Krystian Olek, Grzegorz Krzos

ICT Skills for the Success in African Green Energy Sector

Publishing House of Wroclaw University of Economics and Business

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1 Introduction

In the era of the digitalization and intensive development of IT/ICT technologies, IT/ICT skills are an integral element of the construction, development, and effective operation in the renewable energy sector. The development of technology, the creation of innovations in the industry, and the improvement of competencies are based on knowledge and skills in using IT tools. Therefore, this manual addresses the educational and business sectors in the area of green energy in Africa, which will allow one to acquire basic IT/ICT knowledge applicable to the current stage of the sector's existence. This knowledge can be used, among others, for issues such as:

- monitoring and optimization of efficiency: the development of software and IT systems allows for monitoring the efficiency of renewable energy systems. Thanks to data collected and analysed using appropriate tools, one can optimize installation performance, predict changes, and respond to them faster and more effectively;
- process automation: IT systems allow for the automation of processes in the renewable energy sector. This speeds up and facilitates the management of energy sources, helps to respond more quickly to changes in external conditions, and optimizes energy consumption;
- failure diagnosis and maintenance management: thanks to developed IT systems, one can quickly detect failures or problems in renewable energy systems. Such solutions make it easier to diagnose problems and manage maintenance and repair schedules;
- management of energy networks: IT systems allow the creation of intelligent energy networks for better control over energy flow, balancing the network load, and optimizing the distribution of electricity;
- forecasting and planning: advanced IT tools allow to analyse historical data and predict trends in the renewable energy sector. Thus, one can forecast energy demand, plan the development of installations, and develop more effective management strategies;
- effective communication and data analysis: IT systems enable better communication between various types of devices in energy networks and allow for the collection and analysis of data. This is crucial for making good business and operational decisions;
- technological development: the renewable energy sector is constantly evolving. IT competencies are therefore necessary to track new technologies, implement innovations, and integrate new solutions with existing systems.

2 Low-Code and No-Code as Simple Tools for Programming and Designing Mobile Apps in the Green Energy Sector

2.1. Low-Code Platforms and Their Characteristics

Low-code has revolutionised programming by enabling the creation of applications without complex coding. This innovative approach simplifies software development using intuitive tools and graphical interfaces instead of traditional script or code writing.

The critical strength of low-code lies in streamlining the application development process. Individuals without programming expertise can quickly create functional applications with user-friendly platforms and tools. The visual interfaces of low-code allow for easy dragging and dropping of elements, making it significantly faster than traditional development methods.

The significant advantage of low-code is that it eliminates the need for in-depth knowledge of complex programming languages. People from different fields, not necessarily IT-related, can effectively create applications, making it an attractive solution for businesses. This results in significant time and resource savings, as low-code enables the faster implementation of new business solutions and applications whilst reducing the costs associated with hiring highly skilled programmers.

It is important to note that low-code is not limited to simple applications. It is evolving rapidly and supports creating powerful applications with advanced features and integrations with various systems. This makes it a promising tool not only for beginners but also for experienced programmers.

Low-code technology in the green energy sector offers tremendous opportunities for innovation and sustainability. With the growing demand for renewable energy solutions and the need for efficient management systems, low-code provides a powerful tool for developing applications tailored to the industry's specific needs.

Low-code's ability to simplify the app development process is particularly advantageous in the green energy sector, where there is a constant need for the rapid deployment of software solutions. With easy-to-use platforms and drag-and-drop interfaces, even non-technical professionals can quickly create applications that optimize energy usage, monitor renewable energy systems, and track carbon emissions.

One of the significant benefits of low-code in the green energy sector is its potential for enabling energy management and analytics. With intuitive tools and graphical interfaces, companies can quickly develop applications that collect, analyse, and visualize real-time data from renewable energy sources, such as solar panels and wind turbines. This empowers businesses to make data--driven decisions for optimizing energy efficiency and reducing their environmental footprint.

Furthermore, the versatility of low-code allows for integrating different systems and technologies within the green energy sector. Developers can create applications that seamlessly connect energy generation equipment, smart grids, and energy storage systems, facilitating efficient energy flow and management. This integration capability is crucial for leveraging renewable energy sources effectively and maximizing their potential.

Additionally, the cost-saving aspect of low-code is precious for companies operating in the green energy sector. Organizations can allocate their resources more effectively by reducing the need for highly skilled programmers, investing in research and development or expanding their renewable energy infrastructure. This can ultimately accelerate the transition to a more sustainable and cleaner energy future.

As low-code technology continues to evolve, its potential for supporting and advancing the green energy sector is promising. From developing applications that facilitate remote monitoring of renewable energy systems, to creating sophisticated energy management platforms, low--code empowers businesses to actively combat climate change and achieve a greener and more sustainable future.

2.1.1. Mendix

The Mendix low-code platform presents a valuable solution for application development in the African green energy sector. With its ability to create applications without complex coding, Mendix offers significant advantages in this fast-paced industry.

Using the Mendix Model-Driven Development approach, stakeholders in the African green energy sector can visually design customized app models to meet their specific requirements. This flexibility enables the development of tailor-made applications for various purposes, including renewable energy projects, grid management systems, energy efficiency monitoring tools, and consumer-facing applications that promote sustainable practices.

The Mendix platform serves large enterprise organizations and individual developers operating in the African green energy space. Major companies like Philips, KLM, and L'Oréal have successfully utilized the platform to optimize operations, enhance energy management, and drive sustainable initiatives.

For individual developers or smaller entities in the African green energy landscape, Mendix provides an opportunity to create personalized applications, ranging from energy-tracking tools for households and small businesses to innovative solutions for managing renewable energy projects.

Furthermore, Mendix is committed to keeping pace with technological advancements through continuous updates and enhancements. The recent release of Mendix 8, which introduced improved user interfaces, enhanced performance, and support for cloud-native deployment, signifies the platform's dedication to meeting the evolving needs of the African green energy sector. This ensures that developers and organizations have access to cutting-edge tools that enable sustainable innovation and efficiency.

The Mendix low-code platform is a valuable ally as the African green energy sector grows. By simplifying application development and providing a range of capabilities, it empowers

stakeholders to drive sustainable development, optimize energy usage, and create a greener future for the continent.

To log in to the platform, go to **www.mendix.com.** One can verify basic functionalities free of charge for a limited time. The home page of the platform is in Figure 1.

Figure 1. Mendix platform home page

Source: (Mendix, n.d.).

To confirm the program's usefulness in the renewable energy sector, selected sectors of the program application are presented in Figure 2.

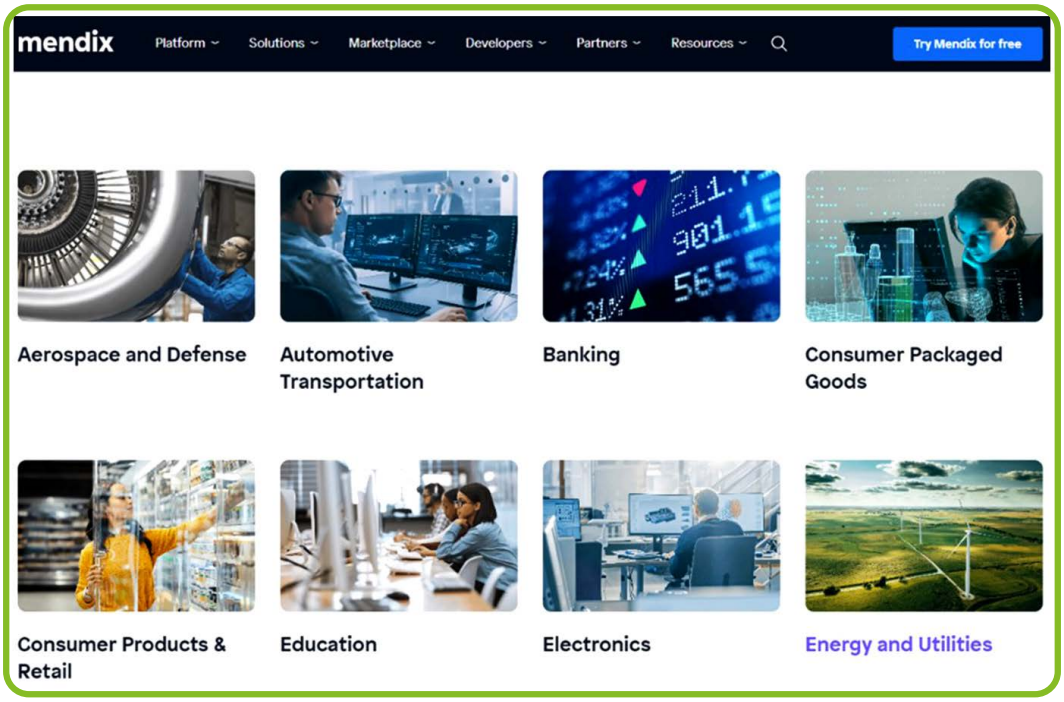

Figure 2. Functionalities of Mendix

Source: (Mendix, n.d.).

