

EVALUATION AND ACCREDITATION DOCUMENTS

M.Sc. Corrosion Technology

Africa Centre of Excellence in Future Energies
and Electrochemical Systems (ACE FUELS)

Federal University of Technology Owerri (FUTO)

Owerri, Nigeria

June 2024

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EVALUATION REPORT

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and Electrochemical Systems (ACE FUELS)

Federal University of Technology Owerri (FUTO)

Owerri, Nigeria

May 2024

The Federal University of Technology Owerri has mandated the Hcéres to perform the evaluation of its Future Energies M.Sc. programme. The evaluation is based on the “External Evaluation Standards” of foreign study programmes, adopted by the Hcéres Board on 31st January 2022. These standards are available on the Hcéres website (hceres.fr).

On behalf of the experts committee¹ :

Olivier Boutin, President of the committee

In the name of Hcéres¹ :

Stéphane Le Boulter, Acting President

¹In accordance with articles R. 114-15 and R. 114-10 of the Research Code, evaluation reports are signed by the chairman of the experts committee and countersigned by the President of Hcéres.

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I. STUDY PROGRAMME IDENTITY SHEET

- University: Federal University of Technology Owerri (FUTO), Owerri, Nigeria
- Title of the programme: M.Sc. Corrosion Technology
- Year of creation and context: 2019. The programme has been supported by ACE FUELS since its creation.
- Site where the programme is taught: Federal University of Technology Owerri (FUTO), Owerri, Nigeria

PROGRAMME DIRECTOR

- Surname, first name: Akalazi, Chrisogonus
- Profession and grade: Reader
- Main subject taught: Corrosion Electrochemistry

METHODS AND RESULTS OF THE PREVIOUS ACCREDITATION(S)

- In 2022, the programme was evaluated by the National Universities Commission (NUC). The programme received its full accreditation by the NUC for 5 years, from April 2022 to April 2027.
- No previous international accreditation.

HUMAN AND MATERIAL RESOURCES DEDICATED TO THE PROGRAMME

– Human resources

Academic staff	Professors	Readers	Senior Lecturers	Lecturers	Total
	14	4	11	4	33
Technical staff	Chief and Deputy Chief Technologists	Principal and Senior Laboratory Technologists	Technologists	Senior Laboratory Supervisor	Total
	3	9	6	1	19
Administrative staff	Administrative Team Leader	Senior Assistant Registrar	Administrative Officer and Assistants	Others	Total
	1	1	4	5	11

- **Material resources:** the Centre disposes of many resources including specific classrooms, ZOOM video conferencing facilities, and the Olyex Learning Management system for delivering quality lessons and assessments. Additionally, the centre provides access to lesson contents anytime and anywhere for personalised learning. It also features a fully Networked Computational Modelling Laboratory, Language Laboratory, and Multimedia Conference Room. Furthermore, the centre has a well-stocked Library, virtual library (Proquest data base, and specific journals from Science Direct), and specific modelling software such as Material studio and Matlab,. It has built a general-purpose laboratory with state-of-the-art equipment including FTIR microscope, AFM, potentiostat/galvanostat, polishing machine, autoclave, and lab incubator. The lab resources of the partner departments are also accessible.

STUDENT POPULATION: EVOLUTION AND TYPOLOGY OVER THE LAST 4 YEARS

		2019/2020	2020/2021	2021/2022	2022/2023
Enrolment	Male	-	6	5	8
	Female	-	1	0	0
	Total	-	7	5	8
	<i>including foreigners</i>	-	0	0	1
Graduates	Male	-	2	-	-
	Female	-	0	-	-
	Total	-	2	-	-
	<i>including foreigners</i>	-	0	-	-

II. PRESENTATION OF THE STUDY PROGRAMME

1 – Presentation of the study programme

The Africa Centre of Excellence in Future Energies and Electrochemical Systems (ACE FUELS) at the Federal University of Technology Owerri was established in 2019 to address the growing need for education, skills, and information in renewable and other clean energy sources within the sub region. Its primary goal is to cultivate a critical mass of well-trained researchers capable of meeting the requirement of R&D professionals in Clean Energy and related high technology applications. Additionally, the Centre aims to spearhead and support high end research, expand knowledge beyond existing industry practices, promote local content in research and innovations, and foster industry-academia collaborations and involve partnerships with local industry initiatives within the region to help develop competencies by providing bespoke work-based learning events, activities and tools in line with global best practices. The Centre offers eight M.Sc. and Ph.D. programmes across 4 fields: Future Energies, Nanotechnology, Electrochemical Technology, and Corrosion. These disciplines complement each other and are prioritised for research and development, knowledge sharing and dissemination, community education, technical skills enhancement, and capacity development.

The M.Sc. Corrosion Technology programme offers fundamental training in corrosion science, covering aspects such as monitoring and diagnosing corrosion (including their origin, nature, and mechanism), as well as various corrosion control technologies aimed at mitigating the impact of this natural degradation process of structural materials deployed in service in different aggressive environments, such as those encountered in oil and gas operations.

During the initial 12-month period, students engage in three modules. The first module entails compulsory disciplinary courses focusing on corrosion, with a particular emphasis on its relevance to energy sector, sustainability, and resource economics. Following this foundational phase, the specialisation module offers greater flexibility, allowing students to choose from a selection of three specialised courses out of five in corrosion science, as well as three optional courses out of 18 multidisciplinary courses common to all Master's courses in the Centre. A crucial component of the programme is the six-month research project module, where students delve into in-depth research within the University. Finally, the programme culminates in a one-to-six-month internship with one of the programme's industrial partners, providing students with valuable practical experience and industry exposure.

2 – Presentation of the programme's self-evaluation approach

Although the Department of Physics has a committee on quality assurance, no information was provided on the way self-evaluation was conducted. The submitted self-evaluation report was rich, with appendices providing qualitative and quantitative data. A few additional documents were requested, and were all received within the week.

III. COMPOSITION OF THE EXPERTS PANEL

- **Olivier BOUTIN**, Chair of the panel, Full professor, Aix-Marseille University, France
- **Renaud BOUCHET**, Full professor, INP Grenoble, France
- **Melika HINAJE**, Full professor, Lorraine University, France
- **Julie FINKEL**, Ph.D. candidate, University of Montpellier, France

Hcéres was represented by **Zakia MESTARI**, project manager, Europe and International Department.

