

GREEN INDUSTRIALIZATION IN AFRICA: Opportunities and Tensions in Africa-Europe Relations

SCOPING PAPER ON NIGERIA

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Disclaimer

The aim of this project was to discuss a variety of views therefore each paper does only reflect the views of the author(s) and not the views of other participants in the project or the Ukama network as a whole.

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The Ukama platform aims at building an informal dialogue process between a diversity of African and European experts bringing together perspectives of the Europe-Africa cooperation, including Climate, Sustainable Development, Economic transformation, International Cooperation, Finance and Trade to facilitate the emergence of such shared expectations. The main objective of the platform is to convene critical thinkers to help set out the themes and issues that are relevant for shared sense of prosperity for Africa and Europe.

GREEN INDUSTRIALIZATION IN AFRICA: Opportunities and Tensions in Africa-Europe Relations

Scoping paper on Nigeria

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LIST OF ACRONYMS

MTNDP	Medium-Term National Development Plan	EPA	Economic Partnership Agreement
GDP	Gross Domestic Product	EIB	European Investment Bank
KWh	KiloWatt Hour	AUA63	African Union Agenda 2063
MW	MegaWatt	NNPC	Nigeria National Petroleum Corporation Limited
GW	GigaWatt	NA2050	Nigeria's Agenda 2050
EU	European Union	NIES	Nigeria International Energy Summit
NDC	Nationally Determined Contributions	REMap	Nigeria's Renewable Energy Roadmap
ETP	EGD	TES	Transforming Energy Scenario
UN	United Nations	NGEP	National Gas Expansion Program
AU	African Union	TEI	Team Europe Initiative
EGD	European Union Green New Deal	H₂-Atlas	Green Hydrogen AtlasAfrica
GDIP	Green Deal Industrial Plan	BMBF	Federal Ministry of Education and Research
RePowerEU	Renewable Energy Powering Europe's Future	AEEP	Africa-EU Energy Partnership
CBAM	Carbon Border Adjustment Mechanism	ECHA	European Clean Hydrogen Alliance
CRM	Critical Raw Minerals	AfCFTA	African Continental Free Trade Agreement
REA	Rural Electrification Agency	LIC	Low Income Country
NERC	Nigerian Electricity Regulatory Commission	NZIA	Net-Zero Industry Act
IRENA	International Renewable Energy Agency	EV	Electric Vehicle
G-H₂	Green Hydrogen	BRI	Belt and Road Initiative
B-H₂	Blue Hydrogen	ECOWAS	Economic Community of West African States
NREEP	National Renewable Energy and Energy Efficiency Policy	UNGA	United Nations General Assembly
EF	Employment Factors	GCCA	Global Climate Change Alliance
UNDP	United Nations Development Programme	ECA	European Court of Auditors
CGE	Computable General Equilibrium	ESG	Environmental, Social and Governance
C&I	Construction and Installation	JETP	Just Energy Transition Partnership
O&M	Operation and Maintenance	WASCAL	West African Science Service Center on Climate Change and Adapted Land Use
ILO	International Labor Organisation		
GJAM	Green Jobs Assessment Model		
FTE	Full time Equivalent Employment		
SHS	Solar Home System		
WEF	World Economic Forum		
NAPTIN	National Power Training Institute of Nigeria		
NGSDP	Graduate Skill Development Programme		
NESP	Nigeria Economic Sustainability Plan		
NOUN	National Open University of Nigeria		
GIZ	German Agency for International Cooperation		
AFD	Fren Development Agency		

Abstract

In this report, we explore the context of industrialization in Nigeria and uncover critical insights into the nation's industrial sector's composition and the shift from a reliance on crude oil and natural gas to more diverse activities. Manufacturing, exhibiting resilience, has remained a stable contributor. The report underscores the urgent need for re-industrialization as Nigeria navigates its path toward green economic transformation. By addressing the complexities and potential of green industrialization, this report aims to shed light on the opportunities and tensions in Africa-Europe relations, offering a comprehensive understanding of Nigeria's journey towards a sustainable and prosperous future.

Against a backdrop of high poverty rates, unemployment, and climate change concerns, Nigeria's Agenda 2050 seeks to transform the nation into a competitive, knowledge-centric economy with ambitious targets for GDP growth and per capita income. A central component of this transformation is the revival of industrialization. However, the report highlights the challenges within the sector, which has seen a significant decline in its contribution to GDP over the past two decades.

This scoping report delves into the dynamic landscape of industrialization in Nigeria, a nation challenged by economic diversification, infrastructure deficits, and governance obstacles. It explores this through the lens of a just and equitable energy transition by viewing policies made by the Nigerian government and agencies within. Our focus was restricted to comprehending the political economy challenges throughout the shift and the employment opportunities. Analysis focused on where the majority of jobs

are, what factors are responsible for industrialisation and who the winners and losers would be in the face of green industrialisation in the country.

A key focus of the paper was on the concerns, narratives, interests, possibilities, tensions, and role—or lack thereof—that Europe plays (and can yet play) in Africa's green industrialization and the similarities that exist between the policy frameworks of both entities. We learn that although Nigeria and the EU have an interest in developing a low-carbon economy, their primary driving forces are very different. Nevertheless, this cooperation is essential to each entity's successful completion of its own energy and/or economic transformation and security. While Europe's focus is set on its commitment to reducing greenhouse gas emissions, it approaches the issue of energy security and job creation with a focus on business and job creation. Nigeria's case, however, is different, as the country's priorities are on the needs of its inhabitants in terms of economic and social development.

As we explore the context of industrialization in Nigeria, we uncover critical insights into the nation's industrial sector's composition and the shift from a reliance on crude oil and natural gas to more diverse activities. Manufacturing, exhibiting resilience, has remained a stable contributor. The report underscores the urgent need for re-industrialization as Nigeria navigates its path toward green economic transformation. By addressing the complexities and potential of green industrialization, this report aims to shed light on the opportunities and tensions in Africa-Europe relations, offering a comprehensive understanding of Nigeria's journey towards a sustainable and prosperous future.

INTRODUCTION: GREEN INDUSTRIALIZATION IN NIGERIA

Nigeria, despite its vast oil reserves, faces multifaceted development challenges. These encompass fragile economic growth, lack of diversification, and infrastructural deficits in key sectors like power. Governance is often hindered by institutional weaknesses, and there is a pronounced trend of deindustrialization. Concurrently, high levels of poverty, unemployment, socio-economic disparities, climate change, limited fiscal space challenges persist (National Planning Commission, 2021).

Nigeria's Agenda 2050 (NA 2050), operationalized via sequential five-year Medium-Term National Development Plan (MTNDP), aims to transform the nation into a competitive, industrialized, and knowledge-centric economy. The vision is for Nigeria to become an Upper-Middle Income Country, driven by economic restructuring and heightened per capita income. Targets include a 7% annual GDP growth from 2021 to 2050 and a per capita income of \$33,328 by 2050. Central to this vision is enhancing economic structure, resourceful poverty reduction, and fostering an environment conducive to individual potential, while addressing global climate concerns and transitioning to a green economy (National Planning

Commission, 2021). Based on the plan, in various important areas, including Manufacturing and Industry, Agro-Processing, Transportation, Infrastructure, Waste Management, Housing and Construction, Water Resource Management, Forestry, and Biodiversity Conservation, the Nigerian government is giving priority to green industrialisation.

Industrialisation is one key approach that is considered to turn things around, and the Nigerian Government is determined to transform several sectors to realise the country's aspirations. The context of industrialization, however, is challenging. The sector comprises thirteen (13) activity sub-sectors.¹ In 2000, Nigeria's industrial sector was a powerhouse, contributing 44% to the nation's GDP. However, by 2021, this figure had dwindled to 21%, marking a significant decline in just over two decades. The crude oil and natural gas sub-sector, once a dominant force at 29%, decreased to 7% by 2021. Meanwhile, manufacturing remained

¹ Oil Refining; Cement; Food, Beverages, and Tobacco; Textile, Apparel, and Footwear; Wood and Wood products; Pulp Paper and Paper products; Chemical and Pharmaceutical products; Non-metallic Products, Plastic and Rubber products; Electrical and Electronic, Basic Metal and Iron and Steel; Motor Vehicles and Assembly, and Other Manufacturing.