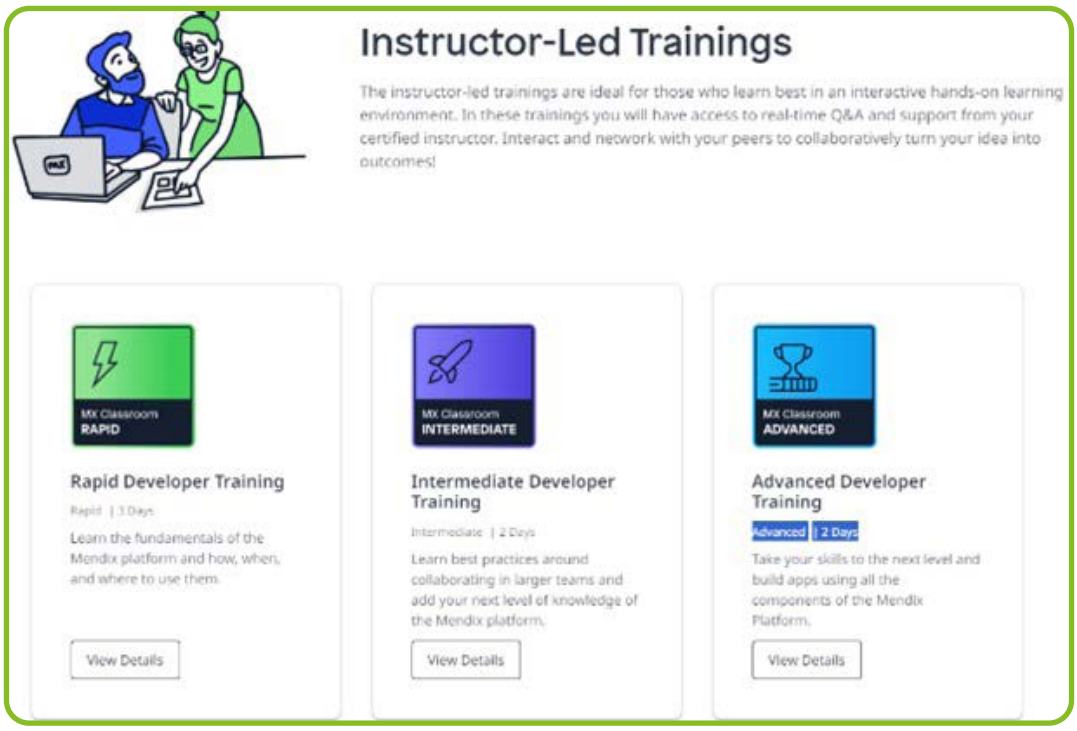

Figure 3. Mendix tutorial

Source: (Mendix, n.d.).

Mendix is a handy tool that allows a person without previous contact with programming to become familiar with the subject and its basic concepts, therefore a dictionary of basic terms related to low coding was created, which explains the fundamental issues of building programs. Additionally, one can take advantage of paid training introducing those without previous experience to MENDIX programming (see Figure 3).

2.1.2. OutSystems

OutSystems, a low-code software development platform, offers a range of powerful features that empower development teams in the green energy technology sector to create and deploy software applications quickly.

The platform's visual development environment sets it apart, providing an intuitive interface that simplifies the software creation process. Through a drag-and-drop approach, developers of all expertise can efficiently build applications whilst reducing the likelihood of errors and bugs. This visual interface boosts coding productivity, minimizes learning curves, and ensures greater accuracy, ultimately speeding up application development.

OutSystems also offers a vast library of pre-designed components and templates, known as built--in templates, which reduces the need for custom code by providing a comprehensive repository of user interface elements, integrations, and coding logic. By leveraging these pre-designed resources, developers can accelerate the development process and deliver software faster.

Furthermore, OutSystems facilitates seamless integrations with external data sources, enterprise systems, and APIs, providing a robust platform for developing integrated applications. Using

connectors and tools provided by OutSystems, programmers can effortlessly integrate their applications with existing infrastructures, saving valuable time and resources.

Recognizing the importance of Agile methodologies in software development, OutSystems offers features specifically designed to support Agile teams. This includes version control, collaborative tools, and automated testing capabilities, promoting improved communication, collaboration, and alignment among team members. Additionally, the platform supports continuous integration and delivery, allowing DevOps teams to implement faster iterations and shorter release cycles.

OutSystems also excels in mobile development, providing the ability to create native mobile apps for both Android and iOS platforms. With support for responsive design elements, offline data synchronization, and device-specific features, the platform simplifies the process of developing mobile applications. Developers can also reuse code across multiple platforms, reducing development time and enhancing code reusability and maintainability.

Lastly, OutSystems ensures scalability and high performance by generating optimized code and managing the underlying infrastructure of applications. This capability allows applications developed in OutSystems to handle increased loads without compromising performance. As the user base expands in the green energy sector, OutSystems enables a consistent user experience and ensures that applications can scale accordingly.

With its comprehensive range of features, OutSystems is an invaluable tool for the green energy technology sector, empowering development teams to create innovative software applications that drive sustainable solutions rapidly.

Moreover, one of the standout features of the OutSystems platform is its comprehensive security, compliance, and governance capabilities, which significantly differentiates it from other low--code providers. OutSystems employs a security-by-design approach, incorporating 250 unique security checks, some enhanced by artificial intelligence technology – this ensures the security of applications at every stage of the development-to-production journey. Notably, OutSystems allows for implementing enterprise static application security testing (SAST) solutions, further bolstering confidence in the platform's security measures.

In addition to its robust security features, OutSystems offers an advanced governance model designed specifically for enterprise software factories. This governance model provides a framework for maintaining compliance with various security certifications, including SOC2, HIPAA, and others. By adhering to these compliance standards, OutSystems assures users that applications built on its platform meet industry regulations and requirements.

With its focus on security, compliance, and governance, OutSystems ensures that organizations can confidently develop and deploy applications. The platform's comprehensive security checks, integration with enterprise SAST solutions, and adherence to compliance certifications make it a reliable and trustworthy choice for businesses needing robust security measures.

To register for the platform, go to the website **www.outsystems.com** and click the Start Free icon on the home page (see Figure 4).

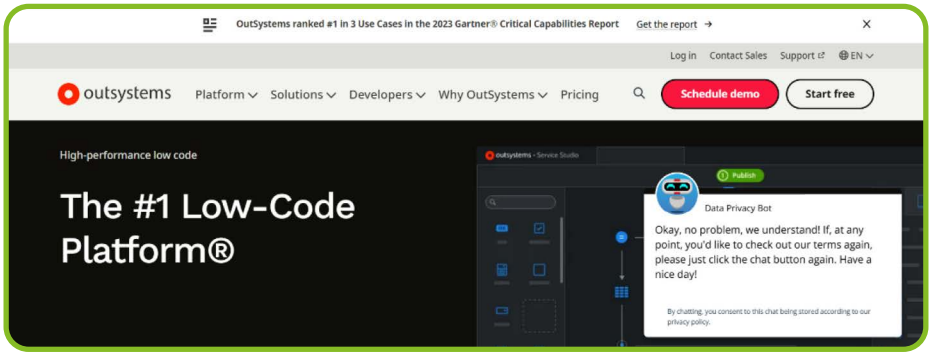

Figure 4. Registration interface

Source: (Outsystems, n.d.).

Figure 5 shows a panel where one can use the platform to create software dedicated to the energy sector.

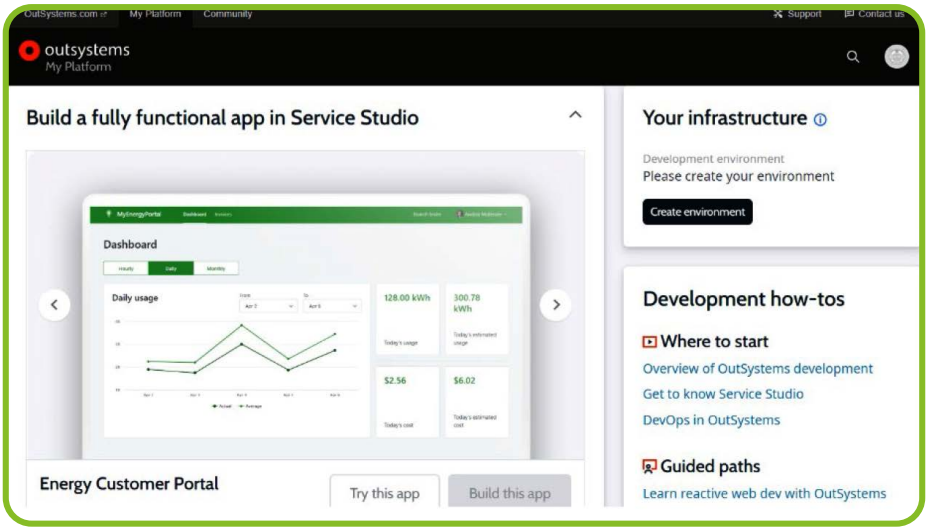

Figure 5. Energy custom portal

Source: (Outsystems, n.d.).

OutSystems, due to its simplicity of use and extensive library of functionalities, can successfully become a tool for learning and professional programming and creating mobile applications for the renewable energy sector. Such a solution may seem extremely attractive and desirable in African countries with low IT/ICT education.

2.1.3. Microsoft Power Apps

Microsoft Power Apps is another low-code tool Microsoft developed a few years ago. Similarly to the previously presented Mendix and OutSystems, it helps novice users to delve into the secrets of creating software and mobile applications without needing advanced programming knowledge. The tool contains basic application-building modules and artificial intelligence that minimize human involvement in program creation.

Microsoft Power Apps offers valuable opportunities for leveraging green energy solutions in Africa. With the ability to create custom applications, African organizations and individuals can address specific challenges faced in the region. These applications can focus on managing renewable energy projects, monitoring energy consumption, or tracking the performance of green energy systems such as solar panels and wind turbines.

Automation is another crucial aspect where Power Apps can significantly benefit the African green energy sector. Integrating with Power Automate can streamline tasks and workflows related to energy data collection, analysis, and reporting. This reduces manual effort, increases efficiency, and allows more effective decision-making in optimizing energy usage and resource allocation.

Power Apps also plays a crucial role in data integration. By connecting to local and regional energy data platforms, databases, and cloud services, African organizations can access and analyse relevant data to gain insights into energy consumption patterns, identify renewable energy potential, and evaluate the impact of green energy initiatives on local communities. This data-driven approach facilitates evidence-based decision-making and enhances the region's scalability of green energy solutions.

Mobile accessibility is essential in Africa, bearing in mind the widespread use of mobile devices globally. Power Apps enables mobile application development that allows field workers and technicians to access and utilize green energy solutions while on the go. This is particularly beneficial in areas with limited infrastructure, where mobile devices are primary data collection and remote monitoring tools.

