustainable water environment is critical to all stakeholders in Nigeria and hence its national interest. Major restructuring is required and strategic challenges include drinking water quality, water wastage eg, leaking pipes, environmental issues related to effluent discharge and irrigation issues and for industry to meet these challenges in a productive and competitive manner.

Nigeria's water resources are therefore at a critical point with challenges affecting the water including the amount available, the unequal distribution and access to clean water, the quality and state of water infrastructure, droughts causing some towns to run dry and corruption that has affected municipal treatment plants, resulting in sewage flows into streets, rivers and groundwater [16].

Population pressures on the fragile natural resource base, in turn, aggravate the factors leading to desertification. The vicious circle of cause and effect can lead to a scenario of expansion of the areas susceptible to the phenomenon, with impact on agricultural production, which consequently leads to increased poverty for the region [1].

Welding and joining technology transfers could therefore contribute to meeting the national objectives in the following ways:

- Urgent need for Nigeria to upgrade its water catchment, storage, treatment and distribution and waste water infrastructure in both urban and rural applications;
- Minimisation of resource wastage and the risks of serious health and supply breakdown due to failing pipes/distribution;
- Maintenance of aging infrastructure.
- The use and benefit of improved welding fabrication and construction technologies which have been shown by numerous examples of plant required for climate-resilient water sources. These are those on which climate variability, such as variations in rainfall, temperature and drought has little or no influence with two of the most significant being desalination and water recycling plants. The NIW and the welding industry can truly assist the country in this regard.

NIW's networks within IIW have developed and implemented over the years examples of technologies in applications which have led to cleaner, better quality drinking water; more

efficient irrigation, less water wastage, more efficient waste water treatment, less pollution, better water capture and increased water resources.

Such inter-relationships between poverty and the environment are also evident where access to basic sanitation, sewage treatment and solid waste management, are not adequate leading to environmental degradation in Nigerian cities as well as having an adverse impact on the health of the population.

The continual transfer of such existing and new technologies into both Nigeria and regional countries, as well as training the people to apply them, is paramount for achieving this SDG.



SDG 7 Ensure access to affordable, reliable, sustainable and modern energy for all.

Access to electrical power is a key requirement to meet the challenges of sustainable economic growth and development in sub-Saharan Africa as well as progress many of the UN SDGs. Although Nigeria is the largest economy in sub-Saharan Africa, the limitations in the power sector constrain growth. Nigeria is endowed with large oil, gas, hydro and solar resources, and it has the potential to generate 12,522 MW of electric power from existing plants.

Unfortunately, on most days it is only able to dispatch 4,000 MW, which is insufficient for a country of over 200 million people. The Nigerian power sector experiences many broad challenges related to electricity policy enforcement, regulatory uncertainty, gas supply, transmission system constraints and major power sector planning shortfalls that have kept the sector from reaching commercial viability [19].

Its present energy mix is dominated by thermal (80%) and hydro (20%) power generating sources but it is also embracing the use of renewable sources such as biomass and solar to produce electricity mostly for rural and semi-urban areas that are out of reach of distribution companies. The Rural Electrification Agency has actively been commissioning electrification projects since 2014 using solar energy as the main source of electricity.

There are some very good initiatives taking place in Nigeria through organisations such as Power Africa, a US government led initiative which has supported the development of 3,043 MW of electricity generation projects. Aid agencies are also working closely with the Nigerian Government to assist in the rehabilitation and upgrade of Nigeria's electricity transmission substations and lines. This will expand the power transmission network and capacity, allowing distribution companies to improve reliability and supply to consumers [19].

There are also opportunities for local companies to produce off-grid power solutions for companies and households. These could include solar panels, installation equipment, distribution equipment and batteries [20].

It is very important that NIW, the welding industry and its networks work very closely to ensure that there are industries competent to manufacture, install and maintain the appropriate equipment and facilities to ensure affordable, reliable, sustainable and clean modern energy for the country.