Figure 1a. Nigerian Sectoral Structure of GDP

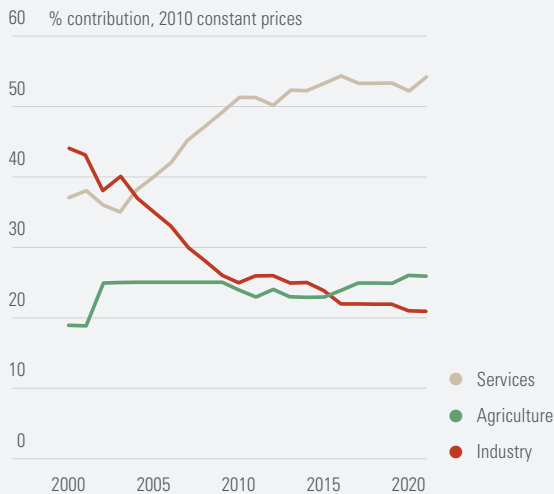
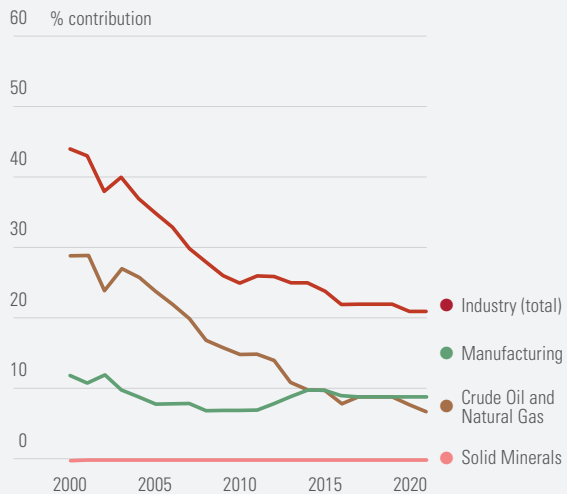


Figure 1b. Structure of Industrial Production to GDP



Source: Authors' compilation using Central Bank of Nigeria (CBN) 2021 Statistical Bulletin: Domestic Production, Consumption and Prices (<https://www.cbn.gov.ng/documents/statbulletin.asp>) dataset

relatively stable, hovering around 9% to 10% in the past decade, showcasing resilience amidst the broader decline (**Figure 1**). Clearly, there is need for re-industrialization in Nigeria.

Nigeria's industrialization struggles due to energy constraints, impacting production, despite its rich renewable energy and natural resources (see **Table A1** in the Appendix). Despite being Africa's top economy, its 2019 power consumption per capita was just 144kWh, lagging behind South Africa's 4,200kWh, Ghana's 351kWh, Sub Saharan Africa's 483kWh average, and the EU's 6,022kWh. Amidst transitions, including digital and energy, Nigeria must choose between oil dependence and renewable energy. Regardless of the direction, foreign expertise and finance are crucial. The problem is that the countries with the resources have decided that they are no longer financing new fossil-fuel projects.²

Nigeria, committed to the 2015 Paris Agreement, has revised/updated its 2021 National Determined Contributions (NDC) to achieve a 47% emission reduction conditional on international support, aligning with the global 1.5°C pathway. In 2022, Nigeria launched its Energy Transition Plan (ETP), pledging carbon neutrality by 2060 with an anticipated investment of US\$1.9 trillion. While the transition promises increased investments and job opportunities in renewable energy, it also hints at potential stagnation and job losses in the fossil fuel sectors, necessitating a careful balance between prospective beneficiaries and adversely affected parties. Energy transitions cause global and local tensions due to varied priorities, policies, and resources. Such tensions arise from energy security debates, economic development stages, and supply chain issues (Buhari, 2022). For a just and equitable transition, understanding the changing job landscape and evidence-based strategies are essential to benefit the country's people.

The EU-Nigeria partnership is built on mutual values and interests. They are both committed to the UN Agenda 2030 SDGs and to the Paris Agreement on climate change, and plans to re-industrialize their economies. These commitments embody green industrialisation—efforts to rapidly grow the economy

without externalising the negative environmental costs of development, driven primarily by renewable energy (Okereke et al., 2019). Nigeria's Agenda 2050 is aligned with the African Union's Agenda 2063, which aims for a sustainable and integrated continent. Nigeria, as Africa's leading economy, has pledged to hit net-zero emissions by 2060. Nigeria Agenda 2050 and the Energy Transition Plan (ETP) underscore this commitment (Energy Transition Office, 2022). This scoping paper emphasizes that these targets and green policy documents exist side-by-side fossil fuel-oriented growth plans (see **Table A2** in the Appendix). Also, despite the climate targets Nigeria has not quite articulated a strong and coherent green industrialization strategy. Highlighting that Nigeria is still caught in between gas and climate action (see **Table A2**). EU's commitment is reflected in the EU's Green New Deal (EGD), targeting climate neutrality by 2050 and enhancing industrial competitiveness through the Green Deal Industrial Plan (EGDIP) (European Commission, 2023). The EU strategically engages Nigeria across three primary sectors: Social, Governance, and Economic, with a focus on health, democracy, and energy diversification respectively.³ As Nigeria's leading export market and a major source of funding for the transition towards a green economy (Aid Atlas, 2023; Observatory of Economic Complexity, 2023; Stout & Meattle, 2022), the EU has also charted a seven-year funding blueprint, the Multiannual Indicative Programme (2021-27), targeting a green economy, governance enhancement, and human development (European Commission, 2021). However, the EU-Nigeria relationship in green industrialization is complex. The EU's 2019 decision to halt financing for overseas fossil fuel projects aligns with climate goals but has sparked concerns in Nigeria about potential economic impacts. Meanwhile, the EU's 2022 Renewable Energy Powering Europe's Future (REPowerEU) initiative, prompted by the Ukraine crisis, aims to diversify gas sources and accelerate the green transition, potentially affects Nigeria's role as an energy supplier. Consequently, Nigeria emerged as largest exporter of LNG to Europe.⁴ Africa's (and Nigeria's) significant reserves of critical raw materials

² <https://afripoli.org/nigerias-energy-transitions-in-a-political-transition>

³ https://www.eeas.europa.eu/nigeria/european-union-and-nigeria_en?s=114#top

⁴ <https://chat.openai.com/c/997f718a-391d-4c4f-8892-6713ed7ee0e7>

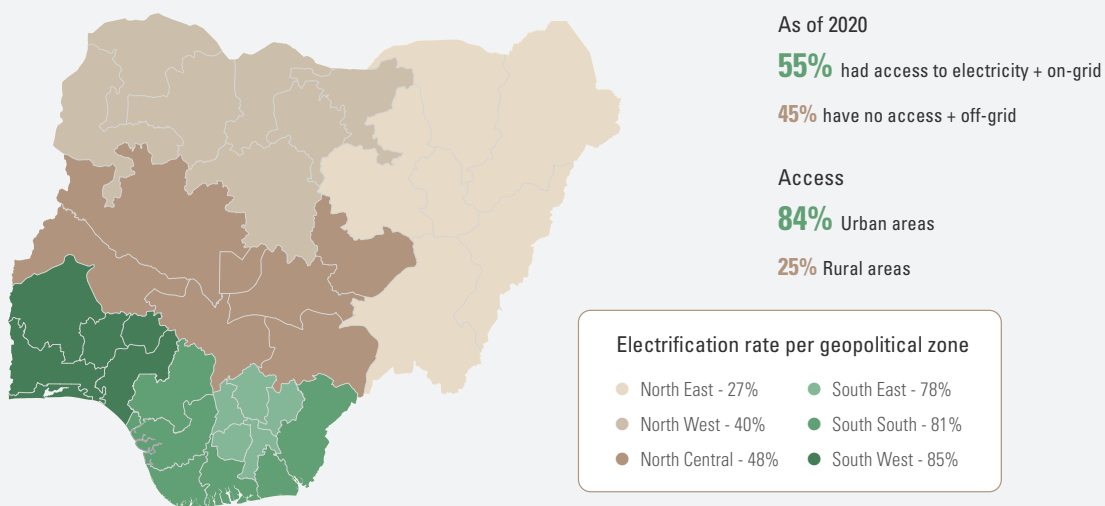
(CRM) are crucial for the EU's green and digital sectors, but EU onshoring targets may conflict with Nigeria's industrialization interests. Moreover, the EU's Carbon Border Adjustment Mechanism (CBAM) faces criticism in Africa as protectionist measures that could limit market access and impose additional burdens. Balancing sustainable development with economic interests will be a key challenge in the EU-Nigeria-Africa relationship. Considering global transitions and Nigeria's ambitions, understanding political and economic factors influencing green Nigeria's transition is vital. While power dynamics and varying interests can impact outcomes, Nigeria envisions a sustainable economy. Nigeria's green transition goals are shaped by political economy dynamics, necessitating strategic planning. With a vision for sustainable growth, Nigeria emphasizes solar energy and green hydrogen, sectors poised for substantial investments, diverse participation, strong governmental support, and international partnerships. This scoping paper uses Nigeria's as a case study to explore the opportunities, challenges, and tensions relating to green industrialization and job creation in Africa. The overarching research question is: what are the key aspects of EU-Nigeria politics as regards Nigeria's ambition for green industrialization and climate action on the one hand and EU's quest for energy security and climate action on the other hand? We

focus on two sectors: solar energy and green hydrogen sectors and explore the potential of these sectors in satisfying energy needs and creating jobs as envisaged in their industrialisation drive. This paper analyses the actors in the sectors and discusses the political economy dimensions of the ongoing transition to better understand interests, tensions, enablers, limitations, and the opportunities to strengthen EU-Africa partnership to inform the required policy or action. The data is sourced from secondary sources — both grey and peer-reviewed literature.⁵

The structure of this document is as follows: Section 2 provides a situation analysis of the solar energy and green hydrogen sectors in Nigeria. Section 3 provides an economic, labour market, and technology analysis of these sectors. Section 4 explores country knowledge and sector aspirations to explore, identify and analyse political economy elements and their impact on achieving a just and equitable transition. Section 5 focuses on the key issues, tensions, and opportunities in the relationship between Europe and Nigeria in the context of green industrialization. Section 6 provides key recommendations.