Collaboration and knowledge-sharing are vital components in the African green energy sector, and Power Apps can serve as a platform to facilitate such activities. By creating applications that promote communication, data sharing, and collaboration among organizations, researchers, and policymakers, synergistic efforts can be encouraged to drive sustainable energy practices, spur innovation, and be a catalyst for positive change in the region.

Power Apps' scalability and flexibility are additional advantages in the African context. The platform can adapt to the specific needs and challenges faced by different African countries and regions where green energy adoption rates and infrastructure development vary. This adaptability empowers organizations and individuals to customize applications to suit local requirements and seamlessly scale solutions to support the transition to green energy in diverse African markets.

By harnessing the capabilities of Microsoft Power Apps, African stakeholders can expedite adopting and deploying green energy solutions, contribute to sustainable development goals, and play a vital role in transforming the energy sector across the continent.

One can log on to the platform at **www.microsoft.com/en-us/power-platform** under the "Get started" icon (see Figure 6).

The user can choose one of the four modules that he/she needs most. Each module has unique tools that allow to adapt the system to the user's requirements. These modules are presented in Figure 7.

In addition to the functionalities of Microsoft Power Apps, the company is distinguished in the market by its recognizable brand, with a vast network of distribution and customer service points around the world. Many customers use Microsoft software, which makes them feel attached to the brand and enthusiastic about the company's new products. Users associate Microsoft

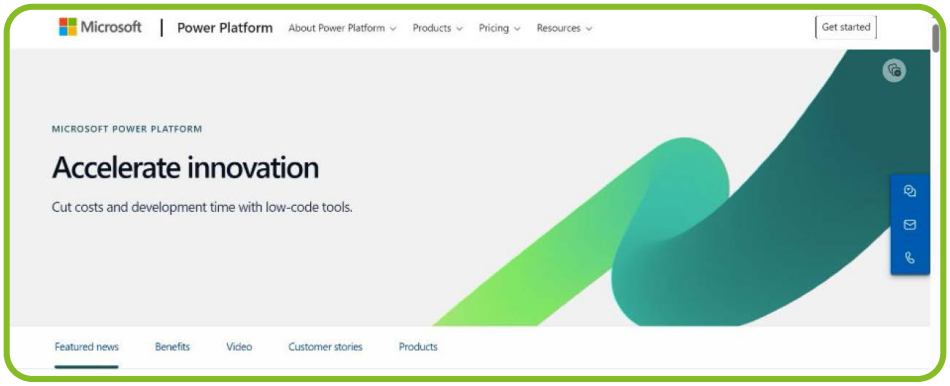

Figure 6. Power Apps platform home page

Source: (Microsoft, n.d.).

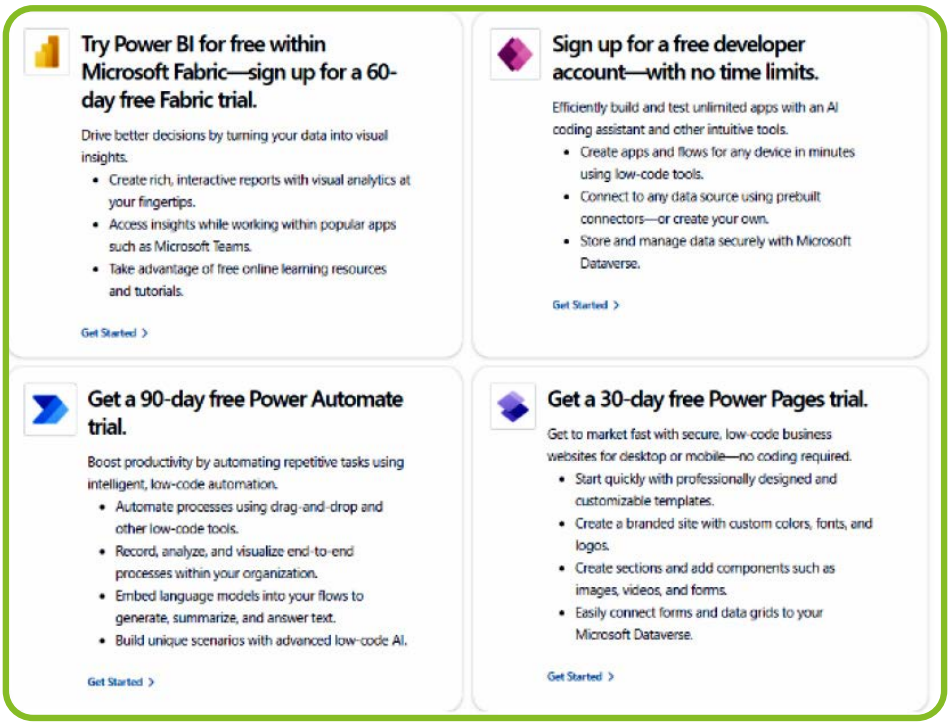

Figure 7. Power Apps platform modules

Source: (Microsoft, n.d.).

with reliability and ease of use, which makes Power Apps a popular choice among those interested in programming and specialists looking for more accessible tools in their daily work.

2.2. No-Code Platforms and Their Characteristics

No-code platforms have revolutionised the way applications are designed and developed by eliminating the need for coding skills and programming knowledge. This innovative approach aligns with the self-service movement, empowering business users to independently create, manage, and utilize data-centric applications, ultimately enhancing their workflow efficiency.

In practice, while no-code automation tools claim to eliminate the need for coding, underlying coding processes are involved. However, top-tier tools cleverly conceal this requirement by providing intuitive visual interfaces. Users can easily construct process maps by simply engaging in point-and-click actions and employing drag-and-drop functionalities. The supporting software then takes care of the actual coding aspects, sparing users from the complexities of traditional coding methods.

Distinct from pure no-code platforms, low-code solutions offer a middle ground. These solutions require occasional IT intervention to fine-tune and customize the no-code development with minimal coding involvement. In such instances, users can rely on IT support to tailor the no-code framework to their needs, ensuring optimal functionality without requiring extensive coding expertise.

Expanding on the implementation of no-code platforms in the green energy sector in Africa, it is evident that these tools have immense potential to drive innovation, improve efficiency, and facilitate sustainable practices. The no-code approach allows energy organizations, renewable project developers, and even individual users to create tailored applications without the barrier of coding complexities, which are often scarce in the African context.

By leveraging no-code platforms, the green energy sector in Africa can witness accelerated progress in areas such as project management, energy monitoring, data analysis, and reporting. Organizations can create custom applications to streamline renewable energy project management processes, such as tracking project timelines, monitoring resource utilization, and ensuring compliance with environmental standards.

Moreover, no-code platforms provide a user-friendly solution for managing and analysing energy consumption. Users can develop applications to collect and analyse energy data from various sources, such as smart meters and monitoring devices, to identify inefficiencies, optimize energy usage, and reduce waste. This data-driven approach supports evidence-based decision-making and actionable insights to mitigate energy challenges in Africa.

Furthermore, the ability to create applications for tracking the performance of green energy systems such as solar panels and wind turbines, is crucial for ensuring their optimal operation and maintenance. By utilizing no-code platforms, field workers and technicians can access user--friendly mobile applications that remotely monitor and efficiently manage renewable energy assets, even in remote and underserved areas of Africa.

Through collaborative no-code application development, the green energy sector in Africa can benefit from knowledge-sharing, the exchange of best practices, and coordination among different organizations, researchers, and policymakers. This promotes synergistic efforts and encourages sharing innovative solutions to address common challenges, foster sustainable practices, and advance the green energy sector.

2.2.1. Bubble

Bubble.io stands out as one of the top contenders in no-code platforms, highly regarded for its vibrant community and unwavering commitment to continuous improvement. This platform offers a user-friendly drag-and-drop editor, robust workflows, and a flexible database structure, enabling users to construct intricate applications without coding expertise. While it caters

to entrepreneurs, business owners, and aspiring developers, mastering the full extent of its capabilities requires dedication and persistence.

An outstanding strength of Bubble.io is its scalability, robust security features, and extensive range of seamless integrations. These factors reinforce its position as a dependable foundation for the rapid development and deployment of web applications. What sets Bubble apart is its visual programming language, which strikes the perfect balance between accessibility for beginners and flexibility comparable to platforms categorized as low-code. This empowers users to control app aesthetics, data structures, and overall performance, making Bubble.io ideal for prototyping or creating fully scalable products.

Working within Bubble's editor involves designing the app's user interface such as the controls offered by Canva, managing data through an interface resembling Excel, and setting up logic with step-by-step workflows. Although there may be a slight learning curve, the process is engaging and comprehensible, allowing users to grasp the fundamentals and gain the confidence to start building. Challenges may arise along the journey, but forums and YouTube are valuable resources for finding solutions. Users can enhance their skills and accelerate the development process through experimentation and research.

One unparalleled advantage of Bubble.io lies in its active and supportive community and abundant available resources. Comprehensive step-by-step videos, introductory courses, and written guides contribute to an extensive knowledge base that users can tap into for guidance. Coaching services and development boot camps are available to provide accelerated learning opportunities for those seeking to expedite their proficiency.

By leveraging the immense capabilities of Bubble.io and utilizing the support of its community and resources, users can unlock their full potential in creating robust and advanced applications without the need for coding skills. This empowers entrepreneurs and businesses in the green energy sector in Africa to rapidly develop and deploy innovative solutions, ultimately driving the growth of sustainable practices and the transition to green energy across the continent.

To register for the platform, go to **https://bubble.io/** and click the "Get started" icon on the home page (see Figure 8).