IV. VISIT DESCRIPTION

- **Date of the visit:** the visit took place on Tuesday 16th January 2024.
- **Summary of the proceedings:** before the visit occurred, the self-evaluation report and numerous appendices (42) had been received by the experts. Two preparatory meetings took place between the Director of the Hcéres Europe and International Department, the project manager, and the panel of experts in Paris on 20th December and online on 8th January. The on-site visit lasted for one day, following a schedule agreed upon between the ACE FUELS, the National Universities Commission, and

the panel. During the visit, the experts asked for a few more documents to get quantitative data, all of which have been received.

- **Organisation of the visit:** for safety reasons, the visit was organised in hybrid mode in Abuja, and the panel was not able to visit the Centre in Owerri. Instead, the Centre leaders, the programme director, and the postgraduate coordinator of the Federal University of Technology met the panel in Abuja, as along with some students and academics. In addition, a video of the site showing the facilities (buildings, teaching rooms, and the laboratory with the park of machines) was sent in advance to give a real oversight of the centre.
- **Cooperation of study programme and institution to be accredited:** ACE FUELS has been very cooperative throughout the process. The self-evaluation report was submitted according to the agreed schedule, and all questions asked before and during the visit were answered clearly and precisely. The panel is satisfied with the conclusions reached, which are based on available and relevant information provided. Moreover, the implication of the National Universities Commission has been very helpful throughout the process.
- **People met:** the committee was able to meet with 27 people from different panels:

	Session	Audience
8:00 – 9:30	Presentation of the programme and discussion with the top management	Centre Leaders, programmes directors and their teams
9:30 – 10:30	Academic staff	Representative panel of academics from both programmes
10:45 – 11:45	Quality assurance	Quality assurance representatives
11:45 – 12:45	Alumni	Representative panel of alumni
13:45 – 14:45	Socio-economic partners and employers	Representative panel of socio-economic partners and employers
14:45 – 15:45	Students	Representative panel of students from both programmes
16:30 – 17:00	Closing session	Centre Leaders, programmes directors and their teams

V. EVALUATION REPORT

1 – Training policy and characterisation

The programme has a clear positioning within the training landscape, especially within FUTO University, aiming to have a national and regional outlook focused on West Africa. The M.Sc. Corrosion Technology is one of the four different multidisciplinary M.Sc. programmes of the African Centre of Excellence in Future Energies and Electrochemical Systems (ACE FUELS). The core activities of the Centre align with the top priority research areas of FUTO University, in particular Energy and Environment, and Advanced Materials. The centre has gathered several skills to develop a specialised and complementary M.Sc. degree with a curriculum featuring high-level courses in Corrosion Science, making it unique on both a national and regional scale. Corrosion has a significant economic impact, with the oil and gas industry in Nigeria alone experiencing annual revenues losses of \$765 million due to corrosion-related issues, with further profound environmental degradation from product spillage. Moreover, corrosion affects all major industrial infrastructures, including renewable energy systems like wind turbines, solar panels, and other energy materials. The imperative for these industries is to develop corrosion-resistant structures to increase the durability and reliability of their systems. This approach strongly aligns with the mission of the Federal University of Technology, which aims to offer practical and result-oriented programmes and training geared towards transforming the nation's economy with a sound technological foundation. The initiative also satisfies the energy priority of the New Partnership for Africa's Development (NEPAD), as well as the National Economic Empowerment and Development Strategies (NEEDS). The programme aligns with its core education mandate by strengthening or adapting existing programmes in partner Departments to bridge science with technology, in line with the Centre's objectives. In addition to the other M.Sc. programmes of the Centre, the programme has also introduced an innovative, bespoke multidisciplinary Ph.D. programme in Corrosion Technology. This initiative caters to students seeking to advance their education at the doctoral level. The multidisciplinary courses draw from departments such as Chemistry and Chemical Engineering, Physics, Polymer Engineering, and Materials Science. The M.Sc. programme offers multidisciplinary and interdisciplinary contributions, integrating mandatory scientific courses such as Corrosion in the Energy Sector and Corrosion and Environmental Management; alongside non-scientific courses like Research Methods & Innovation and Entrepreneurship. In the elective courses within the specialisation module, the programme also incorporates sustainable development-related issues, including: Climate Change, Smart Grid Technology Overview, Renewable Energy Finance and Management, and Energy Analysis.

Even though international partnerships are intense, they could be developed further with universities directly related to the programme, and students' incoming and outgoing mobility remains extremely limited, with only one foreign student enrolled in 2022. ACE-FUELS has established direct partnership with 22 national institutions (University of Nigeria, Nsukka; Nnamdi Azikiwe University, Awka, etc.), regional organisations (WACEENET), and international academic institutions (TEA-LP, MoU with the Institute of Nuclear and Energy Research, Sao Paulo, Brazil (IPEN), etc.). These collaborations encompass various activities such as training, research, co-supervision of students, organisation of conferences, access to facilities, and joint workshops. The West African Centre of Excellence for Energy Network (WACEENET), comprising three Nigerian Centres (ACE-FUELS, ACE SPED, ACE CEFOR), one Centre in Ghana (ACE RCEES), and one in Togo (ACE CERME), has endorsed the Erasmus+ programme and committed to cooperating on the exchange of students and/or staff as part of the West Africa Regional Mobility (WARM) Programme. This openness should help to prepare students for participation in incoming and outgoing mobility programmes. In addition, a Pan African Electrochemistry Network was established in 2016 by scientists from Nigeria, Ghana, South Africa, Ethiopia, Egypt, and the United Kingdom, with the aim of popularising the electrochemical science in Africa. This network facilitates postgraduate training, research, co-supervision, lecture delivery, joint workshops, and advice on curricula. Furthermore, the ACE-FUELS Webinar Series (held monthly) initiated on 10th June 2021, provides a platform for scientific engagement and interaction between international academic lecturers and students.

Regarding the research community, the programme is clearly positioned. The M.Sc. Corrosion Technologies programme is associated to a doctoral research programme. The associated laboratories are the Electrochemistry & Materials Science Research Unit, and the multidisciplinary Electrochemical Energy, Interfaces and Nanotechnology (EMINeNT) Research group. Lecturers have been rigorously selected from the different centre's partner departments on the basis of their CVs, publications, and expertise in the corrosion science. Research within the centre primarily focuses on corrosion control of metallic materials, including development of novel corrosion inhibitors derived from local biomass resources, as well as the creation of functional anticorrosion coatings like super hydrophobic coatings and self-healing coatings. These research endeavours strongly support the objectives of the programme.