⁵ The grey literature sources include government ministries, departments, and agencies (MDA) websites and publications. The peer-reviewed literature sources include Google Scholar, Web of Science, Scopus, etc.

Figure 2. Access to electricity situation in Nigeria



Source: (REA, 2021).

SITUATION ANALYSIS OF THE TWO SECTORS

Nigeria's Agenda 2050 (NA2050) notes that Nigeria is energy poor and attributes the underperformance of the country's industrial sector and manufacturing sub-sector to energy poverty (National Planning Commission, 2021). About 90 million remain off-grid, marking Nigeria as having the largest unelectrified population globally. Urban areas fare better with an 84% electrification rate, contrasting with a mere 25% in rural locales. Disparities are also evident regionally, with northern zones like North-East at 27% access, while southern zones like South-West reach 85% (REA, 2021) (see **Figure 2**).

According to the Nigerian Electricity Regulatory Commission (NERC, 2020), the average daily available generation capacity in 2020 stood at 6,107MW—falling slightly by 2.75% compared to 6,227MW in 2019—while the average generation was 4,054MWh. The industry recorded the highest daily peak generation of 5,520MWh in October 2020.

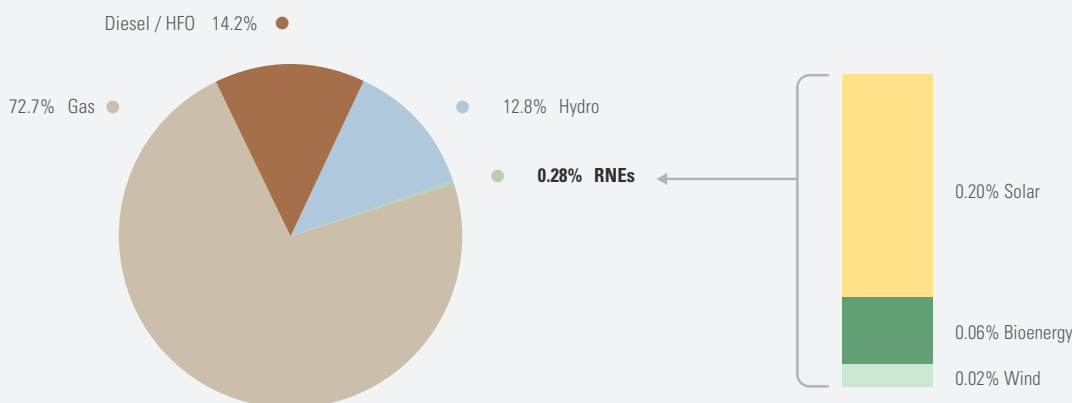
Moreover, the total electric energy generated increased by 5.24% from 33,489,175MWh in 2019 to 35,242,547MWh in 2020. This increase was linked to improved capacity utilisation was due to a reduction in technical and operational constraints relating to gas supply shortage, water management at the

hydropower stations, transmission, and distribution constraints, etc. Meanwhile, compared to the generation capacity of 6,107MW, the present power demand is estimated at 17,520MW, including latent and suppressed demand. To close this gap, Nigeria plans to create 30,000MW by 2030.

Fossil fuel and hydro are the two main sources of power for generating electricity in Nigeria. Electricity generation from fossil fuel, composed mainly of gas thermal power sources, (72.73%), hydro power sources, (12.82%), Diesel/HFO sources (14.17%) and renewable sources (0.28%) (see **Figure 3**). The figure indicates that available installed capacity for renewable energy sources is low in the total installed power mix in the country. Specifically, solar contribute a mere 0.2% of installed capacity Nigeria.

Meanwhile, Nigeria boasts significant solar potential, with daily irradiation equivalent to energy from over a million tons of oil, far surpassing its oil and gas outputs. It receives about 4.85×10^{12} kW/h of solar irradiation per day (see **Figure A1**). This comes from an average of six hours per day of sunlight, which is equivalent to the energy produced from about 1.08 million tons of oil per day (Agbo et al., 2021). Further, this figure corresponds to about 4,000 times

Figure 3. Composition of Installed Power Plants in Nigeria, 2020



Source: NA2050 (National Planning Commission, 2021, p. 91)

the current daily crude oil production in Nigeria and about 13,000 times the natural gas daily production, based on standard energy units (Agbo et al., 2021). This vast clean energy source can propel various economic sectors (National Planning Commission, 2021). Yet, despite its underutilized potential, Nigeria's solar PV market is one of the fastest growing in Sub-Saharan Africa, fueled by the support and active intervention of donors, commercial initiatives, and supportive policies and programme—like the rural electrification programme—to install PV systems in off-grid schools and other public service facilities through presidential influence (REA, 2021). Solar PV's attractiveness lies in its sustainability, versatility, ease of use, and declining costs (All-On & BCG, 2021).

Hydrogen is produced in Nigeria on a modest scale, with Transcorp Ughelli Power using it for cooling its large generators (Aryee et al., 2022). Companies like NewX are progressing with blue and green hydrogen projects. Further, cement production, ammonia production and industrial heating account for 93% of the energy-related emissions from industry in Nigeria (Energy Transition Office, 2022). Thus, green hydrogen (G-H₂) presents a revolutionary pathway for energy

efficiency and decarbonization (IRENA, 2021). Thus, Nigeria's industrial decarbonization, according to its ETP, involves the replacement of grey hydrogen (Hydrogen produced from fossil fuels) with green and blue hydrogen in ammonia production, and the adoption of zero emissions fuels such as clean electricity and hydrogen for heating instead of natural gas and biomass (Energy Transition Office, 2022).⁶ The waste heat from cement plants offers potential for onsite hydrogen production. Solar mini-grids in Nigeria, typically paired with battery storage, could benefit from green hydrogen, addressing challenges of space, weight, and low energy density. In transportation, Nigeria's reliance on petrol due to its oil production and imported vehicles might shift. In 2021, Nigeria started designing engines running on natural gas, hinting at hydrogen's potential role in transportation. Moreover, the global G-H₂ market, poised for a boom, aims to soar from USD 4.02 billion in 2022 to USD 331.98 billion by 2032.⁷ The German government's establishment of a "Hydrogen Office" in Nigeria highlights deepening international ties in green energy. These technology advances promise jobs, affordable energy, and higher living standards.

ECONOMICS, LABOUR MARKET AND TECHNOLOGY ANALYSIS

Job Creation

The quantification of the socioeconomic consequences is at the core of preoccupations for policy-makers, especially in fossil fuel-exporting countries (Emenekwe, Okereke, et al., 2022; Malik et al., 2021; Ram et al., 2022; Rutovitz et al., 2015). In other words, the potential jobs impact is a crucial focus of Just Transition—a green transition would cause a loss of jobs in fossil-based economic activities, while there would be gains in the green economy. Nigeria acknowledges the importance of electricity to its economy and has outlined strategies in its energy

policy to tackle sectoral challenges. Nigeria has a clear ambition in its National Renewable Energy and Energy Efficiency Policy (NREEEP) to increase power generation to 30 GW by 2030 (Chanchari et al., 2023). Further, the revised NDC plans for an increase in solar in the power mix by increasing grid and off-grid solar energy generation capacity by 19.5 GW by 2030. A detailed breakdown is available in **Table 1**.

Employment effects from renewable deployment or energy policies have two primary methods of measurement. The first is input-output (IO) or computable general equilibrium models (CGE), which consider the economy's goods and services flow

⁶ <https://www.energytransition.gov/ng/industry-2-2-2/>

⁷ <https://www.precedenceresearch.com/green-hydrogen-market>

(Emenekwe, Onyeneke, et al., 2022; UNDP and ILO, 2021). These capture macro-economic impacts, including employment, from energy and climate policies. However, they lack detailed job breakdown by technology or fuel. The second, more pertinent to this paper, calculates job intensities or employment factors (EF), representing jobs per unit investment or production. When aligned with energy pathways, they indicate direct employment in a sector. Indirect jobs can also be included using multipliers. Jobs in the energy sector are segmented into stages like manufacturing, construction and installation (C & I), operation and maintenance (O & M), and fuel supply (Malik et al., 2021; Ram et al., 2022; Rutovitz et al., 2015). Each stage and technology need a unique employment factor, and globally, region-specific factors. Manufacturing and C & I jobs relate to added capacity, O & M to existing capacity, and fuel supply factors to production. Job breakdowns also offer insights into the temporal, spatial, and skill characteristics of each technology (Malik et al., 2021; Ram et al., 2022; Rutovitz et al., 2015).