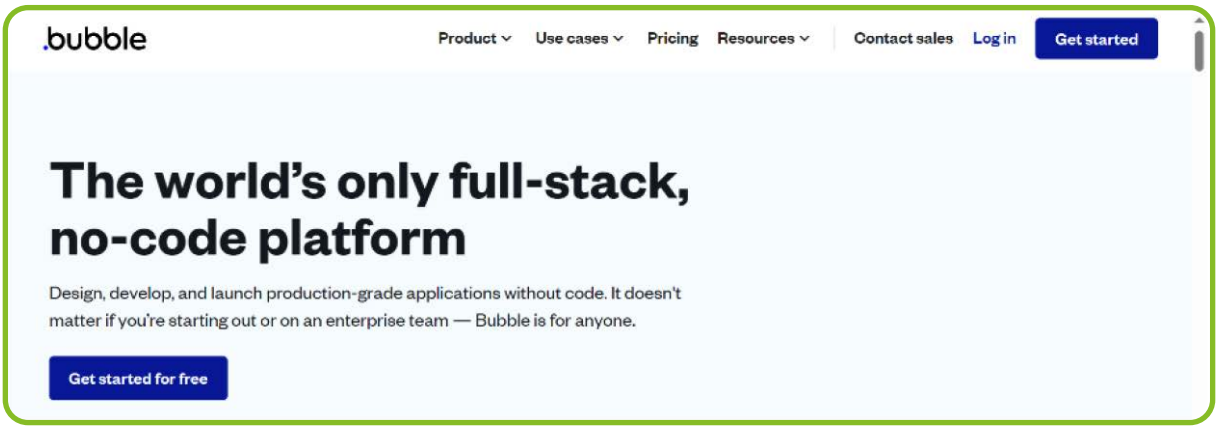

Figure 8. Registration platform of Bubble

Source: (Bubble, n.d.).

After logging into the system, the users answer questions about their programming knowledge, involvement, and ideas for the application. This allows the platform to profile the user and select appropriate tools for his needs. Next, the first application creator starts, where one can design functional windows, background colours, animations, and other application elements, working on a simple drag-and-drop principle. This scheme is shown in Figure 9.

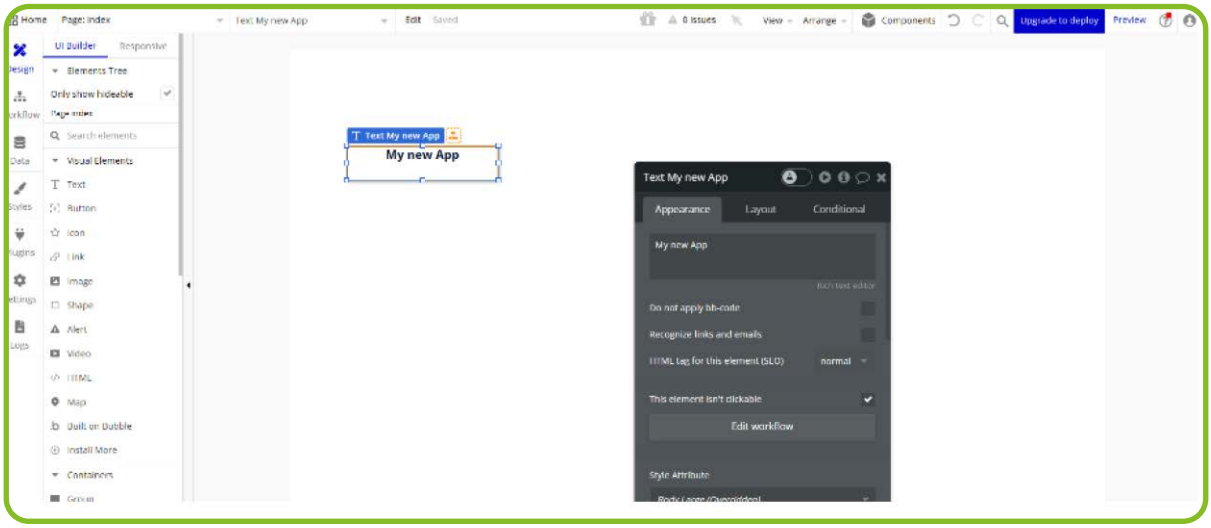

Figure 9. Application creator of Bubble

Source: (Bubble, n.d.).

The first impressions after starting with the application may evoke different feelings in the user. Some people may immediately understand how to build individual application elements, while others may feel overwhelmed by various functionalities. It is worth using the tips and instructional videos on the platform and streaming platforms, beneficial for understanding the assumptions of the platform and its basic functionalities.

2.2.2. Carrd

Carrd is a versatile platform that simplifies creating one-page websites, crucial for showcasing products, business ideas, and gathering mailing lists, all conveniently under a personalized domain. This user-friendly tool is perfect for individuals and businesses who want to set up a website swiftly and effortlessly without any coding skills required. It is an ideal option for presenting work or effectively sharing information online.

Carrd's standout quality lies in its accessibility, which does not demand coding expertise. Creating a website using Carrd does not necessitate coding proficiency; it is designed for everyone. Register an account and pick a template aligned with the vision to get started. Having chosen a template, adding content becomes effortless. Incorporating text, images, videos, and other elements to personalize the site is a seamless process. Carrd also offers extensive customization features, enabling the user to tailor the website according to unique requirements and branding preferences.

Carrd distinguishes itself through its direct approach, providing an uncomplicated user interface and engaging visuals that simplify the development of one-page websites for diverse needs. Its drag-and-drop editor facilitates the seamless addition of numerous content elements like text, lists, images, buttons, videos, tables, and containers.

Carrd provides a live preview feature during the building process, allowing users to seamlessly drag and drop elements on the canvas. Elements like text, images, and forms can be effortlessly placed to create the desired layout. Upgrading to a Pro account for more advanced functionalities unlocks additional features, such as slideshows. These forms integrate with CRM and email marketing tools like ActiveCampaign and Mailchimp and the ability to incorporate third-party widgets, e.g. Stripe and Facebook.

Carrd offers a wide range of responsive templates for website creation, available in both free and Pro plans, ensuring website responsiveness across devices, adapting seamlessly to various screen sizes. This guarantees that the website maintains a polished and professional look on desktops, tablets, and smartphones. Additionally, Carrd's editor allows easy toggling between desktop and mobile views during the design process, producing the website which looks good on all devices.

With Carrd, individuals and businesses can access a powerful yet intuitive platform for creating impactful one-page websites. Whether showcasing an artist's portfolio, a small business promoting products, or a blogger sharing thoughts, Carrd provides the tools needed to create a visually stunning and functional website without the difficulties of coding.

Carrd's no-code platform offers valuable support for Africa's green energy sector. It helps showcase eco-friendly solutions, educates communities about renewables, aids in fundraising for green projects, and fosters collaboration among stakeholders. With its user-friendly interface, Carrd empowers easy website creation, enabling an impactful online presence and educational outreach across Africa's renewable energy landscape.

To log in, go to **carrd.co**. Registration is not required to use the free website templates. The user can choose the one that best meets his/her expectations from the variety of the existing templates, many of which are free (see Figure 10).

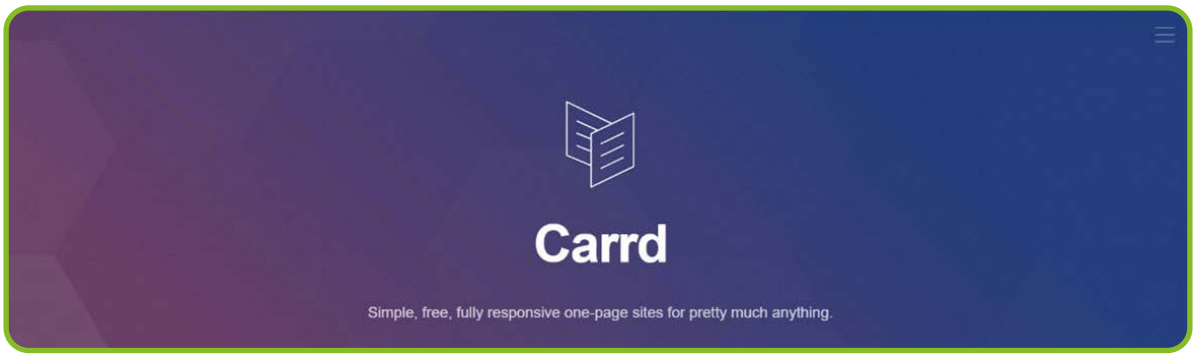

Figure 10. Carrd's platform home page

Source: (Carrd, n.d.).

There is no need to use templates as one can design a template to build personalized website content.

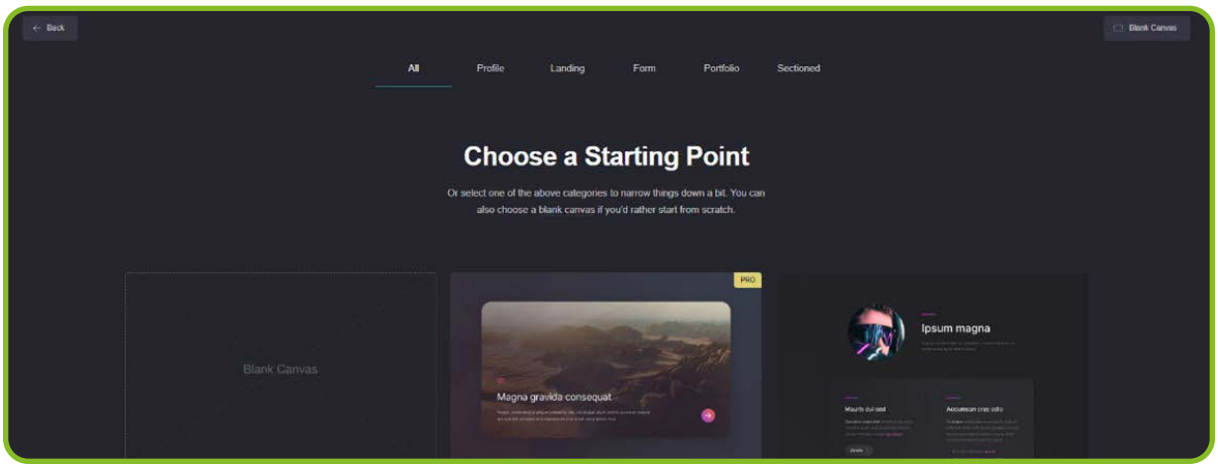

Figure 11. A tab for creating a simple website on the Carrd platform

Source: (Carrd, n.d.).