The Centre engages with socio-economic partners by providing scientific and technical courses and training to professionals' levels of expertise. These interactions are facilitated through the ACE-FUELS Training and Skills Support Programme, which includes offerings such as Professional Corrosion Courses, Electrochemistry Short Courses, Corrosion Short Courses, and cathodic protection systems training. Additionally, for emerging leaders, the Centre operates ACE-FUELS Leadership Academy, which focuses on communication, team building, resource procurement, and fostering a culture of excellence. Moreover, the Centre also offers consultancy services through its recently accredited laboratory (e.g., the corrosion tribology unit). This accreditation has enabled the programme to establish valuable partnerships (National Petroleum Company, and Shell), and facilitates technology transfer. With the curriculum, students undertake internships ranging from one to six months at industrial partner facilities, and research projects typically involving partnerships or co-supervision with industrial partners.

In conclusion, the M.Sc. Corrosion Technology occupies a central position within the recently established ACE-FUELS, offering a high level and distinctive education in corrosion science within the West-African region. The curriculum integrates research-based training, non-scientific courses on innovation and entrepreneurship, as well as interdisciplinary sustainable development courses (such as Climate Change, Smart Grid Technology Overview, Renewable Energy Finance and Management, and Energy Analysis). The Master degree is associated with a Ph.D. programme in corrosion science and is an active participant in the West African Centre of Excellence network (WACEENET). While student outgoing and incoming mobility remains somewhat limited, there is potential for expanding partnerships with universities directly related to the programme to enhance mobility opportunities. The programme benefits from strong support from research activities in corrosion science at FUTO, as well as through participation in the panafrikan electrochemical network and monthly webinars featuring international academic lecturers. In addition, socio-economic partnerships facilitate student advancement and enhance the programme's recognition and visibility through industry experts' lectures, internships ranging from one to six months in industry partner facilities, professional corrosion modules, and corrosion consultancy services.

2 – Pedagogical organisation of the study programme

The M.Sc. Corrosion Technology programme is well-designed as full-time, 18-month curricula, consisting of three modules known to the students, which allows them to specialise and train in their field of interest. The academic session begins each year in October and ends in August of the following year, divided into two semesters. The academic calendar for each new semester is endorsed by the University Senate before the commencement of the preceding semester. Throughout the programme, students engage in 12 months of learning, instruction, and research conducted on campus. Upon completion, students are required to submit their thesis and undertake a mandatory internship lasting one to six months with one of the Centre's industrial partners. The programme entails a total of 50 compulsory credits.

The M.Sc. Corrosion technologies programme consists of three modules which include lectures, tutorials, seminars, hands-on sessions, and guest lectures by industry subject-matter experts:

- the mandatory module comprises five courses, amounting to a total of 15 credits units. This module covers the fundamental of corrosion, various protection methods, management of corrosion threats, including environmental, social and economic impact analysis, and corrosion specific to the energy sector, which is relevant for students' job-market integration;
- the module of specialisation (15 credit units) provides flexibility for students to focus on their field of interest. They must select three fundamental courses from a list of five in their area of specialisation: Anticorrosion coatings technology, Corrosion inhibition/inhibitors, Microbial induced corrosion, Cathodic protection, and Corrosion in reinforced concrete. Additionally, students can choose any three courses from a list of elective courses, allowing for interdisciplinary opening and connection between programmes. However, due to the specialised nature of the compulsory module in the first semester, students are unable to switch to another programme during their M.Sc.; they would need to begin a new programme from the start of the second year, which could be improved;
- the project module enables students to undertake and complete an in-depth individual research project involving experimental, theoretical, or computational studies in their area of interest. Students have access to the facilities of the Centre and partner departments to conduct their research. This module includes three seminar sessions: research proposal, progress report, and final report. At the beginning of the programme, each students is assigned two academic supervisors who are experts in the programme's area. These supervisors guide the student's work and progress throughout the study period to foster their success. If necessary, an industry-based supervisor may also be included. The 2023 list of thesis project includes topics such as biomass-based corrosion inhibitors for steel in concrete,

corrosion inhibitors for aluminium in metal-air batteries, and a deep learning-based model for predicting corrosion inhibition efficiency of small organic molecules;

- finally, after successful completion of the three modules, the final semester is devoted to the one-to-six-month-internship with an industrial partner. At the end of the internship, students undergo an oral examination of their thesis.

Apart from standard lectures, students can benefit from inverted teaching methods, monthly webinars series featuring international lecturers focusing on research-oriented topics, and webinars on innovation and entrepreneurship. In addition, students engage in the review of scientific articles relevant to each specific course. The programme started during the Covid-19 pandemic where all the lectures were given on-line. While lectures are now offered both in-person and online, the flexibility provided by online platform such as Olyx Learning Management platform allows students to access quality lesson contents anytime and anywhere, facilitating personalised learning and standardisation of materials. The platform also facilitates the administration of assessments and the monitoring and analysis of performance. The master programme is thus accessible both in class and through the various platforms. Moreover, the use of different online platforms as well as international (TEA-LP, Correct) and regional (WACEENET) knowledge networks provides students with valuable opportunities to learn or to be trained in the use of information and communication technologies.

Even though assistance is offered to international students, both in terms of language and material support, no specific preparation is provided for incoming and outgoing mobility, which could be an area for further development and enhancement. Instruction is conducted in English, with assistance available through the English Language Support Programme at the FUTO Language Laboratory. For Regional/International students for whom English is not their first language, the English Language Support Programme offers English language lessons, tutorials, and interactive sessions to improve academic English language skills. An orientation programme is organised during the first week for all newly admitted students, as part of the onboarding activities to acquaint them with the Centre resources and larger University community. The international office assists incoming regional students with visa and resident permit procedures, arranges insurance and flight/transportation, provides accommodation in University hostels, and ensures adequate recreational facilities.