Even with a determined effort to move to cleaner energy sources, energy sources such as coal, oil and gas will still be in existence and growing and will require the same attention to reliability in service as provided by the technologies, personnel and companies existing in NIW's networks.

As the implementation of energy sources grows, NIW's support for the transfer of necessary technologies to the appropriate implementers must also grow.



SDG 8 Promote sustained, inclusive and sustainable economic growth.

Nigeria's informal economy is one of the largest on the continent, estimated at 53% of the labour force and accounting for 65% of GDP. It is estimated that 75% of all new jobs are informal. Youth have a combined unemployment and underemployment rate of 55.4% or 24.5 million. With 38% of the 15 to 24 year-olds not in education, employment or training, it means that these young people are not gaining the skills to enter the labour market or to become self-employed [1].

It is critical that building the required skills into young people to enable them to move into secure and less precarious forms of employment is essential to reduce poverty as well as diversify the economy beyond dependence on oil and gas. NIW is drafting and implementing a national code for welding practice for the informal sector.

The **Generation Unlimited** intervention which targets employment for 20 million youth is a good example. There are also efforts to provide greater access to finance to leverage greater private sector-led growth aimed at Micro, Small and Medium Enterprises (MSMEs) [21].

The Government is also keen to place more emphasis on vocational skills and entrepreneurial training specifically towards the needs of older persons in the informal sector [1].

There are many factors which can have a positive effect on the growth of a country's economy. Some of these involve creating the correct cultures within the country. For example, NIW has had a positive influence on cultures related to ethics, skills respect, productivity, quality, work, health and safety, environmental, innovation and service excellence amongst others in the welding related industries. Examples of how these can contribute to an excellent national welding capability can be easily shown.

NIW and its members, being in the "welding industry", have a positive effect on economic growth. Innovation and the need to have competent people to play their part in innovation also places emphasis on the importance of education, training, qualification and certification of people as well as certification of companies in the country to improve this SDG. These are areas in which NIW plays a significant role.

NIW could implement strategies to assist companies with new and appropriate technologies, links with education and training organisations and capitalise on the excellent success of the IIW MCS ISO 3834 company certification programme with numerous Nigerian companies becoming certified, all this contributing to improving this SDG.



SDG 9 Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.

For successful industrialisation, a country needs a skilled workforce and one that includes welding and related qualified and certified personnel to ensure sustainable industrialisation and provide the ongoing innovation.

Ever since its formation in 1980, NIW, its members and networks, have been involved in the building up of a vast array of resilient infrastructure in Nigeria to world class standards.

NIW has inspired an innovation culture both in itself and in the country.

An innovation culture is where everybody and every effort contributes to bringing in something new, to making changes (ideas, methods etc.) whether in simple or complex forms and includes applying inventions and the adoption of R&D outcomes.

Implementation of innovative ideas and processes especially for smaller firms requires an effective link between the firms themselves and sources of technology. Research and development must therefore link in well with what technology diffusion provides but there must be market awareness of the R&D outcomes if technology diffusion mechanisms are to be effective and increase innovation. NIW, its members and networks, have been at the forefront in this regard

Companies themselves must recognise the importance of new technology to their business, and hence R&D, so that the market demand for new technologies continually improves and the level of technology uptake at the individual company level increases.

The development of sufficient people as both technology deliverers and technology receptors is critical to ensure that innovation can take place. NIW has also been at the forefront of this to world class standards.

The development of national and international standards are also essential to ensure the integrity and reliability of welded components and resilient infrastructure. Nigerian industry has helped ensure this through its involvement through NIW and its **Mutual Recognition Agreement (MRA) with Standards Organisation of Nigeria (SON)**.

NIW representatives have been involved in many SON Technical Committees related to welding and non-destructive examination, pressure equipment, health and safety amongst others and with the participation of a large number of NIW members and allied industry associations.