Carrd is one of the simplest no-code platforms available on the market, with a limited function for creating a single-page website, hence it is popular among the least technically advanced users.

2.2.3. Webflow

Webflow stands out among the premier visual website builders, distinguished by its exceptional power and extensive customizability. It was purpose-built to empower designers and entrepreneurs, enabling them to forge highly dynamic, feature-rich websites devoid of the necessity for coding prowess. Despite its slightly steeper learning curve, Webflow remains an attractive option.

For those frustrated by the limitations of conventional drag-and-drop website builders, Webflow emerges as an ideal solution. Its unparalleled design customization capabilities cater to individuals with a penchant for design finesse. Offering an array of meticulously crafted instructional videos, Webflow aims to expedite the learning curve and generously provides an initial free tier for beginners.

Marketed as a no-code tool, Webflow introduces a drag-and-drop interface and an array of templates, facilitating the development of responsive and customizable websites without delving into the intricacies of coding. Nevertheless, ongoing debates question whether Webflow squarely fits within the no-code domain, ventures into the realm of low-code, or potentially represents a code-writing interface.

Functioning as a visual HTML and CSS code editor, the Webflow development interface operates on a WYSIWYG system, allowing users to construct websites by intuitively dragging and dropping elements onto the page. Behind the scenes, it automatically generates HTML, CSS, and JavaScript code while allowing for custom code insertion, ensuring both adaptability and efficiency.

Webflow is an all-encompassing platform for designing, constructing, and launching websites or e-commerce establishments without requiring coding expertise. Its robust feature set includes responsive design, on-page animations, interactive forms, and more. Supported by Webflow

University, a repository replete with tutorials and resources, users can seamlessly transition from novices to seasoned experts, enriching and educational the learning journey.

Moreover, Webflow excels in various aspects: revolutionizing e-commerce with its extensive e-commerce functionality, streamlining website building through automation, and offering seamless integration between Figma and Webflow. This integration allows users to transition smoothly from the design phase to the execution stage, enhancing workflow efficiency.

To register for the platform, go to **https://webflow.com/** and click the "Get started" icon on the home page (see Figure 12).

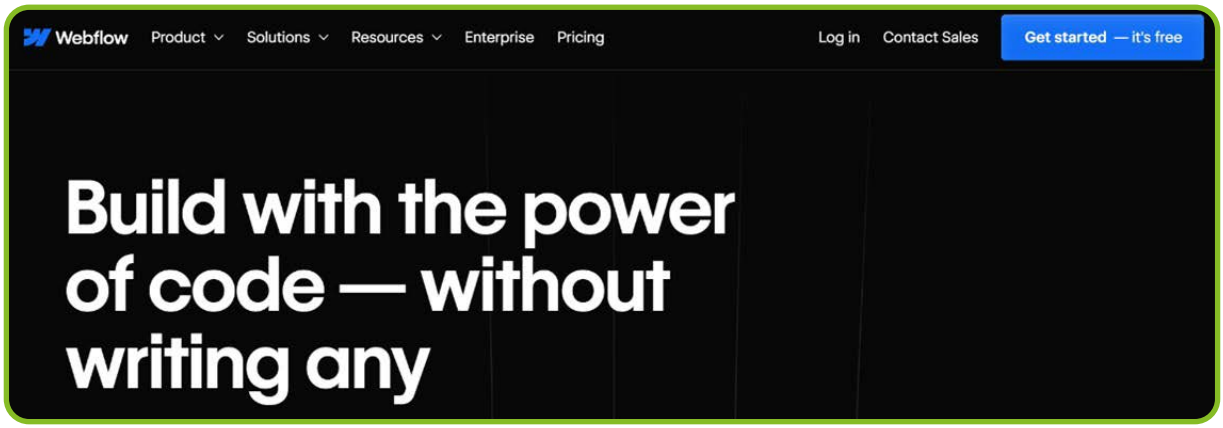

Figure 12. The home page of the Webflow platform

Source: (Webflow, n.d.).

After logging in, the platform collects information about the user to create a preferential panel tailored to his/her needs.

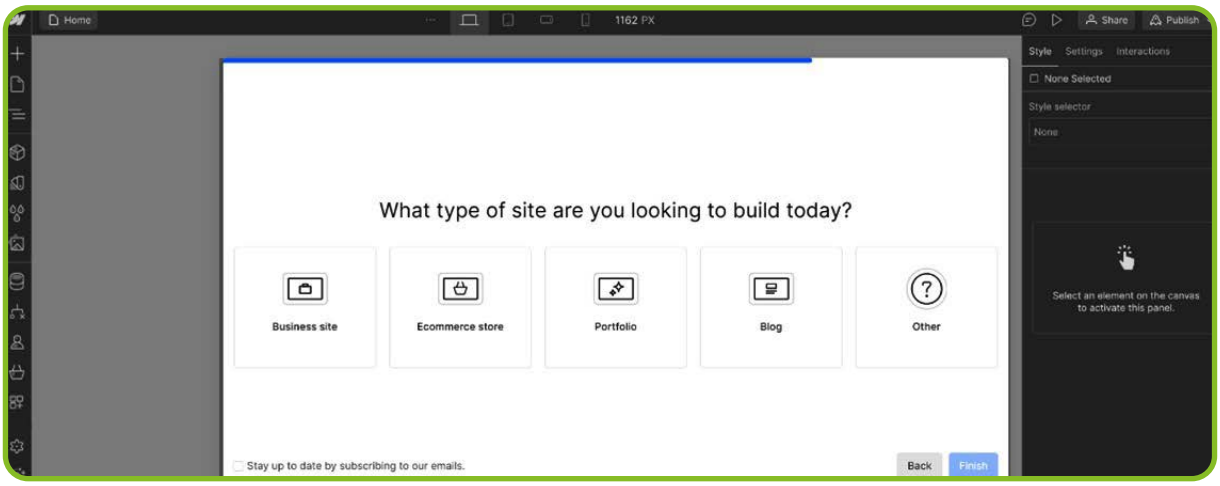

Figure 13. The main panel of the Webflow platform

Source: (Webflow, n.d.).

On the main panel, there are templates one can use, some of which are free, while some require a fee. Naturally, a website can be designed from scratch.

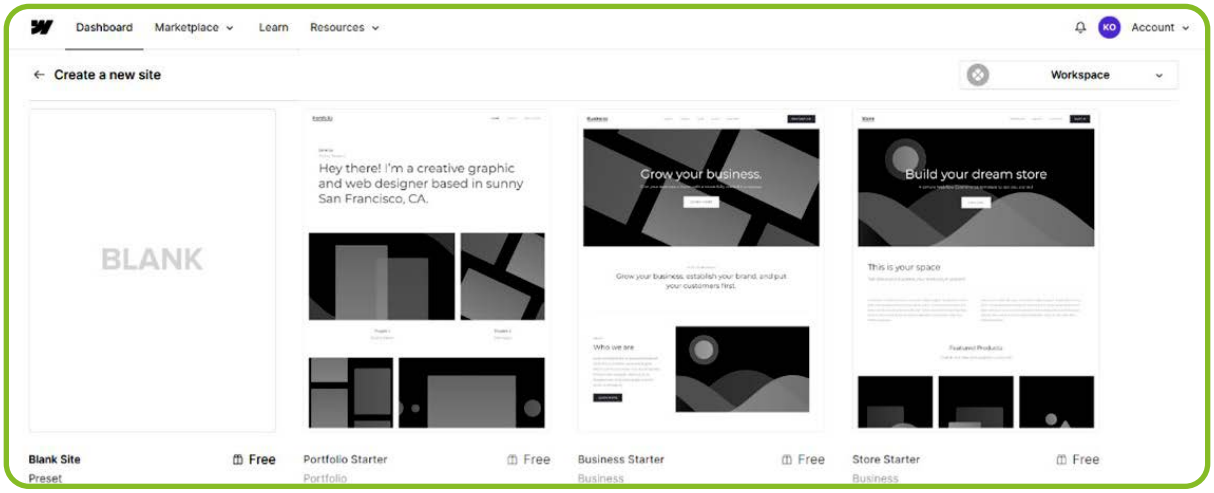

Figure 14. Templates of platforms in Webflow system

Source: (Webflow, n.d.).

After selecting the appropriate template, the user is provided with an extensive step-by--step tutorial on how to build a complex website with subpages that may contain many functionalities.