Beside the Entrepreneurship course in the mandatory module, the programme offers expert industry seminars covering various topics such as entrepreneurship, manufacturing, development and policy, investment, and banking. In addition, students are directly involved in the socio-economic sector through the mandatory internship, which concludes the training and is conducted within industrial partner companies. Finally, the programme also offers an executive programme in the field of corrosion, offering different formats including short courses, specialised courses integrated into the curriculum, and specific training sessions designed for one week, coupled with a certification aimed at the professional sector, facilitating lifelong learning. These initiatives foster communication and the establishment of partnerships with socio-economic partners.

In conclusion, the programme offers a well-structured pedagogical organisation over 18 months (three semesters) consisting of three modules. The first module includes five compulsory disciplinary courses focusing on corrosion, with an emphasis on the energy sector, sustainability, and resource economics. The specialisation module provides flexibility, allowing students to choose three specialised courses out of a possible five, along with three elective courses from a pool of 18 multidisciplinary courses. The final module involves a six-month research project. Following the completion of these modules, the final semester is devoted to a one-to-six-month internship with one of the programme's industrial partners. The programme offers rigorous training through research, including mono-review and a six-month research project, with high standards for students who are expected to produce a publication by the end of the M.Sc. programme. All course materials and information are available on dedicated platforms, facilitating teaching both online and on-site, and offering greater flexibility, especially for students balancing work commitments. Finally, the programme maintains strong connections with the socio-economic world, offering specific modules certified for continuing professional training.

3 – Attractiveness, performance and relevance of the study programme

The programme uses various channels to disseminate information to attract students, including social media platforms, flyers, posters, and industry contacts. Even though it also monitors students' applications and showed willingness to improve students' enrolment, the number of students applying to the programme remains low (100 for the whole Centre's programmes per year), with seven enrolled students in 2020/2021, five in 2021/2022, and eight in 2022/2023. Physical outreach efforts, such as workshops in regional countries and involvement of regional students as ambassadors, are also used to promote the programme. Additionally, the programme participates in international consortia, such as the consortium for excellence in Canadian corrosion education, to enhance

its visibility and reach. Admission criteria and programme information are efficiently communicated through the programme's website, ensuring transparency and accessibility for prospective students. Non-discriminatory clauses are implemented, and support services, including full scholarships and accommodation for regional students, as well as English language support for students from French-speaking countries, are provided to promote diversity and inclusivity. However, some minor challenges remain, particularly regarding access to scholarships for Nigerian students, which could be improved to alleviate financial constraints that may hinder their success in the programme. Nonetheless, the programme holds full accreditation by the Nigerian National Universities Commission, further validating its quality and high credibility. Also, the programme has faced challenges in attracting women and students from countries other than Nigeria. Since 2020, only one foreign student has enrolled, from Liberia, which limits the value of some implemented measures, such as the involvement of regional ambassadors. However, the general-purpose laboratory built by the Centre, equipped with up-to-date equipment for corrosion studies, is a significant asset for the programme and it is unmatched in the region. This state-of-the-art facility is expected to attract more students to the programme.

The study programme monitors the students' success rates through a unique assessment protocol, which includes review exercises focused on research publications, tests, and quizzes. Students are expected to co-author and publish at least one article about their research work in a relevant peer-reviewed journal and perform literature review exercises. However, this requirement to publish in a peer-reviewed journal may slow down the graduation process, leading to a low number of graduated students (only two since 2020). Lecturers play a key role in guiding students through the assessment process. The programme uses this information, as along with lecture evaluation surveys filled out by students, to customise their teaching plans and engagement with students. However, the students' success rates are not publicly disclosed.

The programme has adopted the graduate tracer mechanism developed by the Association of African Universities (AAU) to monitor and track the progress of the graduates. Moreover, the programme has established partnerships with academic institutions at the national, regional and international levels, as well as with industrial partners and research laboratories. These partnerships benefit to graduate students by providing them practical experience, networking opportunities, research opportunities, and access to workshops and webinars. The programme is focused on accelerating the demonstration and deployment of new technologies, as well as translating research breakthroughs and technological innovations into industrial and commercial products and processes that engage students. Information about the programme's graduate students is publicly available on the Centre's website.

In conclusion, the programme raises its attractiveness through various information systems including virtual and physical ones. It is also part of the consortium for excellence in Canadian corrosion education, emphasising internationalisation, equity and interdisciplinarity. Despite efforts to attract regional students, such as offering them full scholarship, accommodation, and language support, the program struggles to enrol students from outside Nigeria, with only one non-Nigerian student enrolled since 2020. Moreover, the overall number of enrolled students remains low. Additionally, the lack of funding for living costs for Nigerian students presents a significant challenge. Student progress is evaluated through a unique assessment protocol, allowing for the adaptation of teaching plans and support measures. However, this data is not made public, unlike information about graduate students, which is available on the Centre website. The programme has adopted the graduate tracer mechanism developed by the AAU to monitor and track the progress of graduated students. Nevertheless, the requirement to publish in a peer-reviewed journal appears to slow down the graduation process, as evidenced by only two graduates since 2020.

4 – Academic programme management and continuous improvement

The teaching and administrative staff involved in the ACE-FUELS are carefully selected from relevant partner departments at FUTO University, possessing doctorate degrees and demonstrating strong research output. Their roles are clearly defined. Additionally, staff members are sourced from academic and sectoral partners. The leadership of the Centre, oversees global team management with monthly meetings. Other key roles within the Centre Management Team include a Monitoring & Evaluation Officer, Administrative Team Leader, Project Coordinator, Digital Content Coordinator Officer, Training and Education Coordinator, among others. These individuals are responsible for administration, budget planning, and monitoring. Planning and coordination of activities appear to be sufficient, supported by the 18 administrative personnel listed in the Handbook for students, who ensure the smooth running of the ACE-FUELS study programme. The teaching team comprises professors, readers, senior lecturers, lecturers, and sectoral partners which roles, each with clearly defined roles. They are highly involved in their teaching mission, student mentorship, and research supervision.

The programme benefits from sufficient resources in terms of personnel and facilities. In particular, the adequate staffing levels ensure efficient programme management. In addition to offering top-rate teaching, learning, and research facilities, the ACE-FUELS Centre ensures that students have access to adequate and comfortable

workspace and accommodation in University Hostels. Additionally, the Centre provides sufficient recreational facilities for the students' well-being. The WACEENET network organises regular workshops and provides grants for staff and students outgoing mobility opportunities (Togo, Ghana).