Jobs associated with the power sector have been broadly categorized into manufacturing (MJ_{it}), Construction and Installation (CIJ_{it}), Operation and Maintenance (OMJ_{it}), and Fuel Supply (Fuel) (refer to **Figure B1** in the Appendix for a schematic of how the direct jobs are calculated). For this analysis, the scope is limited to the first three categories (manufacturing, Construction and Installation, and Operation and Maintenance) since fuel supply is not associated with solar energy. Total jobs created in the energy transition up to 2040 are therefore estimated using **Eq. (1)**:

$$TJ_{it} = MJ_{it} + CIJ_{it} + OMJ_{it}$$

where represents the technology deployed—i.e., solar centralized or decentralized. The implementation

of this approach is based on the method proposed by Rutovitz et al. (2015) and adopted by Ram, et al. (2022) and Malik et al. (2021), who analyse job creation during the global energy transition towards 100% renewable power system by mid-century. These authors use the Employment Factor approach (EF) due to its “simplicity and effectiveness.” Employment Factors for various technologies are shown in **Table 2**. The methodology includes a Regionalization Factor to reflect global labor productivity variations, using data from sources like the International Labour Organization (ILO). For Sub-Saharan Africa, a 2030 value of 4.38 is suggested. However, this study adjusts it to 4, anticipating improved labor productivity in the area. The indirect and induced job-years could not be estimated, but earlier studies show these figures can be significant; as much as two to three times the direct job-years (Global Green Growth Institute, 2021). Consequently, this paper surmises indirect and induced jobs by multiplying direct jobs by a factor of 1.5. The results of the analysis are shown in **Table 3**.

By 2030, off-grid solar PV is projected to offer double the jobs in construction and installation (309,668 Job-years/MW) compared to utility-scale Solar PV (154,834 Job-years/MW). Similarly, off-grid solar PV's operation and maintenance will provide approximately double the jobs (25,844 Jobs/MW) versus utility-scale (12,922 Jobs/MW). When accounting for indirect and induced jobs, the total job numbers surge by around 50% across all categories. This underscores the significance of power plant investments, especially in rooftop Solar PV technology, as a robust job creator for Nigeria in the coming decade.

There is a dearth of empirical studies using the approach adopted in this paper. However, we provide

Table 1. Anticipated Solar Power Projects Under Updated NDC by 2030

Sector	Technology	Measure
Power	On-grid solar	6.5 GW Solar PV \equiv 6,500 MW
	Off-grid solar	13 GW off-grid solar (i.e., mini-grids 5.3 GW, Solar Home Systems, and streetlights 2.7 GW, self-generation 5 GW) \equiv 13,000 MW

Note: Battery storage capacities were not specified in the updated NDC

Table 2. Employment Factors (Direct Jobs)

Technology	Manufacturing [Job-years/MW]	Construction and Installation [Job-years/MW]	Operation and Maintenance [Jobs/MW]
On-grid solar	6.7	13	0.7
Off-grid solar	6.7	26	1.4

Table 3. Estimated jobs from additional power plants by 2030 (NDC updated)

Technology	Manufacturing [Job-years/MW]	Construction and Installation [Job-years/MW]	Operation and Maintenance [Jobs/MW]
On-grid solar	39,899	154,834	12,922
Off-grid solar	39,899	309,668	25,844
Total Direct Jobs	79,798	464,502	38,766
Total including Indirect and induced jobs	119,697	696,753	58,149

Note: fuel supply jobs are not considered in solar assessments

estimates from other studies with similar objectives for comparison. A UNDP and ILO (2021) study assessed the impact of Nigeria's climate policies, emphasizing green jobs with the Green Jobs Assessment Model (GJAM). Their results show that renewable energy boosts employment by 27%, with gas close behind at 25%. Interestingly, while renewable energy supports economic growth, it only causes a small rise in emissions. Conversely, gas investment increases both the economy and emissions at the same rate. Investing \$1 million in renewables creates 150 full time equivalent employment (FTEs). Another study (Emenekwe et al., 2022) analysed green energy investment opportunities in Nigeria. Their focus was on the Nigeria Economic Sustainability Plan (NESP) target to provide solar home systems (SHS) to 5 million Nigerian households. Their result shows that investing \$1 million generates 687 FTEs. These SHS are projected to reduce emissions by 115 million tCO₂-eq by 2030. Nigeria's ETP provided jobs assessment of the transition with respect to solar energy and green hydrogen—with direct jobs in the power sector, but also considered indirect and induced jobs. The result of the Net Zero scenario anticipates 170 jobs by 2030, with a notable increase to 420,000 by 2060 (Energy Transition Office, 2022) (see **Figure B2**).

According to a report released on the sidelines of the 2022 United Nations Climate Change Conference (COP27) by Masdar and the Abu Dhabi Sustainable Week platform, Africa has the potential to capture approximately 10% of the global green hydrogen market, which will also help create 3.7 million jobs and a continental GDP of up to 120 billion dollars. According to the report, Africa could be one of the most competitive sources of green hydrogen in the world, with costs ranging from \$1.8 to \$2.6 per kilogram (kg) in 2030, falling to around \$1.2 to \$1.6 per kilogram by 2050 as

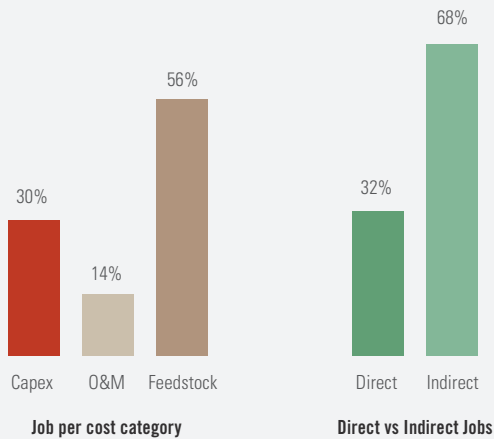
hydrogen production technology matures and renewable energy costs continue to fall (Hako, 2022). Nigeria's ETP anticipates local hydrogen demand for 46 TWh of electricity by 2050 and 34 GW of centralized hydrogen production. Present hydrogen projects, mostly in the pre-commercial phase, have limited electrolyser capacities, usually under 50MW, leading to modest hydrogen demand growth projected until 2030.

There is a dearth of empirically estimated employment effects of green hydrogen investment in Nigeria—and Africa at large. Namibia predicts 80,000 jobs from its green hydrogen sector by 2030, growing to 600,000 by 2040 (Government of the Republic of Namibia, 2022). Further, In the EU, each billion Euro invested in G-H₂ could yield 20,000 supply chain jobs by 2050—production, transmission, storage and utilization (see **Figure 4**) (European Commission, 2019).

Skills Development and Local Talent Pipeline

The transition to renewable energy technologies demand new skill sets. Seplat Nigeria Plc and the WEF reports highlight a current skills gap, especially in the electricity sub-sector. This gap is attributed to years of neglect pre-privatization and the increasing focus of international energy players on renewable energy (Seplat, 2019; World Economic Forum, 2023). The need for professionals with expertise in low carbon fuels, renewable energy, and distributed generation is evident. The World Economic Forum (2023) reports that many large and small-scale clean energy projects rely on foreign expertise for technical assistance and financing advice in Nigeria. Increased energy access, productive use and a just energy transition require expanding skills – especially to rural areas. Thus, skill

Figure 4. Green Hydrogen value chain job creation in the EU by 2050



Source: Authors' compilation based on European Commission (2019).

enhancement is vital for Nigeria's universal energy access and green industrialization ambitions. The National Power Training Institute of Nigeria (NAPTIN), with its flagship programs Graduate Skill Development Programme (NGSDP) and the NAPTIN Technical Skills Acquisition Programme (NTSAP) equip professionals with the requisite skills for the energy sector. Also, NAPTIN's partnerships with entities like the German Agency for International Cooperation (GIZ) Nigeria Energy Support Programme (NESP) initiative, French Development Agency (AFD) and National Open University of Nigeria (NOUN) amplify its impact. Still, there is need to scale up workforce training and retraining activities for the green transition through increased partnerships and funding.