NIW has regularly over the years organized seminars for the industry, dedicated to the development and implementation of new standards and the NIW Newsletters and posting

of information via other traditional and social media often provide news on international, regional and Nigerian standards.



SDG 10 Reduce inequality within and among countries.

It is important to conduct a needs analysis in a country to establish exactly what is required to improve the quality of life in the country and have solutions to improve equality [22],[23],[24]..

In the welding related field in Nigeria there are examples of how such needs analyses have been conducted by NIW and then used to put in place appropriate strategies and action plans. For example, PTDF in collaboration with NIW undertook an **Institutional capacity survey**.

NIW has an excellent record of involving a wide range of organisations, both nationally and internationally, in its various needs analyses and strategic planning exercises over the years. For example, NIW has held workshops and congresses on technology innovation and national welding capabilities involving Nigerian and international experts to identify such needs and implement solutions which all contribute to reducing inequality [25], [26].

Key NIW and welding industry initiatives have then involved growing opportunities in the manufacturing, maintenance and construction industries and creating the career pathways for people to improve and help reduce existing inequalities.

NIW is probably in the ideal position to continually identify such needs, in Nigeria and recommend and provide appropriate solutions and hence increased opportunities. The results which will be achieved will help improve the SDG.



SDG 11 Make cities and human settlements inclusive, safe, resilient, and sustainable.

There has been an unprecedented growth of cities and settlements in Nigeria over the past seven decades with the need to create safe and affordable buildings including housing as well as safe and efficient public transport. There has also been a growing trend to make such structures more resilient to disasters such as earthquakes, fires, floods and landslides as well as failures due to shoddy quality and explosions due to faulty equipment.

Nigeria has a major challenge with the rate of urbanisation increasing rapidly in the country and slum proliferation increasing. This also generates environmental problems with social consequences; precarious housing conditions for the poorer populations, often

in irregular areas such as riverbanks and hill slopes, making them more susceptible to natural disasters such as floods and landslides.

Floods are the major cause of disasters and problems such as poor quality drinking water and sanitation, public health, food shortages, as well as some houses in both rural and urban communities collapsing because they don't have the solid structural strength. Water can obliterate the road and rail networks.

NIW has access to the IIW networks which have been heavily involved in developing and applying relevant technologies for use in many applications in human settlements as well as being involved in appropriate organisations related to the metals, pressure equipment and structural steel industry.

The certification of fabricators and construction companies to national, regional and international standards to build such products as bridges, flyovers and train networks is one method the welding industry uses to ensure the reliability and integrity of the wide range of welded products and structures. NIW, working with the appropriate authorities, could introduce the IIW Manufacturers Certification Scheme According to ISO 3834 (IIW MCS ISO 3834) thus helping ensure the competency of Nigerian fabrication and construction companies to create reliable welded structures and road and rail vehicles. Such an initiative will also increase opportunities for local manufacture and increased job opportunities.

Due to the Covid-19 pandemic, IIW Members have introduced virtual audits and training which have proved to be very successful. With the "tyranny of distance" which exists in Nigeria, the technologies which have been developed and implemented catering to the challenges of remoteness of both companies and individuals, and in particular poor communities, could lead to more effective training, education, testing and auditing systems in Nigeria. This will naturally assist good progress in a number of the SDGs.

NIW has always promoted the uniform rollout and implementation of the appropriate national and international standards across Nigeria to ensure the reliability and integrity of welded structures/products.

Through the establishment of its NIW Certification division, NIW would ensure that all personnel trained and qualified and companies certified under its auspices, meet the required national or international standards.



SDG 12 Ensure sustainable consumption and production patterns.

There are many examples of sound environmental and Work, Health and Safety {WHS} management practices around the world to assist in control of many wastes related to welding.

An environmental culture of an organisation could be defined as the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that

determine the commitment to, and the style and proficiency of, an organisation's environmental management.