The continuous improvement process of the programme is well implemented, through courses assessment by the students and monthly meetings driven by the Centre Management Team. These meetings have been established to discuss programmes and development strategies aimed at improving the study programme and monitoring progress toward achieving the desired outcomes. Every course within the programme undergo formal assessment by the students. Students have the opportunity to engage with their lecturers and the training coordinator to address any questions or concerns that they may have regarding the lectures. Furthermore, the students are required to complete an online anonymous questionnaire twice a year, which covers various aspects of the course modules and programmes. The results of these evaluations are discussed during these meetings and are used to inform improvements to the programme curriculum. While students are not directly involved in these meetings, they have access to the programme evaluation, information about programme contributors, and their respective statuses.

The various quality-and-ethics measures implemented for students or academics are transparent and accessible to the audience: the procedures and benefits of continuous assessment are well-described in the M.Sc. Corrosion Technology Handbook. The curriculum is implemented through a pedagogical approach that emphasizes alignment in terms of knowledge and skills. Admission to the programme is highly selective. Prospective students must hold a second class honours degree in a relevant science or engineering discipline from a Nigerian university, or an equivalent qualification from a foreign university. Once this requirement is met, applicants undergo computer-based aptitude tests and interviews, which can be conducted face-to-face or online. During these assessments, candidates are evaluated on criteria such as excellence in research, motivation, ability to take initiative and work independently, communication skills, and enthusiasm. Candidates who score at least 60% of the total points are admitted to the programme. The use of a dedicated website with several downloadable documents, including the Handbook for M.Sc. Corrosion technology, ensures that students and other stakeholders are well-informed about the program's objectives regarding the acquisition of knowledge and skills. Throughout the 18-months M.Sc. programme, research integrity and ethics are addressed through courses such as Research Methods & Innovation, mono-reviews and webinar exposure (Springer), and the research project module, which includes training on lab safety and research ethics. Moreover, students have access to a Handbook containing rules and regulation. Research-based learning and courses on research methods utilise on-line library services to facilitate access to resources. The programme has defined and implemented anti-plagiarism and anti-fraud measures using software such as Turnitin.

In conclusion, the programme benefits from outstanding leadership provided by the Centre's management team, which coordinates the four programmes of ACE-FUELS with a specific coordinator for each programme. The dedicated team oversees the administration, budget monitoring, planning, and coordinating of activities, ensuring the effective functioning of the programme. The teaching team, comprised of experts from partner departments, delivers high-quality instruction and mentorship to students. Effective communication among the various teams facilitates smooth operations and continuous improvement of the program. Student feedback is collected and evaluated twice a year, leading to actionable measures for programme improvement. The rigorous selection process ensures that students admitted to the programme are highly qualified and motivated. During courses, student performance is assessed conventionally through exercises and quizzes, and 20% of the mark for each compulsory course comes from a review of a research publication in the specific area of the course.

VI. CONCLUSION

Funded by the World Bank and the French Development Agency, ACE-FUELS was established in 2019. The Centre's management team plays a pivotal role in ensuring the effective functioning of the Corrosion Technology programme, overseeing administration, financial monitoring, and coordination of activities. Each programme within the Centre (four in total) is supported by a dedicated coordinator, facilitating streamlined operations. The teaching team, carefully selected from partner departments based on the excellence in teaching and research, contributes to the high-quality of instruction. Effective communication among the teams fosters collaboration and improves programme efficiency.

The M.Sc. Corrosion Technologies programme offers a unique curriculum in Corrosion Science in the Sub-Saharan region. With a meticulously structured curriculum spanning 18 months across three semesters, the programme provides a comprehensive educational experience.

The programme offers solid training through research, including a mono review and a six-month research project. While these requirements enhance the educational value of the programme, they can also extend the graduation timeline. Additionally, students are expected to produce a publication by the end of the master's programme. A doctoral programme in Corrosion Science served as a continuation of the Master's programme. The programme promotes an international and multicultural learning environment through multidisciplinary webinars featuring international researchers, as well as seminars and courses facilitated by international networks such as WACEENET and TEA-LP. All information and course materials are available through dedicated platforms, enabling students to access resources conveniently both online and in person. This accessibility enhances flexibility, particularly for students balancing studies with other commitments, such as work. However, the lack of funding for living costs poses a challenge for Nigerian students, particularly those enrolled in the full-time programme. During the modules, student performance is assessed with a conventional method using exercises and quizzes. 20% of the mark for each compulsory course comes from the review (mono review) of a research publication in the specific field of the course.

The programme has established strong connections with partners in the socio-economic sector, fostering valuable collaborations and opportunities for students. These partnerships involve organising conferences with industrial experts, collaborating on student supervision, facilitating one-to-six-month internships at industrial partner facilities, offering modules certified for professional training, fostering expert relations through a consulting firm initiated by the Centre, and obtaining accreditation for their laboratories. Additionally, the curriculum includes training in non-scientific areas such as innovation and entrepreneurship, along with interdisciplinary courses addressing sustainable development topics like climate change, smart grid technology, renewable energies financing and management, and energy analysis. The programme undergoes biannual evaluations by students, with feedback discussed at meetings of the Board of Studies and the Centre's management to implement continuous improvements. The programme emphasises a rigorous selection process for students. To enhance its appeal, it should leverage various information channels, including virtual and physical platforms, and reinforce or establish new MoUs with international partner universities in the relevant field. The programme actively participates in regional and international networks such as the AAU, WACEENET, the Pan-African Electrochemistry Networks, and the Consortium for Excellence in Canadian Corrosion Education. Despite offering full scholarships, the accommodation, living costs, and language support to regional students, the programme struggles to attract them, with only one non-Nigerian student enrolled since 2020, resulting in a low overall enrolment.