THE POLITICAL ECONOMY OF GREEN INDUSTRIALIZATION AND JUST ENERGY TRANSITION

Overview

Nigeria's industrialization discourse is historically anchored in its oil wealth, but country has never seemed to be in control of the oil resource or the industry. Till date, Nigeria has never been able to develop the value chain of the fossil fuel industry despite the abundance of resources. The result is export of the fossil fuel out in its raw form, and importation of refined products. Exploration of fossil fuel in Nigeria is dominated by multinational companies (MNCs) that enjoy huge tax breaks, but add little jobs, technology transfer and value chain development to the economy. In 2021, civil society legislative advocacy Centre (CISLAC) reported that Nigeria lost about \$2.9 billion annually to tax waivers to MNCs in the oil industry. This issue persists because the country seems not to be able exploit her oil resources without the MNCs. **With attention now shifting towards a diversified, greener economy, driven by global renewable energy trends amid climate change concerns**

the country again seem to enjoy abundance of critical raw materials required for the green economy. Thus, new opportunities seem to open for a fresh start on a new industrial policy. However, Nigeria's transition can easily be complex, with tensions between immediate economic needs and long-term environmental aspirations. It should be noted that from the point of view of African industrialization, avoiding GHG emissions is still seen by some key actors as rich countries '*kicking away the ladder*', thus inhibiting African economic development (Byiers et. al., 2023). Issoufou and Ouattara (2011), for instance suggest that African countries must be cautious in attempting to invest in green technologies, due to decline in productivity growth associated with such investment.

Nigeria, being a significant oil producer in Africa, is therefore at a pivotal juncture in the green industrialization and a just energy transition journey. Key political economy factors, including Nigeria's national development aspirations, interest of various stakeholder at home, international

commitments, prevailing environmental challenges, and the vast economic opportunities that green industrialization presents. Nigeria's NA2050 and its MTNDP 2021–2025, the NDC 2021 Update, ETP 2022, among others, underscore the nation's ambition to diversify its economy, reduce its carbon footprint, and ensure a better quality of life for its citizens. It is therefore important that the country strikes a balance between its economic, social, and environmental objectives, with a particular emphasis on fostering green jobs, enhancing resource efficiency, and mitigating environmental degradation. Nigeria's commitment to international frameworks such as the Paris Agreement and the Sustainable Development Goals (SDGs) necessitates the formulation and implementation of policies geared towards reducing greenhouse gas emissions. **The embrace of green industrialization, particularly solar energy and green hydrogen, can play a pivotal role in alleviating environmental strains, bolstering resilience, and generating employment.**

Nigeria Industrial and Energy Policy Making Process: Role and Priorities of Stakeholders

The policy-making process in Nigeria is fundamentally governed by the principle of federal supremacy, a constitutional mandate that ensures the federal government's leadership in all stages of planning—from formulation to implementation and evaluation. Central to this framework is the National Economic Council (NEC), which serves to advise the president on the nation's economic affairs, with a particular focus on coordinating the economic planning and development programs across various state governments. **The policy-making process (including industrial and energy policies) in Nigeria is underpinned by the collaboration of three primary groups: academics/technocrats, government entities, and non-government actors (Table 4).** Academics and technocrats, often influenced by international perspectives, offer predictions and advice, which become instrumental in the interactions between governmental and non-governmental participants.

Academics and technocrats, often with international backgrounds, provide expert predictions and recommendations that influence the interactions between government and non-government actors, ultimately shaping policy decisions. Government actors comprise the legislature, executive (including chief executives, cabinet members, and advisers), bureaucrats (civil servants and administrative professionals), and the judiciary. Non-government actors include political parties, various interest groups (such as the private sector, labour unions, NGOs, civil society organizations), and the general citizenry. Prominent among the non-government actors are development partners like the European Union (EU) and other global bodies. Their influence, combined with the powerful sway of businesses and corporate entities, plays a crucial role in shaping Nigeria's policies through both bilateral and multilateral engagements.

Stakeholder Analysis: Key Role of EU and other Development Partners

The solar energy and hydrogen sectors in Nigeria are characterized by a plethora of stakeholders, each with distinct interests and challenges. The dynamics governing their interactions are fluid and evolve over time. Prominent actors encompass development partners, the Nigerian government, the private sector, and civil society. Development partners, including the EU, the World Bank, and the African Development Bank (AfDB), play a crucial role in providing financial and technical assistance for the development of solar energy in Nigeria. Each of these entities has its own set of priorities. For instance, the World Bank-assisted Nigeria Electrification Project (NEP) aims to increase access to electricity services for households, public educational institutions, and underserved areas.

The EU has particularly been at the forefront of green transitions, pushing for sustainable practices and offering partnerships and funding to countries like Nigeria. The alignment of discourses between Nigeria and the EU can foster cooperation but may also lead to tensions if expectations and outcomes differ. From the EU perspective, there's a strong push for green transitions, evident in their Green Deal and various funding mechanisms for renewable projects in Africa. In July 2022, under the Team Europe Initiative (TEI), the EU has launched a \$1.35 billion

Nigerian Green Energy Project (NGEP) which is expected to be completed by 2027. Aligned with the EU's Green Deal, the TEI-NGEP aims to aid Nigeria in its economic diversification efforts, emphasizing increased renewable energy access for productive purposes and fostering agricultural development. This

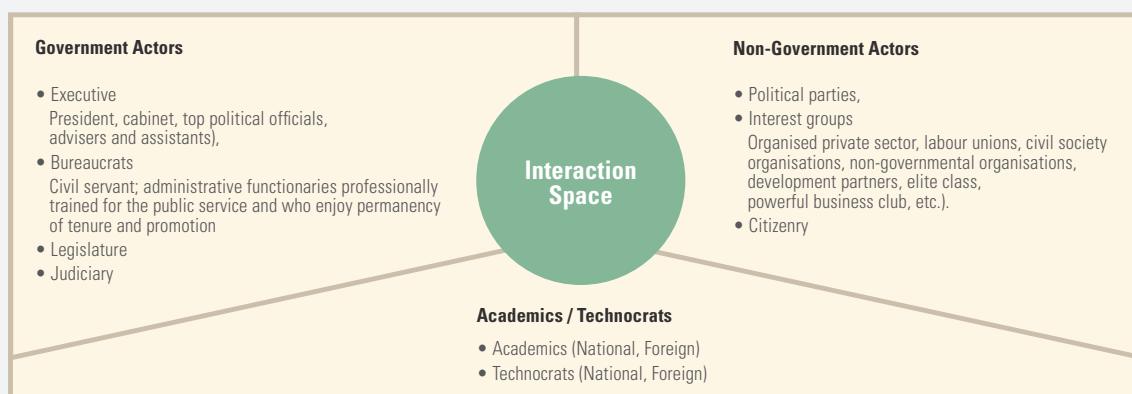
approach integrates circular economy tenets within its growth models. The TEI is anticipated to reinforce Nigeria's commitment to its climate goals.⁸

⁸ EC https://capacity4dev.europa.eu/resources/team-europe-tracker/partner-countries/nigeria/nigeria-green-economy_en

Table 4. Stakeholders / Interest Group Priorities in Nigeria's Industrial Policy Process

Stakeholders/ Interest Group	Roles/Priorities	Tensions, Constraints, and Challenges
Ministries and Government Agencies	<ul style="list-style-type: none"> Formulate fiscal, industrial, monetary, and credit policies. Oversee tariff technical reviews, exploration and production of oil and gas, electrification of rural areas, and more. Coordinate economic plans and synchronize federal and state goals. 	<ul style="list-style-type: none"> Leadership and governance issues delaying economic transformation. Ineffectiveness of anti-corruption agencies. Lack of national consensus against corruption. Weak institutions unable to perform governance-related functions. Lack of coordination leading to institutional conflict and absence of synergy among MDAs.
Legislature	<ul style="list-style-type: none"> Ensure appropriate laws for economic policy. Oversee resource allocation and government accountability. Represent constituents in decision-making. 	<ul style="list-style-type: none"> Effectiveness constrained by political partisanship and corruption. Economic growth and development impacted by the content and process of legislation.
Membership Associations and Chambers	<ul style="list-style-type: none"> Engage in policy processes. Represent organized private sector interests. Consult in policymaking. Create a conducive investment climate. 	<ul style="list-style-type: none"> Inadequate engagement level in policy processes. Insufficient capacity and quality for engagement.
Academic and Research Institutions	<ul style="list-style-type: none"> Support the preparation of development plans. Contribute to policy formulation and review. 	<ul style="list-style-type: none"> Their influence in policymaking is not always achieved in a mutual or reinforcing manner. Public policies often designed to protect class interests of state controllers.
Professional Bodies and Think Tanks	<ul style="list-style-type: none"> Contribute to policy content. Support effective policy implementation. 	<ul style="list-style-type: none"> Potential misalignment between policy recommendations and actual needs of the country, leading to ineffective policy directives.
Development Partners	<ul style="list-style-type: none"> Provide technical and financial assistance. Support with industrial policy advice. Enable bilateral and multilateral cooperation. 	<ul style="list-style-type: none"> Risk of perceived neocolonialism or external pressure without considering Nigeria's unique challenges. Misalignment between development partner goals and Nigeria's specific needs.
Public-Private Platforms	<ul style="list-style-type: none"> Promote integrated support for industrialization. Foster strong partnerships with the government. 	<ul style="list-style-type: none"> Differing priorities and interests between public and private entities can lead to conflicts and slow progress.
Organized Labour	<ul style="list-style-type: none"> Mobilize support for industrial development. Engage government on economic solutions. Recognize and address constraints to industrialization. 	<ul style="list-style-type: none"> Their involvement in policymaking is tenuous and needs strengthening. Challenges like policy inconsistency, high interest rates, and unfavourable tariff regimes impact their effectiveness.