NIW has been heavily involved in the appropriate Nigerian and International organisations and IIW Commissions in these areas and the transfer of appropriate technologies into industry and the community at large.

Working with other organisations in its networks including IIW, SASSDA and AFSA, the transfer of information on dealing with wastes from the processes involved in the cutting, fabrication, construction of applications using metals is continually taking place via seminars, workshops, guidance notes, education and training courses.



SDG 13 Take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy.

Nigeria has a tropical climate with two distinct seasons, wet and dry. These seasons vary depending upon geographical location with the Southern part having a longer period of rainy season than the Northern part.

The Nigerian climate has been irregular over the years alternating between periods of extreme dry or rainy seasons. Claims have been made that climate change has led to seasons of drought and excess flooding affecting agricultural activities and loss of shelter. For example, in 2019 floods had displaced approximately 1.9 million Nigerians.

Energy resources power both domestic and industry needs, and are a key contributor to a country's economic prosperity. The demand for energy increases as a country's economy and population grow. Fossil fuels such as oil, natural gas and coal are examples of non-renewable resources and they cannot be replaced as quickly as they are being used. In contrast, resources that are referred to as renewable energy sources can be used again and again, without depletion, or can be replenished in a short time frame. The wind, sun (solar) and waves are all sources of renewable energy.

Although the Nigerian government is committed to reducing emissions by increasing the use of renewable energy, in particular solar, it also has plans to expand generation through the addition of six coal fired power and nine gas plants by 2037.

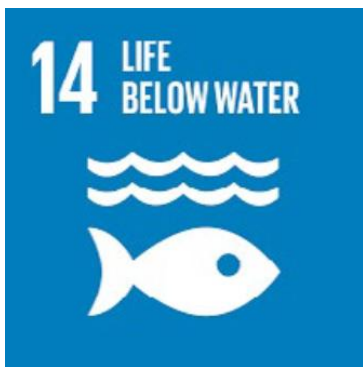
The challenges for the welding industry and its networks, is to continue to be heavily involved in related work in all these different types of energy, whether new or existing, ensuring their reliability and integrity. This will require organisations such as NIW having strategies in place to ensure that the welding industry has a competent workforce and technologies to design, manufacture, construct, repair and maintain all the relevant equipment and facilities.

Nigeria is rich in natural resources but highly dependent on oil which has resulted in the neglect of other sectors in which the metal ores industry has not been exempted [27].

Steel is at the core of a green economy, in which economic growth and environmental responsibility work hand in hand. Once steel is produced it becomes a permanent resource because it is 100% recyclable without loss of quality and has a potentially endless life cycle [28].

At a time when the Nigerian Government is exploring alternative ways of diversifying foreign exchange earnings away from oil, self-sufficiency in steel production, including opportunities to expand manufacturing and construction industries through the growing production and use of steel, would lead to many other benefits. For example, according to the World Steel Association, steel use per capita for finished steel products stood at 8kg in 2017, significantly below the world average of 214.5kg. With increasing levels of unemployment, the growth in steel production has the capacity to employ a large number of the nation's labour force both directly and indirectly [29].

NIW and the welding industry will collaborate with government and the steel producing industry to meet the challenges ahead including the benefits to the SDGs through the significant growth in steel usage by 2030.



SDG 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

In terms of challenges below the water, there are many concerns about the whole range of pollution taking place which can have a major significant effect on the marine ecosystems. Since welding is used in numerous applications which will be used in water, the integrity of the welds becomes paramount.

If one considers the range of applications covering ships, boats, oil and gas carrying pipelines and tankers, failures can result for example in fires and oil pollution from small spills to catastrophic damage. The high integrity and reliability of welded structures in marine applications to this SDG is essential.

The expertise in NIW's networks has been used to mitigate such problems particularly through the development work and involvement of its networks of world class experts, and will continue to do so.

Unfortunately, oil spill disaster can also be caused not just by tanker break-up but also by illegal discharge and tanker clean up and especially in Nigeria by sabotage.