Strengths

- The highly structured curriculum, with unique expertise in the region in Corrosion Technologies, aligning with the country's and the region's needs for infrastructure development and natural resource valorisation
- The highly qualified and dedicated staff at all levels, from management (ACE-FUELS) to teaching and research, with effective quality assurance processes continuously assessing and measuring the success of students, the programme, and its improvement
- The leading laboratory backing the programme, enabling cutting-edge training, fostering research, and accrediting programme expertise for industry
- The strong interactions with socio-economic partners through internships, student co-supervision, industry-oriented conferences, and modules dedicated to lifelong professional training
- The multidisciplinary environment that students are exposed to, including monthly webinars featuring researchers from around the world presenting their work in areas relevant to the Centre's focus

Weaknesses

- The quite low number of students per year, and therefore the overall attractiveness of the programme
- The limited outgoing mobility
- The absence of a students' representative in the different boards
- The high workload for the students, e.g., an article published at the end of the M.Sc., which may delay the student's graduation
- The sustainability of the programme funding

Recommendations

- Encourage applications to several of the Centre's programmes with an order of priority, to distribute applications more evenly across the Centre and make up for the lack of visibility of the Corrosion technology programme. To improve the attractiveness of the programme on a national and regional scale, multiply the use of communication channels and mobilise networks of academic and socio-economic partners.
- Strengthen the pan African research network, the ACE collaboration network (WACEENET) in the specific field of the programme, form new University partnerships to memorandums of understanding locally and abroad, to promote student exchanges for training and research.
- Invite student representatives to participate in decision-making processes in the programme through an elective process to the Centre board, so they can express their perspectives on issues related to organisation, curriculum, conference content, and appeal of the programme.
- Even if the programme's high level of expectation is rather constructive, notably with a mandatory *published* article before graduation, the requirement could be limited to an article *submitted* to the outcome of the Master's programme, in order to shorten the graduation period.
- Pursue the ambition to become a key player in the region for training and expertise on corrosion technology, including industrial infrastructure corrosion and their protection; continue to develop strategic industrial partnership with oil and gas companies, professional training, and development of the Consulting Company associated to the Centre to obtain funding support and visibility.

VII. COMMENTS OF THE INSTITUTION



May 30, 2024

Federal University of Technology Owerri

Office of the Deputy Vice Chancellor
Research, Development & Innovation

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Olivier Boutin
President,
International Evaluation and Accreditation Committee,
Higher Education Evaluation Research (HCERES)

HCÉRES EVALUATION FOLLOW UP REPORT FOR ACE-FUELS MSc PROGRAMME in CORROSION TECHNOLOGY

I write to acknowledge the evaluation report for the MSc Corrosion Technology Programme.

This Follow-up Report is submitted to the Higher Education Evaluation Research (HCÉRES) for the purpose of determining the resolution of recommendations identified during the January 2024 site visit.

I certify that there was broad participation and review by the Centre Management and university community and believe this report accurately reflects the nature and substance of the University and the ACE-FUELS MSc programme in Corrosion Technology.

Please accept the assurances of my highest regards.



Prof. Emeka Oguzie
Deputy Vice-Chancellor
(Research, Development & Innovation)
*Centre Leader, Africa Centre of Excellence in Future Energies
and Electrochemical Systems (ACE-FUELS)*



Vice Chancellor: Prof. Nnenna N. Oti, B. Agric, MSc (Nigeria), PGD (Belgium), PhD (FUTO)

PREAMBLE

The Africa Centre of Excellence in Future Energies and Electrochemical Systems (ACE-FUELS) at the Federal University of Technology Owerri has mandated the Higher Education Evaluation Research (HCÉRES) to perform the evaluation of its Corrosion Technology M.Sc. programme, submitted a Self-Evaluation Report in December 2023 and received a visit from HCÉRES external evaluation team on January 16, 2024. The evaluation team submitted their report in May 2024, that detailed five recommendations as follows:

1. Encourage applications to several of the Centre's programmes with an order of priority, to distribute applications more evenly across the Centre and make up for the lack of visibility of the Corrosion technology programme. To improve the attractiveness of the programme on a national and regional scale, multiply the use of communication channels and mobilise networks of academic and socio-economic partners.
2. Strengthen the pan African research network, the ACE collaboration network (WACEENET) in the specific field of the programme, form new University partnerships to memorandums of understanding locally and abroad, to promote student exchanges for training and research.
3. Invite student representatives to participate in decision-making processes in the programme through an elective process to the Centre board, so they can express their perspectives on issues related to organisation, curriculum, conference content, and appeal of the programme.
4. Even if the programme's high level of expectation is rather constructive, notably with a mandatory *published* article before graduation, the requirement could be limited to an article *submitted* to the outcome of the Master's programme, in order to shorten the graduation period.
5. Pursue the ambition to become a key player in the region for training and expertise on corrosion technology, including industrial infrastructure corrosion and their protection; continue to develop strategic industrial partnership with oil and gas companies, professional training, and development of the Consulting Company associated to the Centre to obtain funding support and visibility.

Response to Recommendation 1

Encourage applications to several of the Centre's programmes with an order of priority, to distribute applications more evenly across the Centre and make up for the lack of visibility of the Corrosion technology programme. To improve the attractiveness of the programme on a national and regional scale, multiply the use of communication channels and mobilise networks of academic and socio-economic partners.

ACE-FUELS has taken action to increase visibility and presence in various social networks, participation in relevant scientific forums and congresses, as well as championing its own initiatives, to create awareness across sectors.

The Centre has since maintained active presence on social media, highlighting its activities and engagements to broad audiences.

Facebook (Meta): <https://www.facebook.com/acefuelsfutonig?mibextid=r540aB75gUcbxw6v>

LinkedIn: https://www.linkedin.com/in/ace-fuels-futo-5ab55918a?utm_source=share&utm_campaign=share_via&utm_content=profile&utm_medium=android_app

Instagram: <https://www.instagram.com/acefuelsfuto?igsh=ajNncjhybnBpZnhk>

PARTICIPATION IN FORUMS AND CONGRESSES

ACE-FUELS has also participated in the following forums/congresses, which provided opportunities for networking and engagement:

- Africa Centres of Excellence International Partnerships Workshop with EU in Mauritius (8th – 10th May 2024)
- Alliance for Renewable Energy (ARE) Energy Access Investment Forum (EAIF) 2024 in Lagos, Nigeria (May 21-23, 2024)

ACTIVITIES:

- ACE-FUELS virtual open day on February 17, 2024, to showcase the Centre's programmes and facilities to potential students. (<https://acefuels-futo.org/ace-fuels-open-day/>)
- ACE-FUELS Greenovation Dialogue Series on 27th March 2024, with a public lecture on "Climate-smart innovations towards green economic development in Sub-Saharan Africa" by Prof. Solomon Agbo (Forschungszentrum Jülich) <https://acefuels-futo.org/ace-fuels-greenovation-dialogue-series/>
- ACE-FUELS Innovation Series Webinar on May 2, 2024, on "The challenges of scale for printable perovskite solar cells" by Prof. Trystan Watson (Swansea University, UK) <https://acefuels-futo.org/acefuels-innovation-series/>

The Centre has established the International Network of Research Scholars and Trainees (INReST, <https://acefuels-futo.org/inrest/>), a student-run platform to formally network and form lasting relationships that will engender excellent scholarship and academic development even beyond their stay as graduate students or research trainees.