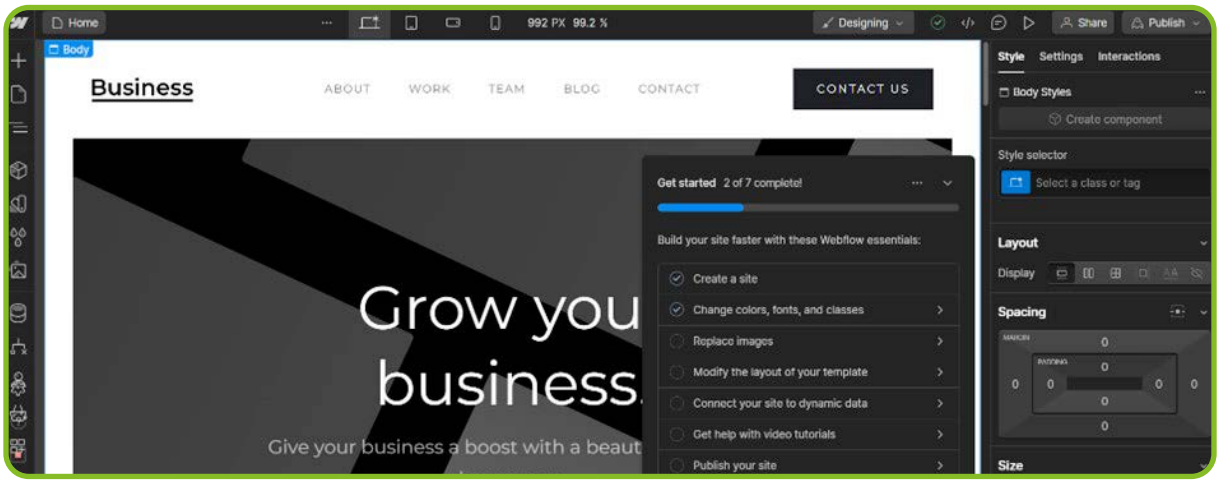

Figure 15. Functionalities of platform creator

Source: (Webflow, n.d.).

Like other no-code platforms, Webflow can support African students, entrepreneurs, and IT specialists in creating less and more advanced websites, e-commerce links, etc.

2.3. Differences and Similarities of Low- and No-Coding

Low-code and no-code platforms have transformed software development, enabling users to craft applications without extensive manual coding. Despite similarities, these platforms diverge in complexity, customization, and the applications they cater to.

No-code platforms cater for individuals with minimal coding experience, offering intuitive interfaces for effortless application development, whereas low-code platforms target users with some programming knowledge, reducing manual coding significantly while requiring specific technical proficiency.

Customization and flexibility vary between the platforms. No-code tools prioritize simplicity, offering limited customization and predefined templates. Low-code platforms provide more flexibility, enabling custom code addition, API integration, and the development of intricate applications.

Regarding application complexity, no-code suits more straightforward projects such as basic websites and mobile apps, while low-code handles complex tasks, among which workflow automation and enterprise-level solutions.

Despite their differences, they all emphasize ease of use, employ visual interfaces with drag--and-drop functionality, and expedite development cycles compared to traditional coding. Both empower 'citizen developers', including business users and entrepreneurs, fostering innovation and diverse participation in software development.

In essence, while sharing common features in the ease of use and empowering non-developers, both low-code and no-code platforms differ in their complexity, customization, and the applications they support, thus democratizing software creation and fostering inclusivity in development.

3 The Importance and Possibilities of Using AI in Creating Professional Programming Codes Applicable to Green Energy

The two most famous artificial intelligence tools that can be used in teaching and developing the renewable energy sector in Africa in terms of programming support are Chat GPT and Google Bard. They have advanced deep learning algorithms and immediate system responsiveness in response to user queries (chatbots). AI can play an indispensable role in crafting professional--grade programming codes that find practical application in the domain of Green Energy. Its influence extends across various dimensions, yielding a multitude of advantages and opportunities:

- Streamlined Algorithm Development: AI's capabilities are instrumental in expediting the creation of algorithms dedicated to optimizing renewable energy systems. By assimilating extensive datasets, AI can conceptualize algorithms that significantly boost the efficacy and productivity of green energy solutions such as solar, wind, and hydroelectric systems.
- Predictive Analytics: AI-powered predictive models serve as a cornerstone in prognosticating energy demands and the variability of renewable sources. These models use historical data and environmental parameters to forecast fluctuations, facilitating superior resource distribution and management of energy grids and ensuring a more stable and consistent energy supply.
- Automated Design and Optimization: leveraging machine learning algorithms, AI excels in automating renewable energy infrastructure's design and refinement processes. It also streamlines energy system design through rapid iterations and optimization strategies, maximizing efficiency while curtailing manual effort and time expenditure.
- Energy Optimization Solutions: AI devises software solutions to fine-tune energy consumption across diverse sectors. It identifies potential energy conservation areas and recommends enhancements, curtailing waste and enhancing efficiency.
- Smart Grid Supervision: AI's capabilities empower the functioning of smart grid technologies, ensuring efficient power distribution. Real-time data analysis enables immediate rerouting of power, preempting blackouts, and harmonizing grid loads, ensuring a dependable and stable energy supply.
- Diagnostic and Maintenance Solutions: AI-driven systems are adept at monitoring and predicting maintenance necessities for renewable energy assets. Analysing data from sensors and machinery enables AI to forecast equipment failures, allowing for preemptive maintenance, minimizing downtime, and extending the lifespan of equipment.

- Customization and Scalability: the adaptability of AI enables tailored solutions customized to meet the unique demands of diverse green energy projects. Its scalability allows seamless adaptation to various project scales, from microgrid setups to expansive renewable energy farms.

Students and employees of the green energy sector can use more AI platforms, which include AI Chat by deepai.org, Bing Chat, and Goat Chat.

4 The Importance and Essence of Mobile Applications/Web Systems That Supervise the Operation of Green Energy Systems

Mobile applications and web systems play a crucial role in supervising and managing renewable energy systems. Their advantage is the possibility of continuous access to current data on the efficiency of power plant/installation operations and events that affect this efficiency. Their significance stems from various key aspects:

- Performance Monitoring: these apps allow for tracking and evaluating the performance of renewable energy systems, including solar panels, wind turbines, and hydroelectric installations. One can ensure optimal system performance by constantly monitoring the energy produced, assessing the efficiency of individual elements, and taking corrective actions when necessary.
- Fault Management and Diagnostics: these apps enable the swift detection of faults and problems within the system. They support diagnostics by tracking operating parameters, detecting failures, and predicting maintenance or repair requirements. This proactive approach helps minimize downtime and optimize system reliability.
- Process Optimization: mobile apps and web systems empower users to control and optimize renewable energy production processes. With automation and remote access to data, operators can quickly respond to changes in weather conditions or other factors that affect energy production. This flexibility allows for the efficient and effective management of renewable energy systems.
- Energy Consumption and Distribution Management: these systems facilitate the optimal utilization of energy produced by managing its distribution and power supply to specific areas or devices based on demand and environmental conditions. Mobile apps and web systems enable efficient energy allocation through intelligent energy grids and prevent overloads and failures.
- Smart Grid Integration: mobile apps and web systems often integrate with intelligent energy grids. They provide insights into energy flow, balance network load, optimize energy distribution, and ensure grid stability. This integration enhances overall system performance and reliability.
- Remote Accessibility and Multi-System Management: these solutions enable remote access to various renewable energy installations, which is particularly valuable when managing large-scale wind and solar farms. Operators can monitor and manage multiple systems from a centralized location, improving efficiency and reducing the need for a physical presence on site.
- Data Analysis and Forecasting: mobile apps and web systems enable the collection and analysis of data from multiple sources. This data-driven approach allows for accurate

energy consumption forecasting, system efficiency, and long-term renewable energy management strategies. By making informed decisions based on data insights, operators can optimize renewable energy systems for maximum performance and sustainability.

4.1. Applications for Monitoring the Operation of Photovoltaic Panels

Inverter manufacturers have developed mobile apps tailored for users of their products, which allow access to real-time readings of energy production from their installations and oversee crucial operational parameters. The evolution of these apps stemmed from the intention to augment the utility of devices that previously held a competitive edge in the market. Today, having a mobile app that functions across various operating systems has become a standard among manufacturers specializing in converting energy from photovoltaic panels into usable energy.

This handbook explores a selection of applications/platforms offered by major manufacturers supporting photovoltaic installations. These apps are readily available for download from various platforms, such as the Play Store (for Android), the Huawei Gallery App (for Huawei devices), and the App Store (for iOS). These manufacturers also provide web-based platforms, ensuring flexibility and accessibility across multiple devices and interfaces.

Notably, these apps are free for users and come equipped with multilingual support, catering to diverse global audiences. Customers can set up a personalized dashboard within the app, linking their inverter device to ensure continuous Internet access. This connectivity is essential for the application to provide up-to-date information.

Beyond monitoring energy production and photovoltaic installation parameters, these apps offer insights into energy storage systems (if connected), presenting a comprehensive view of the building's energy ecosystem. Additionally, users can access data on the economic efficiency of their installation, including the monetary value of the energy produced based on market prices. Furthermore, they shed light on the environmental impact by showcasing reductions in CO2 emissions a critical aspect in promoting sustainable energy practices.

4.1.1. Huawei

Huawei is one of the largest producers of photovoltaic systems in the world, its inverters are used in micro-installations as well as in large farms. Thanks to advanced technology, the Huawei platform and devices boast many functionalities. Huawei inverters come with a 10-year warranty, which can be extended up to 20 years, and are equipped with an electric arc detection function and the option of installing an optimizer. Huawei inverters also have the best price-quality ratio, especially for premium models.

To log in, go to the website **https://solar.huawei.com/** or download the Fusion Solar app from the Huawei Gallery App platform or the website (see Figure 16). The registration method and basic functionalities of the application are presented further.