SDG 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Welding is used in many critical applications which if failure occurs, varying degrees of contamination and destruction can take place. These can range from catastrophes similar to

those mentioned above in SDG 14 through to issues such as sewage spillages onto land and into rivers which is prevalent in Nigeria.

The great benefits of welding, and NIW's and industry's efforts, can be realised however with the proper design, materials, procedures, manufacture, conformity assessment, operations including repair and maintenance as well as decommissioning leading to positive contributions to improving this SDG.

With the rapid development of welding technology and its links to steel as a 100% recyclable material, it is becoming cheaper and faster to make use of metal as a material, hence reducing the load on natural materials such as wood, hence reducing deforestation.



SDG 16 Promote peaceful and inclusive societies for sustainable development provide access to justice for all and build effective accountable and inclusive institutions at all levels.

One of the cardinal objectives of the Nigerian Government's ERGP was to combat corruption in the country which is still a formidable challenge [1].

Often the word "sustainable" is understood by people to refer only to financial sustainability.

It is important to realise that it refers to many other aspects of the SDGs, in particular including the environment and cultural behaviours.

A useful approach is to look for 'ethical leadership' in people at all levels. The most successful leaders inspire others to embrace a common goal through recognition of shared values. They build and maintain effective relationships by living and leading with integrity.

ISO (International Standardisation Organisation) has also introduced standards which involve ethical behaviour. ISO 19600:2014- Compliance Management Systems-Guidelines and ISO 26000 Social Responsibility Guidance Document.

ISO 19600:2014 covers establishing, developing, implementing, evaluating, maintaining and improving an effective and responsive compliance management system within an organisation. They are guidelines and the extent to which they are used depends on the size, structure, nature and complexity of the organisation. The Standard falls under ISO Technical Committee 309, Governance of organisations.

NIW is an effective, accountable and inclusive institution. It is a member based organisation and is accountable to its members. Through its industry committees, it is accountable to the broader Nigerian industry and being a not-for-profit organisation, it puts the needs of industry and communities first. To succeed in its objectives, it ensures that the organisations in its networks are also effective, accountable and inclusive.

Through its technology transfer mechanisms, NIW has the ability to significantly influence this SDG positively through the successful promotion and implementation of the above standards in industry.



SDG 17 Strengthen the means of implementation and revitalise the global partnership for sustainable development.

An important component of achieving this SDG is the use of the formal networks which exist within the welding related industries both locally and globally.

Such networks help in producing a multitude of partnerships, both large and small, ready to work together on appropriate activities to assist in meeting SDG targets in a country.

A general definition of a network is that it consists of a variety of entities (e.g. organisations and people) which are largely autonomous, geographically distributed and heterogeneous in terms of their operating environment, culture, social capital and goals, but that cooperate and/or collaborate to better achieve common or compatible goals.

NIW was the first country in West Africa to become a Member of IIW. It has assisted countries such as Cameroon, Ghana, Uganda and Sao Tome & Principe with improving their national welding capabilities.

One only has to consider NIW's networks such as IIW, SASSDA, AFSA, SAIW, SON, ISO, IAEA, TWF, and International Committee for Non-destructive Testing (ICNDT) etc to see the potential which can be harnessed. Two good example of how such networks can assist with this SDG are shown in references [30] and [31]. Reference 30 shows how the Welding Technology Institute of Australia (WTIA) in Australia created a worldwide network of technological experts and organisations with remarkable success with technology transfer to Australian industry. Reference 31 shows how the CWB Group built up an Association from 1000 members to over 70000 members over a ten year period. When one considers the hundreds of thousands of people welding in Nigeria, a quantum leap by the welding industry's involvement in progressing the SDGs will make an enormous contribution to the Nigerian Government's endeavours.