Figure 5. Mapping of Actors (Stakeholders) in Nigeria's green industrialization and energy transition policy process



Source: Adapted from Just Urban Transition –2021– Stakeholder map

Table 5.

Project name	Total budget	Implementation period	Implementing agencies	Geographical region	Objectives
The Electrification Financing Initiative (ELECTRIFI) country window	30 MEUR	7 years (2018 – 2024)	FMO - EDFIMC	Nationwide	To bridge the gaps in structuring and financing of investments addressing the lack of access to clean, reliable and affordable electricity and energy services in Nigeria
First contribution to AFIF in support of the energy sector in Nigeria	107,7 MEUR	5 years (2016 – 2020)	blending through AFD	Nationwide	To improve access to electricity from renewable sources To reduce environmental impact of the Nigerian energy sector
Second contribution to AFIF in support of the energy sector in Nigeria	65 MEUR	5 years (2016 – 2020)	blending through AFD, FMO	Nationwide; Northern Nigeria	To enable and foster investments for sustainable energy; To allow the diversification of on-grid generation capacity through renewable energy; To improve access to electricity for disadvantaged, mostly rural, communities
SUNREF Nigeria	87.720 MEUR	56 months (from 31/07/2018)	AFD	Nationwide	To improve access to electricity from renewable sources To reduce environmental impact of the Nigerian energy sector

Source: https://www.eeas.europa.eu/delegations/nigeria/european-union-%E2%80%93-nigeria-development-cooperation-programmes-compendium-0_en

Also in 2022, the EU, in collaboration with the German government, provided a €9.3 million fund through the REA to scale up access to electricity in rural communities under the Nigerian Energy Support Programme (NESP) framework. The NESP supports the Mini-Grid/Interconnected Mini-Grid Acceleration Scheme (I)MAS, which provides grants to encourage more solar mini-grid projects in Nigeria and facilitate access to reliable and affordable electricity, especially in the unserved and underserved areas of the country.⁹

Development Partners and Their Influence:

Development partners, including international financial institutions and donor agencies, have significantly influenced Nigeria's energy trajectory. Historically, these entities have shaped the nation's energy policies, often aligning them with broader global objectives. For instance, the World Bank and the International Finance Corporation have been instrumental in promoting renewable energy projects in Nigeria, echoing their efforts in countries. The African Development Bank (AfDB) has also been pivotal, providing both financial and technical support for green energy initiatives. These partnerships, while beneficial, have sometimes led to tensions, especially when local priorities clash with international agendas. The EU and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), a German development agency, provide technical assistance, fundraising support, and policy reform through the Nigeria Electricity Support

Program (NESP). Shell Foundation, as part of a consortium, supports the Nigeria Off-Grid Market Acceleration Program (NOMAP) through technical assistance to address market barriers limiting energy access in Nigeria. Additionally, the Heinrich Boell Foundation Nigeria Renewable Energy Roundtable (NIRER) offers advocacy, training, information on access to finance through the Nigeria Renewable Energy Roundtable (NIRER)—a partnership of government ministries, development agencies and private sector organizations that seeks to resolve issues and bottlenecks that limit the expansion of the off-grid market in Nigeria. Additionally, the United Kingdom Foreign Commonwealth Development Office (FCDO) provides technical assistance through the African Clean Energy Technical Assistance Facility (ACETAF) which aims to catalyse a market-based approach for private sector delivery of renewable energy electrification technologies, with a focus on high quality stand-alone solar systems. The EU and the French Development Agency (AFD) jointly announced a grant agreement of €25 million for the Northern Corridor Project to strengthen the electricity grid in the North-West of Nigeria (AFD, 2022).

The German government is promoting G-H₂ development and export from Nigeria, recognizing its potential benefits. However, Nigeria's G-H₂ market is still nascent, with challenges ranging from policy gaps to market awareness. The Nigerian government's forthcoming G-H₂ strategy could provide the necessary

⁹ REA <https://rea.gov.ng/rea-european-union-and-german-government-provide-grants-to-support-solar-mini-grid-projects-in-nigeria/>

impetus for growth, but collaboration with the private sector and civil society will be crucial.

Stakeholder Relations: Government's Green Initiatives and Challenges

Government institutions in Nigeria play an important role in the solar energy market by serving as the foundation of the overall enabling environment, enacting the necessary regulatory frameworks and administering market catalysing national support programs. Government's role is expressed through several ministries (e.g., Federal Ministries of Power, Petroleum Resources, Environment, Finance, etc.) and agencies (e.g., Rural Electrification Agency [REA], Nigerian Electricity Regulatory Commission [NERC], Energy Commission of Nigeria [ECN], National Power Training Institute of Nigeria [NAPTIN], etc.). In its 2021 updated NDC, the government set ambitious targets to eliminate diesel and gasoline power generation by 2030. Additionally, it targets 30% of on-grid electricity generation from renewables, including 6.5GW from solar energy. Moreover, it targets 13GW off-grid electricity generation from mini-grids (5.3GW), solar home system and streetlights (2.7GW), and self-generation (5GW) (Federal Ministry of Environment, 2021). Nigeria attracts foreign investment in solar PV due to political stability and pro-environment and -capitalist interests. Despite this, challenges like policy inconsistency, limited institutional capacity, and limited public awareness, and substandard product imports hinder solar PV adoption (Owebor, Diemuodeke, Briggs, & Imran, 2021).

The government has shown commitment to solar energy as pivotal tool to support economic activities. The Nigerian Government, through the Rural Electrification Agency (REA) has identified solar PV as a viable alternative to bridge this electricity access gap; with a target to deploy solar PV systems (mini-grids and standalone solar systems) to more than 10 million unelectrified households by 2030 (All-On & BCG, 2021). Government's support for solar PV development has been both direct and indirect. Direct support includes the Solar Connection Intervention Facility (i.e., Solar Power Naija), which the government launched as part of the economic recovery plan in

response to the COVID-19 pandemic—the Economic Sustainability Plan (ESP).¹⁰ The core objectives include expanding energy access to 25 million individuals (5 million new connections) through the provision of Solar Home Systems (SHS) or connection to a mini grid; increasing local content in the off-grid solar value chain and facilitating the growth of the local manufacturing industry; and incentivizing the creation of 250,000 new jobs in the energy sector.¹¹ The indirect support include exemption from import duties on PV components, enforcing systems of product quality standards, and supporting specific credit schemes to suppliers and customers (REF). The National Renewable Energy and Energy Efficiency Policy (NREEEP) of 2015 is the key policy in relation to renewable energy. Some of the incentives under NREEEP include tax incentives to manufacturers of renewable energy and energy efficient equipment and their accessories to promote widespread use including a five-year tax holiday for manufacturers from the date of commencement of manufacturing, and a five-year tax holiday on dividend income from investments on domestic renewable energy sources. Others include incentives for importers to offer energy-efficient appliances and lighting through exemption from excise duty and sales tax; custom duty rebate for two years on the importation of equipment and materials used in renewable energy and energy efficiency projects; and provision of soft loans and special low-interest loans from the power sector development fund for renewable energy supply and energy-efficiency projects (Netherlands Enterprise Agency, 2021). Despite the high potential for solar PV, gas-fired thermal electricity generation is favoured by the government through its control of the primary national gas supplier, the Nigeria Gas Company (NGC).¹²

Stakeholder Relations: Private Sector and Other Stakeholders' Dynamics

Nigeria's private sector is vibrant and diverse, playing a crucial role in the nation's energy landscape. Both local and foreign investors are actively involved in on-grid and off-grid solar projects. Companies like Aliko Dangote's Dangote Industries Limited are exploring

¹⁰ <https://nep.rea.gov.ng/federal-governments-5million-solar-connections-program/>

¹¹ *ibid.*

¹² <https://www.thecable.ng/politics-and-nigerias-electricity-sector>

renewable energy solutions, signalling a shift in the business community's approach to energy. Nigerian Breweries Plc (NB) and Cross Boundary Energy installed and operate a 650-kW solar plant located at NB's Ibadan Brewery.¹³ Further, government and donor support to this sector is limited to general VAT and duty exemptions for PV components as part of the enabling environment. Civil society organizations and missions promote solar PV-powered water pumps and vaccine refrigerators in health clinics to remote off-grid parts (All-On & BCG, 2021).