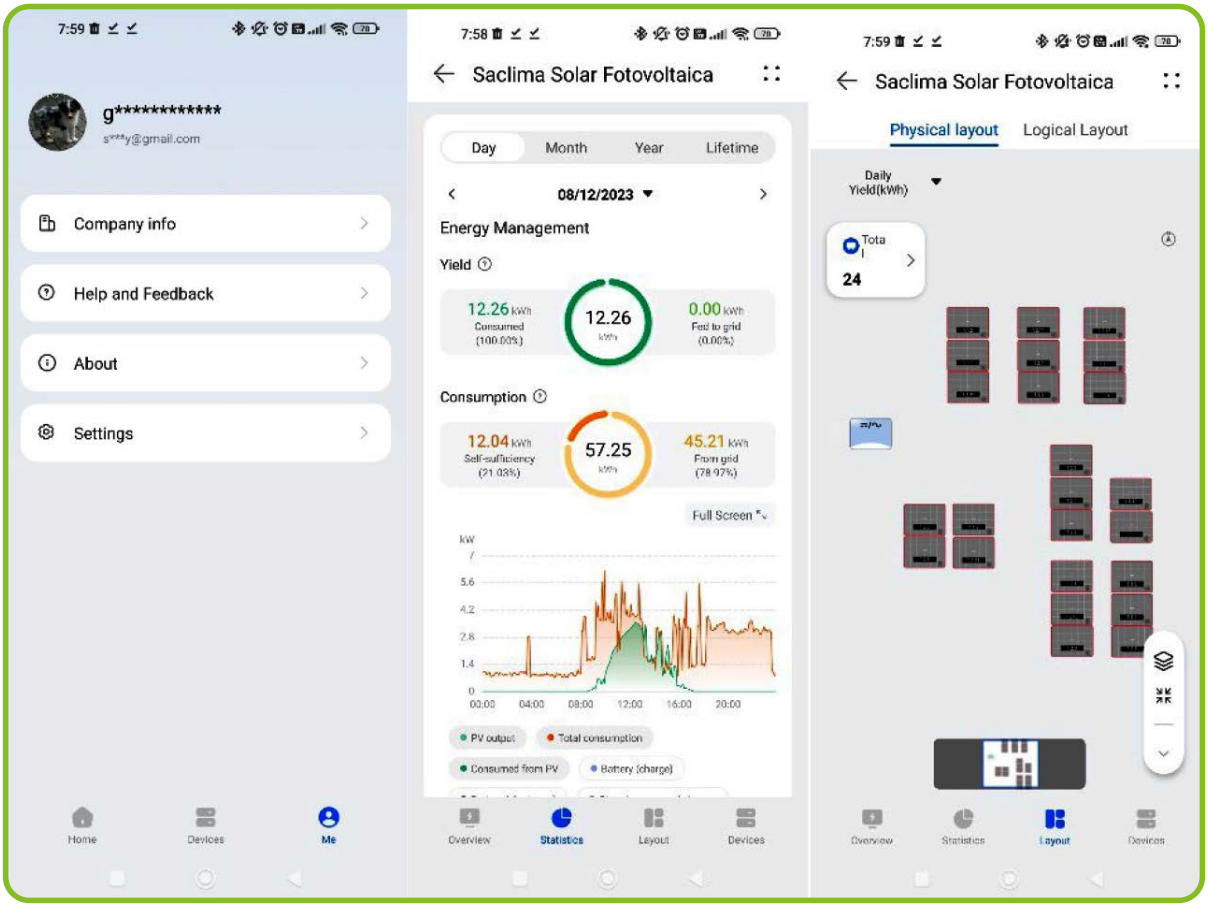

Figure 16. Fusion solar application by Huawei

Source: (Solar, n.d.).

Registration to the app requires providing the following data: e-mail address, telephone number, login, and password. The user can start using the app after account registration is confirmed by e-mail or phone (receiving a message with an activation link/ SMS code). Next, add a photovoltaic installation in the user panel (instructions on adding the installation are available on the YouTube channel on the Huawei profile **https://www.youtube.com/watch?v=rNLzwllezD4**).

After adding the device, one can monitor the state of one's home energy network, including current energy production and consumption. Users can also view the history and estimate savings resulting from energy production from the installation.

An additional function of the app is the ability to verify the efficiency of individual solar panels in the installation. Each panel can be analysed separately, which allows it to be positioned perfectly for the sun rays.

4.1.2. Fronius

Just as Huawei, the Australian company Fronius has created a simple and intuitive mobile app to operate and control its devices. Fronius is a manufacturer of inverters which has been among the best and most trusted brands for years, operating since 1945. One of its flagship products is

the GEN24 hybrid inverter, which has an emergency power function without energy storage. The products enjoy great recognition in Europe and are considered among the best on the market. Registration and logging in are carried out in a similar way to other apps. The app and its primary functions are presented in Figure 17.

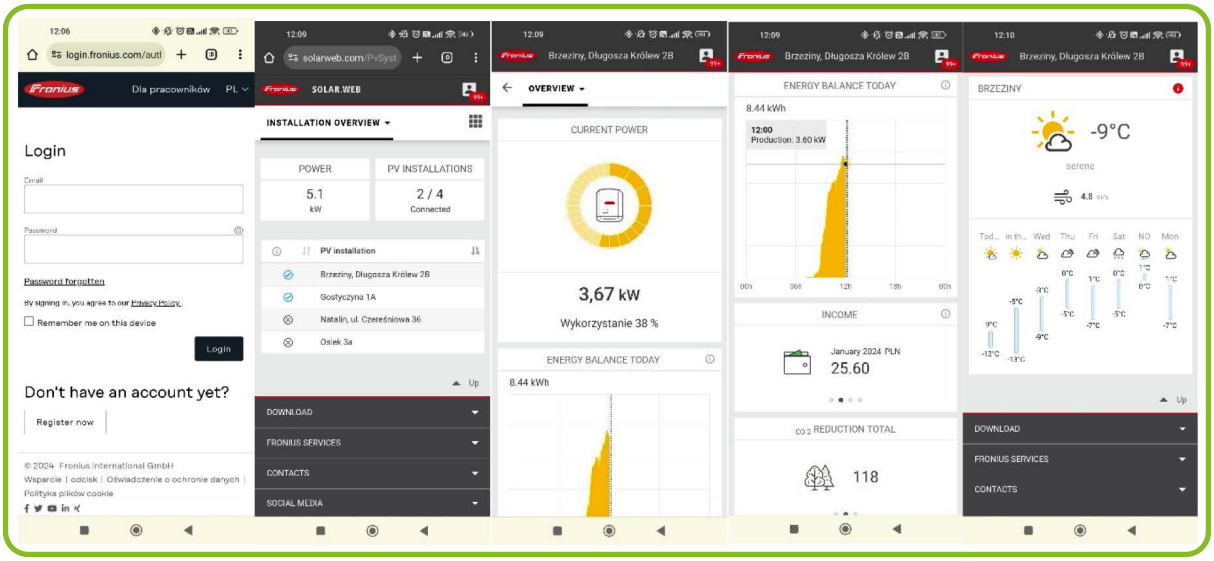

Figure 17. Solarweb application by Fronius

Source: (Fronius, n.d.).

The app is intuitive and allows for the quick analysis of energy production on a given day and at selected historical times; it also shows the weather forecast, which is extremely important in planning the operation of energy-intensive machines. For example, energy can be scheduled as an intensive activity for sunny days in a household. Information reflecting the impact on the natural environment is shown via the reduction of carbon footprint emissions into the atmosphere, together with information about efficiency and money savings generated.

4.1.3. FoxESS

FoxESS inverters are one of the most frequently installed devices in PV installations due to their attractive price and availability of service parts. A significant advantage of FoxESS is the ability to purchase an installation with an energy storage facility provided by the company, which protects the user against power failure in the event of a transmission line failure. The energy storage allows the use of electricity when there is no solar charging (e.g. in the evening and at night), creating the possibility of constructing energy-independent systems that powering houses and small farms. This solution is particularly appreciated in places with no electricity transmission infrastructure, such as mountainous or desert areas far from the transmission network. The app and its basic functionalities are presented in Figure 18. Detailed information on registration and the app's functionality is presented in the user manual at **https://www.fox-ess.com/wp-content/uploads/2023/03/APP-FoxCloud-English-User-Manual.pdf.**

As with the previous apps, there is information about current electricity production, history and statistics, savings expressed in money, and the environmental impact.

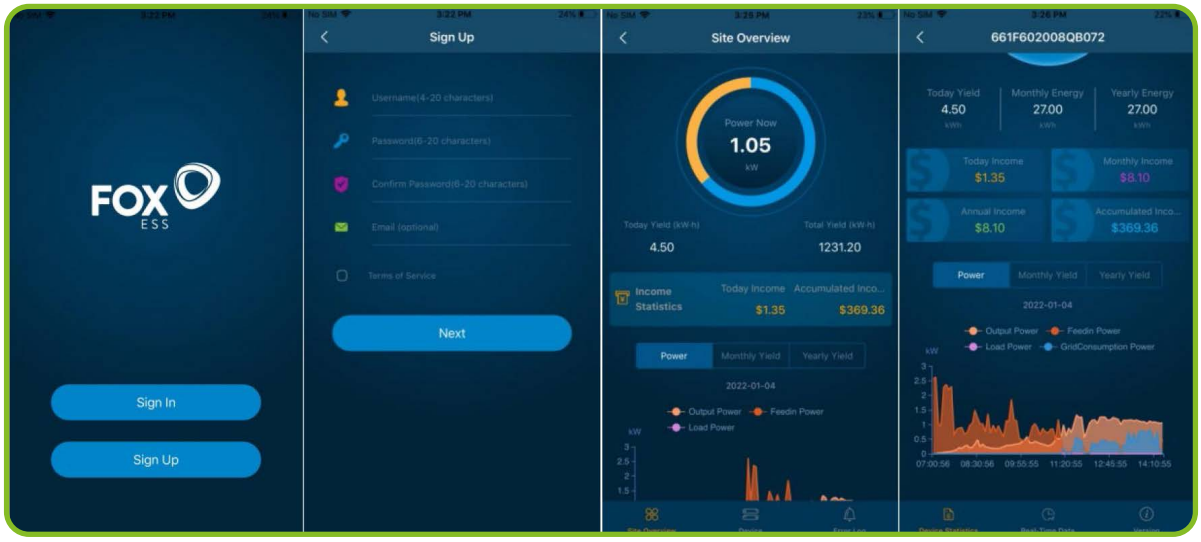

Figure 18. FoxCloud application by FoxESS

Source: (FoxESS, n.d.).

The selected apps are only some examples of those available on the market. Note that there are other equally popular brands of inverters with their apps, e.g. Solar Edge, SMA, Growatt, SunGrow, GoodWE, ABB, and others.