In 2007, the Southern African Institute of Welding (SAIW) and Nigerian Institute of Welding (NIW) started collaborating on education and training in the welding field and more recently in 2021, they were the catalysts for the formation of The Welding Federation (TWF) headquartered in Johannesburg with representatives from South Africa, Kenya, Ethiopia, Uganda, Ghana, Mozambique, Egypt and Nigeria as members [32].

The formation of TWF should result in many technology transfer activities being held in a cooperative and collaborative manner between the TWF Members and other African countries These initiatives could result in outcomes such as funding support from governments and industry for technology support centres in African countries, as well as the transfer to the region of the knowledge and experiences of many world experts across a whole range of critical industrial applications.

Recommendations and Future Actions

For those people, including their organisations, who wish to support and contribute to the achievement of the UN SDGs, please link to Reference [3] titled “Your Country’s National Welding Capability (NWC) and its significance to the UN Sustainable Development Goals (SDGs)” by Chris Smallbone, IIW Past President.

allbones@iinet.net.au

The paper contains many examples and references to various initiatives across welding-related fields which could be introduced for all 17 UN SDGs. If you wish to discuss such ideas further including you and your organisation’s possible contributions to Nigeria’s welding industry initiatives, contact Mr Solomon Edebiri, NIW President, president@niw.ng

It is the intention of NIW to draw up mutually beneficial strategies and action plans with the support of Nigerian governments, industry and aid agencies for implementation to achieve significant progress in UN SDGs for which it has the expertise.

This report is to be a catalyst for such initiatives and create a quantum leap for NIW and the welding industry to support the Nigerian Government to succeed in this major objective by 2030.

References

- [1] Nigeria Integration of the SDGs into National Development Planning. A Secondary Voluntary National Review. June 2020 <https://sustainabledevelopment.un.org/indexVoluntary National Review>
- [2] Executive Order 5 to Augment Sustainable Economic Growth, 4th November 2021. <https://fmic.gov.ng>>Latest News
- [3] Your Country’s National Welding Capability (NWC) and its significance to the UN Sustainable Development Goals by Chris Smallbone, IIW Past President. Keynote Paper, ASR International Conference, Resita, Romania, 22-23 April 2021 <https://asr.ro/documents/C.Smallbone2021.pdf? t=1639211760>
- [4] Macroeconomic and sectoral value added by the production and application of joining technology in Germany, in selected countries in Europe as well as the EU as a whole. Short version of the expert report, Michael Kersting, Waike Moos and Anna Werbeck Ruhr Research Institute, Bochum 2017
- [5] SciELO - Brazil - Establishing and Implementing the Building Blocks of a Country’s National Welding Capability (NWC) <https://www.scielo.br/j/si/a/tDWHcwCpMB3tFYY4xTXWZWt/?lang=en>