Institutional solar PV support is mainly by government and donors for the power provision, for example, the installation in public institutions in off-grid areas by the REA. Mini-grids mostly receive support from development partners and government. Some mini-grids are owned and operated by local cooperatives under community-based systems. The government has introduced FiTs and PPAs to guarantee set payments to solar energy providers for their electricity. These mechanisms boost large-scale solar investments by offering long-term revenue certainty, facilitating funding, and attracting foreign direct investment.¹⁴ Generally, rural electrification receives substantial subsidies through rural electrification agencies or cross-subsidization within utilities. Viable options for government and donor interventions to support PV in rural electrification include the provision of project development support, subsidies, and finance and, more indirectly, by providing the necessary regulatory set up for operators. Several development partner support is geared toward influencing policy through capacity-building and providing technical support to develop specific policy measures.

The private sector includes local and foreign investors, community-based organizations, and cooperatives. They invest and develop on-grid and off-grid solar projects in Nigeria (All-On & BCG, 2021). Private sector benefits from a favourable policy environment, the high solar potential, and the growing demand for electricity in Nigeria. There has been intense competition between the private sector actors, with some using the state to impose formal standards which were not widely adopted in the market. Others have

influenced policy to deliberately keep the tariff low, with support from government.

Civil Society and Advocacy Civil society organizations in Nigeria play a pivotal role in the energy sector. The civil society comprises actors such as non-governmental organizations (NGOs), research institutions, media, and consumers. They advocate for sustainable solutions, raise awareness, and often bridge the gap between communities and policymakers. They represent the needs of different stakeholder groups including women, youth, and marginalized groups. Organizations like the Nigerian Renewable Energy Roundtable (NiRER) have been vocal advocates for green energy solutions, emphasizing the socio-economic benefits of such a transition (USAID, 2022).

Communities and Their Role Communities, often at the receiving end of energy policies, are crucial stakeholders. In Nigeria, community engagement is vital, especially in regions with significant energy projects. The Niger Delta, for instance, has been a hotspot for oil-related conflicts. As Nigeria transitions to greener energy solutions, ensuring community involvement and addressing their concerns will be paramount.

Challenges to Industrialization and Job Creation in Nigeria

Solar PV and G-H₂ in Nigeria offer a promising solution to reduce the demand for grid-supplied electricity and fuel carrier for industrial decarbonization. However, their development has largely been left to market dynamics. While solar PV is often touted as an affordable energy solution, especially for rural areas, its adoption faces significant barriers. Key challenges include:

High Upfront Costs and Financing: The initial investment required for solar PV systems can be prohibitive for many, especially in rural areas. Availability of funds is a major challenge. The sector is estimated to need about \$3.1 billion in financing, of which approximately \$1.4 billion in funds are available and investments worth \$227 million were made between 2015 and 2020 by development finance institutions (DFIs), development partners and Nigerian Federal

¹³ NBPLC <https://www.nbplc.com/nigerian-breweries-pioneers-first-solar-powered-brewery-in-africa/>

¹⁴ SolarQuarter <https://solarquarter.com/2023/08/04/nigerias-solar-energy-revolution-government-incentives-fuel-large-scale-investments/>

Government (~55% of total), commercial banks (<1%) and other investors, leaving a financing gap of about \$1.5 billion. Of the investments made, only about 7% were directed towards local SAS companies. According to Archibong and Osafo-Kwaako (2020) Nigeria require about U.S. \$410 billion in incremental funding to finance the country's Energy Transition Plan between 2021 and 2060, thus \$10.5 billion annually. Nigeria's total capital expenditure of 2023 is N5.35 trillion (currently equivalent to \$7.2 billion) is significantly less than the country's annual required investment in green infrastructure. The total capital budget for energy and transport related infrastructure is only \$888.84 million. Added to this inadequacy of financial resource is a shrinking fiscal space for expanding investment in key infrastructure. The 2023 budget of Nigeria's federal government will run on a deficit of N10.78 trillion (52.56% of the budget), a 69% increase from 2022, debt service will be N6.32 trillion (up by 75%), borrowing to support future expenditures is becoming tricky.

In terms of financing models in the solar PV market, significant supplier financing exists in the decentralized PV market, but there are issues with accessing it currently. First, majority of companies (esp. local companies) are in the early stage of development (new entrants) and patient capital (grants and equity) is required to achieve scale. Secondly, most common type of financing offered by investors is debt (~55% of investments between 2020-25). Thirdly, developers find it hard to access loans because of the high interest rates, short loan periods and high collateral requirements etc.

Another key finance-related challenge is the Level of Involvement of local financial institutions in the solar PV market. All On reports that only four commercial banks provide financing to solar PV developers. Further, there are only 5 microfinance institutions (MFIs) provide consumer financing for solar PV products—typically provided via partnerships in with Solar PV companies and development partners. There are no commercial banks currently providing consumer financing. The challenges identified for these unfavourable developments are: concessional financing available but loan tenures are too short and limited commercial bank awareness on how to assess risks related solar PV projects.

Commercial: Demand is highly fragmented with early-stage PV developers unable to offer more competitive prices, hence impacting affordability. There is limited consumer awareness regarding solar and its benefits, which results in PV developers bearing the financial and operational burden of educating customers; this limits impact and attainment of scale in increased adoption of DPV products. The PV market has a highly fragmented demand. This makes it difficult for companies to benefit from economies of scale and lowers profit margins.

Operational: Unclear and cumbersome importation process in Nigeria causes delays in the business operations of PV developers: long wait times (63% more time than SSA average) and high costs (68% more money spent in Nigeria than SSA average); inefficiency in customs administration e.g., lack of performance standards for customs officers; and lack of distinct and appropriate standards e.g., lack of coordination among customs officers, SON around HS codes, exemptions and quality standard. Another operational challenge is Availability of relevant skills in the solar PV market. Skills shortages across value chain limit the ability of PV developers to scale and vertically integrate across value chain. Limited number of qualified installers in the market reduces efficiency of solar PV projects. Also, Nigeria's low human capital index and low quality of education system contribute to the lack of relevant skills in the market. Noteworthy, development of training curriculums specific to solar or incorporating solar PV training into existing curriculum can address current problems.

Enabling environment: The Nigerian government has introduced several regulations that support the growth of the renewable energy (including solar PV) market. Examples include 5-year tax holiday for manufacturing companies in RE sector, 0% import duty on solar components; regulations for FIT for RE sourced electricity; SONCAP standards to ensure customers have access to high quality products. However, there are regulations that limit growth and there are regulatory gaps that need to be addressed. Examples of regulation limiting growth: Increase in import duty on solar products (except panels) from 0% - 5%; increase in VAT (5% - 7.5%); High duty on batteries (~20%); Low licensing threshold (1MW)

for power generation. Examples of gaps for which regulations need to be introduced: Lack of net and gross metering policies; No specific DPV regulatory framework that includes clearly defined guidelines to support growth of the market.

Additionally, government regulations and actions are consistent with the ambition for increased share of solar in power generation mix. Over the last 5 years, the government has introduced several policies and regulation to support activities and growth of the DPV market in Nigeria. Examples include: the National Renewable Energy And Energy Efficiency Policy (NREEEP) and National Renewable Energy Action Plan (NREAP 2015 – 2030) - Develops renewable energy and energy efficiency (RE & EE) targets and action plans. Power Sector Recovery Programme - Increases electricity access by implementing off-grid renewable solutions. NERC Minigrad Regulation - Provides definition, registration and grant of permit for minigrad systems.

Grid Integration Issues: Integrating solar PV into the existing grid poses technical challenges.

Competition from Other Energy Sources: Nigeria's rich oil and gas reserves mean that solar PV competes with well-established fossil fuel industries.

Balancing Stakeholder Interests: The Nigerian government must navigate a complex landscape of stakeholders, from consumers and producers to investors and regulators.

Green Hydrogen: A Nascent Market with Potential The promotion of G-H₂ in Nigeria mirrors some of the challenges faced in Nigeria. Key issues include:

As a major oil-producing country, several stakeholders, from multinational corporations to local communities, depend on oil revenues. These stakeholders might resist the transition to green energy, fearing loss of income and relevance. The Niger Delta region, a major hub for Nigeria's oil industry, has communities that rely heavily on oil revenues. A shift away from oil could lead to socio-economic disruptions in the region.