4.2. Applications for Monitoring the Operation of Wind Turbines

Similar to photovoltaic systems, applications for managing renewable energy systems from wind deliver information functions that show real-time information on energy production and other functional parameters of the installation. The data transferred mainly concern:

- performance monitoring at the core of these apps, providing live updates on energy production levels, wind speed, turbine RPM, and overall efficiency for individual turbines and entire wind farms. They serve as a live dashboard of essential operational parameters;
- fault detection and diagnostics as key features, alerting operators about any anomalies or faults within the turbines. These applications swiftly identify issues, enabling prompt corrective actions to minimize downtime and optimize performance;
- predictive maintenance functionalities using historical data and predictive algorithms to forecast maintenance requirements. This proactive approach helps in scheduling servicing and mitigates unexpected breakdowns, ultimately extending the longevity of the turbines;
- many of these apps integrate weather forecasts, allowing operators to anticipate changes in wind patterns, which assists in optimizing turbine positioning and predicting power output based on incoming weather conditions;

- remote control and automation capabilities being crucial, providing operators with remote access to adjust settings or shut down turbines if necessary. This remote capability ensures efficient management and safety protocols;
- data analytics and reporting functionalities collect and analyse vast amounts of data from multiple turbines and wind farms. They generate comprehensive reports and analytics, empowering informed decision-making to enhance operational efficiency;
- these apps issue real-time alerts and notifications, ensuring operators are immediately informed about any issues or abnormalities in turbine operation, allowing for swift preventive actions;
- the apps often integrate with Supervisory Control and Data Acquisition (SCADA) systems in industrial settings, extending their functionality and control over entire wind farms;
- historical data visualization and analysis capabilities enabling users to visualize trends, performance patterns, and efficiency over time. This feature helps identify areas for improvement and optimize turbine performance.

These apps are indispensable for wind farm operators, energy companies, and maintenance teams, offering actionable insights and control to ensure optimal performance, maximum energy output, and minimal downtime in the renewable energy generation process.

4.2.1. Digital Wind Farm

The most advanced system for managing the operation of wind turbines was developed by one of the oldest and most prominent companies in the world's energy industry, General Electric. The need to create a system that optimizes the efficiency of energy production and allows for the effective management of wind farms results from the growing popularity of these devices among individual and institutional investors.

The Digital Wind Farm comprises two primary components: a 2MW wind turbine and wind power software that actively monitors and optimizes the turbine's performance during energy generation. Seamlessly integrating the wind energy software with the hardware makes it possible to increase energy production by up to 20%, meaning additional millions of dollars in revenue throughout the turbine's lifespan.

In essence, the Digital Wind Farm initiates its operation by creating a digital twin, a cloud--based model mirroring the wind farm's infrastructure. Employing digital twin technology allows engineers to experiment with nearly 20 different turbine configurations, ensuring the development of an optimal turbine design tailored to the unique geographical characteristics of the actual farm location. The digital twin model comes into full effect after the installation of the physical wind turbine. It actively gathers real-time data from its physical counterpart and conducts comprehensive analyses, generating recommendations to enhance its operational efficiency further.

4.2.2. Other Applications

There are platforms available on Android and Apple that not only support the process of managing wind installations but also suggest where to locate the installation, taking into account the terrain and wind flows in the area. Some applications also simulate energy yield from installations in a given area. In such an application, the location is complete (the app automatically downloads information from the network about the terrain and information from databases about wind flow). The user replenishes the wind turbine's power, and the app and the algorithms it contains calculate the energy yield with a very high probability and convert it into profits expressed in money. These apps include WindApp, Wind Farm Operational Controller by SkyLark, and MyWind Turbine.

5 Case Studies of the Use of ICT Tools in the Green Energy Sector

5.1. A Farmer's Problems

Diego is a farmer in southern Spain who grows citrus fruits in a small town 40 miles east of Malaga. He has 30 hectares of land and regularly irrigates using a sprinkler and groundwater resources. Thanks to a subsidy from the European Union for the development of agricultural activities, he decided to expand his activities by growing peanuts on the newly purchased land. Unfortunately, the field's location requires intensive irrigation from the power grid in a distance of 13 miles. The farmer's application to connect the field to the grid was met with little enthusiasm by the operator responsible for the maintenance and operation of the distribution network. The estimated cost of power connection to the field was over EUR 485,000. For Diego, it was a sum he was unable to pay. Calculating the connection and energy costs while irrigating the field was his worst-case scenario. Therefore, the farmer decided to look for information on alternative ways of powering automatic sprinkler pumps that would allow him to grow peanuts effectively. He calculated the demand for the irrigation system, which consisted of a deep well pump with a power of 12 kW and a pressure pump with a power of 18 kW. The average daily demand for electricity would be approximately 450 kW. It is worth noting that the irrigation system works in the late afternoon, at night, and in the morning. His first port of call was a company that deals with photovoltaic installations.

According to PV experts, the possibility of using the energy produced by the farm would make sense if an energy storage with a capacity of approximately 400 kW was attached to the installation. The estimated installation cost would be approximately EUR 275,000 for the installation, and approximately EUR 215,000 for the energy storage, which gives a cost of approximately EUR 490,000. The company provides a 25-year warranty on the panels and structure and a 20-year warranty on the inverter. Energy storage facilities are provided with a 15-year efficiency warranty at a level not lower than 90%.

Diego then went to a company dealing with wind turbine installations, where he heard that the best solution would be a 100KW turbine, which should meet the farm's needs. The cost of purchasing the turbine was EUR 195,000, with the turbine engine covered by a warranty of 5 to 10 years, depending on the manufacturer. However, it is worth emphasizing that windmill blades wear out faster than PV installations and need to be regenerated and/or replaced more often. The cost of blade regeneration is approximately 30% of the purchase price of the entire turbine.

Questions:

1. Considering the location of the field for peanut cultivation, indicate the advantages and disadvantages of the proposed installations of renewable energy sources.
2. Which installations do you think are more beneficial for Diego? Justify your answer.
3. What other alternative energy source could be used in the field?
4. Would connecting to the public electricity grid be a better solution? State the advantages and disadvantages of such a solution.

5.2. Artificial Intelligence: Opportunity or Threat?

Cindy is a young but experienced product manager working in a large corporation that produces complete high-power wind farm installations. Her task at work is to manage a project involving research and development work on innovations related to optimizing the position of blades on a wind turbine rotor at an optimal angle to the wind strength and direction and creating a management system dedicated to this. Innovation requires technicians to conduct experiments on small units and collect the results. Cindy often organizes meetings with the IT team, designers, and technicians to determine the next steps in implementing the project.

The biggest challenge is to create software that will analyse data from many air movement sensors placed along the windmill blades at a given moment and change the angle of inclination of these blades to obtain the highest possible energy production efficiency. Writing an algorithm that would manage this process was a tough challenge for an experienced team of programmers. Many used Python, Java, C/C++, and SQL programming languages but needed help combining data from multiple devices in one algorithm. Therefore, they decided to use the no-code WebFlow platform, which supported them in the software development process thanks to its advanced functionalities. Moreover, IT specialists used artificial intelligence on various chatbots, which allowed them to perfectly adapt the newly created program to the specificity of devices and sensors.

When summarizing the project and presenting the work results to the company's management, Cindy presented the reliable results within the assumed time, budget, and scope. The management board, headed by the president, was delighted with the course of the project, management method, and results of the project, hence they offered the young project manager a promotion to the position of project manager officer, where the project portfolio is managed. The project's success will significantly improve the company's situation, which, thanks to the innovative solutions of its windmills, has significantly increased sales and achieved a significant competitive advantage.

Questions:

1. Do you think that the renewable energy industry will develop only thanks to the innovations created?
2. In your opinion, is artificial intelligence an opportunity or a threat for programmers employed in the IT industry?
3. Does the rapidly progressing process of creating artificial intelligence have a negative impact on the development of society? Justify your answer.
4. Should Cindy, despite her young age, accept the responsible position of project manager officer?

6 Summary

IT/ICT competencies in the green energy sector, regardless of geographical location, are the future of the industry's development. Employees will always be needed, and skills related to programming, creating websites, and mobile apps in the era of digitalization will constantly evolve along with changing technology. In African countries, IT/ICT education, similarly to highly developed countries, will develop because more and more renewable energy plants will be built there.

The advancing low-code and no-code technology provides opportunities for quick and practical teaching to young people and company employees without advanced programming knowledge. The progress of IT/ICT technology makes creating software, mobile applications, and websites much more accessible. In the energy sector, this applies primarily to creating systems that monitor the operation of power plants, collect and process data regarding its operation, and inform the user about failures or non-standard behaviour of the installation.

To acquire the competencies necessary to work in the industry, one should first focus on learning from publicly available sources because most popular no-code and low-code platforms have dedicated manuals that explain step-by-step how to create software. It is also worth acquiring knowledge traditionally, i.e. taking IT classes early and choosing specialized secondary schools. Studies facilitate acquiring advanced knowledge of IT/ICT, which can be further expanded with specialized training or workshops. In addition, it is worth investigating the possibility of participating in postgraduate studies, which often help to structure one's knowledge and indicate the possibilities of its original application in the renewable energy industry.

The ability to create programs and/or mobile apps is as crucial as the ability to use them. Most energy production and storage system manufacturers create dedicated apps that allow the user to monitor the power plant 24 hours a day. For many people, investing in a home micro-installation is an endeavour to make savings on rising electricity prices.

To sum up, the renewable energy sector has been developing for a long time, and IT/ICT has started to play a vital role in it. Observing the further development of the green energy sector, one can be sure that the demand for employees will increase, which creates an opportunity for young people entering the labour market to quickly find a job, or for experienced people to change their professional profile. This is further confirmed by data on fossil fuel resources, which are limited and cause an adverse environmental effect.

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