Response to Recommendation 2

Strengthen the pan African research network, the ACE collaboration network (WACEENET) in the specific field of the programme, form new University partnerships to memorandums of understanding locally and abroad, to promote student exchanges for training and research.

- Africa Centres of Excellence International Partnerships Workshop with EU in Mauritius (8th – 10th May 2024) extended collaborations with ACE Centres in East and Southern Africa, as well as with EU institutions. In this regard, the spread and capacity of WACEENET has deepened considerably, opening up more collaboration opportunities.
- Centre's participation in the Transforming Energy Access (TEA) Forum in Kigali (March 13-14, 2024) led to the establishment of collaboration with Sustainable Product Engineering Centre for Innovative Functional Industrial Coatings, Swansea University, UK, on a project to develop Next Generation PV Manufacturing in Africa. Our joint proposal on this topic to UKRI for Ayrton Funds has scaled the first stage and incorporates sufficient opportunities for outgoing mobility.
- ACE-FUELS is collaborating with the Carbon to Metal Coating Institute (C2MCI, <https://www.carbon-2-metal-institute.queensu.ca/>) at Queens University Kingston, Ontario. This collaboration resulted in establishment of the C2MCI Africa Research Network, with provides opportunities for research grants and international mobility.
- He Centre is a pioneer member of the CoRmentor programme (<https://www.uwo.ca/sci/cormentor/labs/index.html>) of Western University Ontario. CORmentor program is to support corrosion students, early career professionals and established professionals, collectively referred to as corrosionists, embarking on a major career change.
- The Centre has established relationships with the Alliance for Renewable Energy, Chinese Academy of Sciences, Forschungszentrum Jülich towards promoting international outgoing mobility for students and faculty.
- The Centre is currently expanding its network of international and regional collaborators in industry and academia.

Response to Recommendation 3

Invite student representatives to participate in decision-making processes in the programme through an elective process to the Centre board, so they can express their perspectives on issues related to organisation, curriculum, conference content, and appeal of the programme.

The Centre has organized open elections amongst the students to elect a student representative, in the person of Mr. John Anyanwu. He is to interface with Centre Management and present students concerns to management.

International Network of Research Scholars and Trainees (INReST, <https://acefuels-futo.org/inrest/>), also provides an organized rallying point for students, with several benefits:

- i. Create a strong network and bond among the research students.
- ii. Assist the Centre in proper on-boarding of newly admitted students and scholars while also helping to share the Centre's activities within the wider student population outside of ACE-FUELS.
- iii. Enhance research and academic mentoring through interactions between current and new students as well as the past students (alumni)
- iv. Organising academic conferences or workshop, seminars, webinars etc in collaboration with ACE-FUELS and other institutions.
- v. Helps to share best practices and knowledge among student scholars themselves for example, organizing academic tutorials or mentoring sessions within the student body (e.g. Research papers writing, statistical and data analysis, material studio BIOVIA suite usage for molecular modelling etc).
- vi. Helps to strengthen the relationship between the scholars and the research scientists or faculty in the Centre
- vii. Helps the students and scholars to work and share together opportunities like funding and grants, scholarships, student exchange programs etc.
- viii. Information dissemination from Centre's academic and administrative staff to students or trainees can be done seamlessly via the association or its officers.
- ix. To create a smooth transition between ACE-FUELS studentship status to alumni status.

Response to Recommendation 4

Even if the programme's high level of expectation is rather constructive, notably with a mandatory published article before graduation, the requirement could be limited to an article submitted to the outcome of the Master's programme, in order to shorten the graduation period.

The publication requirement for graduation is a University Senate decision. Nonetheless, Centre is committed to encourage and mentor students to publish mini review articles at the early stages of their project module and will accept this as graduation requirement.

Response to Recommendation 5

Pursue the ambition to become a key player in the region for training and expertise on corrosion technology, including industrial infrastructure corrosion and their protection; continue to develop strategic industrial partnership with oil and gas companies, professional training, and development of the Consulting Company associated to the Centre to obtain funding support and visibility.

- The Centre is deepening its relationship with the Nigerian Content Development and Monitoring Board (NCDMB), a key regulator in the Nigerian oil and gas sector, to gain access to the key players in the oil and gas industry.
- Initial collaboration of the Centre's Corrosion Scientists with the NCDMB facilitated the establishment of the Centre of Excellence in Local Materials Substitutions, with a dedicated research programme in corrosion protection, serviced by ACE-FUELS.



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ACCREDITATION DECISION

M.Sc. Corrosion Technology

Africa Centre of Excellence in Future Energies
and Electrochemical Systems (ACE-FUELS)

Federal University of Technology Owerri (FUTO)

Owerri, Nigeria

June 2024

SCOPE OF THE ACCREDITATION GRANTED BY HCÉRES

HCÉRES has based its evaluation process on a set of objectives that study programmes must pursue to ensure recognised quality within France and Europe. These objectives are divided up into four accreditation criteria.

The Accreditation Commission issues an opinion about the accreditation of the study programme after examining the file. The Hcéres President takes the decision based on the Commission's opinion and the final evaluation report of the programme. This accreditation decision, taken in plenary session, is the result of a collegial and reasoned process.

The decision issued by Hcéres regarding the accreditation of the study programme corresponds to the awarding of a label to the evaluated entity.

This decision is independent of the accreditations carried out by the French State and therefore does not entail recognition in France of the institution or the diplomas delivered by it.