- [6] Communique issued at the end of the 1st West African IIW International Congress, hosted by the Nigerian Institute of Welding at the International Conference Centre, Abuja, Nigeria, 2 to 6 March 2009
- [7] Welding in the World and the Future. Keynote Address Chris Smallbone, 1st West African IIW International Congress, Abuja, Nigeria. 02 -06 March 2009
- [8] The Nigerian Manufacturing Sector and 'Industrie 4': Opportunities and Challenges. Alumu Salawu Abideen. African Scholar Publications & Research International, VOL. 19 No.7 ISSN: 2276-0732 December 2020.
- [9] Christmas charity begins by homing in on those in need, Bjorn Lomborg, The Weekend Australian, 18-19 December 2021
- [10] Laser and Plasma dental soldering techniques applied to Ti-6Al-4V alloy: ultimate tensile strength and finite element analysis. Castro et al. The Journal of Prosthetic Dentistry, p1-7,2015.DOI: [10.1016/j.prosdent.2014.10.008](https://doi.org/10.1016/j.prosdent.2014.10.008)
- [11] Australia's first 3D printed spine implant
<https://www.rmit.edu.au/advanced-manufacturing> –precinct, 17 August 2015
- [12] Medical Device Consulting-Materials and Joining Technology
<https://www.twi-global.com/medical> equipment
- [13] IIW WGRA-Com Success Story Number 1 *A team effort between three national governments, industry bodies, national welding institutes and Nigerian industry gives hope to new welding inspectors and a model for the future.*
- [14] Role of the International Atomic Energy Agency In Promotion of Radiation Based Non Destructive Testing Techniques, Patrick Brisset, Radioisotopes Products and Radiation Technology, Department of Nuclear Science and Application, IAEA, Vienna, Austria 2008
- [15] AFRA's role in NDT in Africa-past, present and future. Guild, Jim NIW: Jarvis Neil, Nuclear Energy Corporation of Nigeria (NECSA), Published 01 07 2012
<http://www.ndt.net/?id=12422>
- [16] IAB-International Authorisation Board, Report on IIW-IAB Qualification and Certification Systems Activities during 2020, EWF/IIW-IAB Management Team June 2021
- [17] A Discussion Document on creating a culture of Respect for Skills in Nigeria. P.J.J. Dorfling, National Productivity Institute, August 1994.
- [18] Water Aid welcomes Nigerian Government action plan on water and sanitation crisis. Tegan Dunne 14 February 2020.
- [19] Nigeria Power Africa Fact Sheet, 3rd December 2021
<https://www.usaid.gov/powerafrica/nigeria>
- [20] Nigeria-Country Commercial Guide, 13th October 2021
<https://www.trade.gov/country-commercial-guides/Nigeria>

- [21] Generation Unlimited Launches in Nigeria, 20 Million Young People to Benefit, 19th August 2021. <https://www.generationunlimited.org>stories>generation>
- [22] A Comprehensive Advanced Materials Joining and Forming Technology Roadmap-Final Report, Prepared by Tom McGaughy, Hyunok Kim and Harvey Castner, EWI, Columbus, Ohio, 28 April 2017.
- [23] Welding Industry Technology Needs Study-Cooperative Research Centre for Materials Welding and Joining (CRC-MWJ), Planning & Managing Projects Pty Ltd, 30 November 1995.
- [24] Smallbone, C. and Kocak M., "IIW White Paper: Improving Global Quality of Life Through Optimum Use and Innovation of Welding and Joining Technologies" Published by IIW 2012 <http://iiwelding.org>
- [25] West African IIW International Congress, Welding and Steel Technology: Key to industrialisation, Abuja, Nigeria. 02-06 March 2009
- [26] Technology Innovation Workshop "Technology Innovation to Promote Sustainable and Environmentally Friendly Industrial Development" Abuja Nigeria 2nd March 2009.
- [27] An Overview of the Steel Industry in Nigeria Nicholas Ishola Senior Research Officer at Lagos Chamber of Commerce and Industry (LCCI) 19th March 2021 <https://www.linkedin.com>pulse>overview-steel-industry>
- [28] Sustainable Steel: at the core of a green economy, 31 May 2012 <https://worldsteel.org/publications/bookshop/sustainability> 2012
- [29] The Nigeria Steel Industry: An Awakening? 20th October 2020 <https://www.proshareng.com/Nigeria> Economy
- [30] "The OzWeld Technology Support Centres Networks: A Unique Model for Technology Innovation by Industry" Chris Smallbone, Executive Director, WTIA, ASM/AWS 6th International Conference on Trends in Welding Research 15 – 19 April 2002. Pine Mountain, Georgia, USA.
- [31] WELD Canadian Welding & Lifestyle Magazine WINTER 2021 Vol 04 No 16. <https://www.cwbgroup.org/association/publications>
<https://www.cwbgroup.org/association/publications/weld-winter-2021>
- [32] Welding register mitigates recruitment challenge, Khutso Maphatsoe, Engineering News, 30th September <https://www.engineeringnews.co.za>article>welding> - register