Decision No. EI-2024-36 on the accreditation of the M.Sc. Corrosion Technology, delivered by the Federal University of Technology, Owerri, Nigeria

The President of the High Council for the Evaluation of Research and Higher Education,

Considering the Research Code, in particular Articles L. 114-3-1 to L. 114-3-6;

Considering the Board's deliberation of 29th September 2022 on the accreditation criteria for courses abroad (excluding doctoral/PhD programmes);

Considering the Decision No. 2023-9 of 16th March 2023 on the international accreditation procedure of the High Council for the Evaluation of Research and Higher Education;

Considering the agreement DEI_2023_CONV17 of 14th June 2023 for the evaluation/accreditation of fourteen training courses, delivered by six Centres of Excellence in Nigeria;

Considering the opinion issued by the Accreditation Commission on 18th June 2024;

Decides:

Article 1

Noting that the M.Sc. Corrosion Technology delivered by the Federal University of Technology, Owerri, in Nigeria meets the four accreditation criteria, voted by the Board of the High Council on 29th September 2022, as follows:

ACCREDITATION CRITERION 1: TRAINING POLICY AND CHARACTERISATION

The M.Sc. Corrosion Technology occupies a central position within the recently established ACE-FUELS, offering a high level and distinctive education in corrosion science within the West-African region. The curriculum integrates research-based training, non-scientific courses on innovation and entrepreneurship, as well as interdisciplinary sustainable development courses (such as Climate Change, Smart Grid Technology Overview, Renewable Energy Finance and Management, and Energy Analysis). The Master is associated with a Ph.D. programme in corrosion science and is an active participant in the of the West African Centre of Excellence network (WACEENET). While student outgoing and incoming mobility remains somewhat limited, there is potential for expanding partnerships with universities directly related to the programme to enhance mobility opportunities. The programme benefits from strong support from research activities in corrosion science at FUTO, as well as through participation in the panafrikan electrochemical network and monthly webinars featuring international academic lecturers. In addition, socio-economic partnerships facilitate student advancement and enhance the programme's recognition and visibility through industry experts' lectures, internships ranging from one to six months in industry partner facilities, professional corrosion modules, and corrosion consultancy services.

ACCREDITATION CRITERION 2: THE PEDAGOGICAL ORGANISATION OF THE STUDY PROGRAMME

The programme offers a well-structured pedagogical organisation over 18 months (three semesters) consisting of three modules. The first module includes five compulsory disciplinary courses focusing on corrosion, with an emphasis on the energy sector, sustainability, and resource economics. The specialisation module provides flexibility, allowing students to choose three specialised courses out of a possible five, along with three elective courses from a pool of 18 multidisciplinary courses. The final module involves a six-month research project. Following the completion of these modules, the final semester is devoted to a one-to-six-month internship with one of the programme's industrial partners. The programme offers rigorous training through research, including mono-review and a six-month research project, with high standards for students who are expected to produce a publication by the end of the M.Sc. programme. All course materials and information are available on dedicated platforms, facilitating teaching both online and on-site, and offering greater flexibility, especially for students balancing work commitments. Finally, the programme maintains strong connections with the socio-economic world, offering specific modules certified for continuing professional training.

ACCREDITATION CRITERION 3: ATTRACTIVENESS, PERFORMANCE AND RELEVANCE OF THE STUDY PROGRAMME

The programme raises its attractiveness through various information systems including virtual and physical ones. It is also part of the consortium for excellence in Canadian corrosion education, emphasising internationalisation, equity and interdisciplinarity. Despite efforts to attract regional students, such as offering them full scholarship, accommodation, and language support, the program struggles to enrol students from outside Nigeria, with only one non-Nigerian student enrolled since 2020. Moreover, the overall number of enrolled students remains low. Additionally, the lack of funding for living costs for Nigerian students presents a significant challenge. Student progress is evaluated through a unique assessment protocol, allowing for the adaptation of teaching plans and support measures. However, this data is not made public, unlike information about graduate students, which is available on the Centre website. The programme has adopted the graduate tracer mechanism developed by the AAU to monitor and track the progress of graduated students. Nevertheless, the requirement to publish in a peer-reviewed journal appears to slow down the graduation process, as evidenced by only two graduates since 2020.

ACCREDITATION CRITERION 4: MANAGEMENT AND CONTINUOUS IMPROVEMENT OF THE ACADEMIC PROGRAMME

The programme benefits from outstanding leadership provided by the Centre's management team, which coordinates the four programmes of ACE-FUELS with a specific coordinator for each programme. The dedicated team oversees the administration, budget monitoring, planning, and coordinating of activities, ensuring the effective functioning of the programme. The teaching team, comprised of experts from partner departments, delivers high-quality instruction and mentorship to students. Effective communication among the various teams facilitates smooth operations and continuous improvement of the program. Student feedback is collected and evaluated twice a year, leading to actionable measures for programme improvement. The rigorous selection process ensures that students admitted to the programme are highly qualified and motivated. During courses, student performance is assessed conventionally through exercises and quizzes, and 20% of the mark for each compulsory course comes from a review of a research publication in the specific area of the course.

Article 2

The M.Sc. Corrosion Technology delivered by the Federal University of Technology, Owerri, in Nigeria, is accredited for a period of five years from the date of this decision.

Article 3

The decision is accompanied by the following recommendations and comments:

- Encourage applications to several of the Centre's programmes with an order of priority, to distribute applications more evenly across the Centre and make up for the lack of visibility of the Corrosion technology programme. To improve the attractiveness of the programme on a national and regional scale, multiply the use of communication channels and mobilise networks of academic and socio-economic partners.
- Strengthen the pan African research network, the ACE collaboration network (WACEENET) in the specific field of the programme, form new University partnerships to memorandums of understanding locally and abroad, to promote student exchanges for training and research.
- Invite student representatives to participate in decision-making processes in the programme through an elective process to the Centre's board, so they can express their perspectives on issues related to organisation, curriculum, conference content, and appeal of the programme.
- Even if the programme's high level of expectation is rather constructive, notably with a mandatory *published* article before graduation, the requirement could be limited to an article *submitted* to the outcome of the Master's programme, in order to shorten the graduation period and to ensure the quality of the journals in which these papers are published.
- Pursue the ambition to become a key player in the region for training and expertise on corrosion technology, including industrial infrastructure corrosion and their protection; continue to develop strategic industrial partnership with oil and gas companies, professional training, and development of the Consulting Company associated to the Centre to obtain funding support and visibility.



Article 4

This decision will be published on the Hcéres website.

Paris, 27th June 2024.

The acting President

signed

Stéphane Le Bouler



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