Nigeria relies heavily on imported technology for renewable energy projects, leading to dependency on foreign expertise and products. This dependency can hinder the development of local expertise and increase costs due to import

tariffs and currency fluctuations. Solar panels and hydrogen production systems, wind turbines, crucial for renewable energy projects, are primarily imported, making Nigeria dependent on foreign suppliers and global market dynamics. While Nigeria has a burgeoning workforce, there's a significant gap in specialized expertise in the renewable energy sector. The lack of local expertise can slow down the implementation of green projects and increase reliance on foreign consultants, leading to capital flight. The development of solar farms or hydrogen facilities often requires foreign experts, which not only increases project costs but also limits knowledge transfer to local professionals.

Finding a role for the private sector could be challenging. The high cost of providing clean energy in the short term relative to non-clean options could be a disincentive for the private sector to venture in clean energy provision. Ideally the private will focus on cost minimization, and short-term profit maximization rather than long-term technological upgrading that will help to create more clean energy access in the future. The result of this is market failure, leaving the state (public sector) to incentivize private sector production of clean energy, provide the big push (if able) or provide the clean energy.

Nigeria's domestic energy and industrialization goals might sometimes conflict with international obligations, especially with entities like the EU. Striking a balance between domestic needs and international commitments can lead to policy dilemmas and potential friction with international partners. While the EU might push for stringent environmental standards in green projects they fund, Nigeria might prioritize rapid industrialization, leading to potential disagreements on project implementation. While the EU offers financial and technical support for green initiatives in Nigeria, it also benefits from accessing Nigeria's market and resources. Balancing Nigeria's interests with the EU's objectives might lead to compromises that aren't always in Nigeria's favour. The EU's push for biofuels led to increased demand for crops like palm oil. While this could benefit Nigerian exporters, it also raises concerns about land use and deforestation.

Winners and Losers in Nigeria's Green Industrialization

Nigeria's transition towards green industrialization will inevitably create both beneficiaries and those adversely affected. The dynamics of this transition, influenced by political, economic, and social factors, will determine the landscape of winners and losers.

Winners

- 1. Consumers with Access to Clean Energy:** Green industrialisation can ensure that communities and individuals historically marginalised have access to clean and affordable energy. Such transitions can bring renewable energy projects closer to rural and underserved areas, providing employment opportunities, improved access to electricity, and reduced pollution levels. The communities will thus gain access to clean, reliable, and affordable energy sources, especially solar PV, will benefit from improved living standards and reduced energy costs.
- 2. Entrepreneurs and Innovators:** The green transition offers vast opportunities for entrepreneurs in Nigeria. Innovators in the solar and green hydrogen sectors can tap into new markets, create jobs, and drive the nation's industrialization forward. According to the IRENA (2022) report, solar energy and G-H₂ sectors can create numerous job opportunities, and Nigeria, with its vast potential, stands to gain significantly.
- 3. Development Partners and Investors:** As Nigeria pushes for green industrialization, there will be increased opportunities for development partners and investors to fund and support various projects, from solar farms to green hydrogen production facilities. These stakeholders can achieve both financial returns and contribute to sustainable development goals.

Losers

- 4. Fossil Fuel Industry and their workers:** A transition toward renewable energy could potentially pose challenges for traditional fossil fuel industries in Nigeria, such as oil and gas extraction. Reduced demand for fossil fuels may lead to job losses and economic downturns in these sectors, impacting individuals and communities dependent on them.

Also, workers lacking the necessary skills to transition into the clean energy sector may face difficulties finding alternative employment opportunities. These workers may experience unemployment and economic insecurity without proper support and retraining programs.

- 5. Environmental Concerns:** While solar energy is a cleaner alternative to fossil fuels, the production, and disposal of solar panels and e-cooking appliances can have environmental implications. Issues such as resource depletion, pollution from manufacturing processes, and waste management of obsolete panels and appliances can pose challenges. Recent studies highlight the impending challenge of solar panel waste, which Nigeria will need to address.
- 6. Policy Makers and Regulators:** Balancing the diverse interests of stakeholders in Nigeria's energy sector will be a complex task. Regulators will grapple with setting fair tariffs, managing subsidies, ensuring quality standards, and fostering innovation while ensuring that the transition remains inclusive and equitable.

Opportunities for Industrialization and Job Creation in Nigeria

Solar-Powered Solutions for Agriculture and Communication Given Nigeria's vast rural areas and the challenges of grid access, there's a significant opportunity for solar-powered cooling & refrigeration systems, especially for cattle farmers. Solar cold storage systems can address the substantial post-harvest losses, a challenge that has economic implications. Additionally, the sales of solar PV systems in Nigeria have been outpacing the rate of new grid connections, indicating a strong market for off-grid solar solutions (All-On & BCG, 2021). Solar PV lighting can play a pivotal role in enhancing educational development in remote rural areas. Furthermore, the rural regions of Nigeria present a vast market for solar water pumping solutions. With the increasing need for connectivity, there's a demand for solar charging points for mobile phones and solar lamps, promoting not just education and health but also financial and digital inclusion.

Electric Vehicle Infrastructure: The emerging electric vehicle industry in Nigeria will necessitate the establishment of charging points across both urban and rural areas, presenting another avenue for green industrialization.

Green Hydrogen (G-H₂) and Its Potential: The last-mile connectivity, a significant priority of the Nigerian government, indicates that increased connectivity will likely surge the demand for e-cooking. With the expanding electricity grids, increasing reliability, and the advent of battery-supported appliances, there's a substantial opportunity for scaling up e-cooking adoption. The dropping prices of lithium-ion batteries and solar photovoltaic (PV) power, coupled with the rising cost of solid biomass fuels, make investing in e-cooking even more attractive. The increasing availability of energy-efficient e-cooking equipment, such as electric pressure cookers and induction cookers, presents an opportunity to promote clean cooking while keeping energy bills low.

Diversification of Economy: Moving away from oil dependence and investing in renewable energy sources like solar and hydrogen can diversify Nigeria's

economy. Countries like Morocco have successfully invested in solar energy, reducing dependence on fossil fuels.

Job Creation: Green industrialization can create new job opportunities in manufacturing, installation, and maintenance of renewable energy technologies. In South Africa, the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) has created thousands of jobs.

Environmental Protection: Transitioning to green energy reduces greenhouse gas emissions and mitigates climate change impacts. Kenya's investment in geothermal energy has significantly reduced carbon emissions.

Energy Security: Investing in solar and hydrogen energy can enhance energy security by reducing reliance on imported fossil fuels. India's push for solar energy has increased energy self-sufficiency. Social and Economic Development: Green industrialization aligns with sustainable development goals, promoting social and economic well-being. Brazil's focus on bioenergy has contributed to rural development and social upliftment.

GREEN INDUSTRIALIZATION IN AFRICA: KEY ISSUES, TENSIONS AND OPPORTUNITIES TO STRENGTHEN EUROPE-NIGERIA RELATIONSHIP

Overview

This section examines the EU-Nigeria (including AU) partnership and compares policy objectives to find common and differing goals. It explores energy transitions, trade, and financial instruments as key areas for EU-Nigeria green industrialization partnership. The EU is a key partner in the implementation of Nigeria's development blueprint—Nigeria Agenda 2050 (NA2050) and its five-year Medium-Term National Development Plans (MTNDPs), guided by the Sustainable Development Goals (SDGs). Behind this relationship is the private sector in Nigeria and Europe contributing to an improved investment and

business climate in the implementation of SDG, and climate financing. EU institutions (including the European Investment Bank (EIB)) have important roles in leveraging climate finance and impact in Nigeria. However, issues and tensions that could be a cause for concern in the EU-Nigeria relationship include, but not limited to, the EU's inconsistency with support for gas exploration in Nigeria and other developing countries, Nigeria's refusal to sign the Economic Partnership Agreement (EPA), driven by the EU, the EU's implementation of the Carbon Border Adjustment Mechanism (CBAM) policy—we explore these in the next sub-section.

Issues and tensions in the EU-Nigeria relationship

The EU and Nigeria share green industrialization goals (Table A2), yet their unique starting points can cause tensions (Karkare & Medinilla, 2023). Europe and Nigeria's divergent priorities in climate and energy policy result in policy tensions. To move EU-Nigeria partnership forward and refocus on the opportunities for a mutually beneficial green transition. The EGD's, AUA63's NA2050's goals depend on international partnerships, especially between the two regions, due to their close socio-economic ties. Implementing the EGD will impact Nigeria. Collaborative efforts on energy transitions and promoting renewable energy can foster trade opportunities and job creation in both continents. However, Nigerian leaders might perceive the EGD as an imposed agenda, linking it to sovereignty and justice concerns (Buhari, 2022). They may fear that it introduces new aid and trade conditionalities and diverts attention from commitments like climate finance and poverty reduction in Nigeria. This section explores the major sources of tension that will need to be addressed.

EU-Nigeria cooperation on energy transitions

Fossil fuel phaseout

The EU relies heavily on other countries to satisfy its energy demand. More than 55.5% of the EU's gross available energy came from imported sources in 2021.¹⁵ Russia was until recently the highest energy supplier, but many African countries contribute significant proportions (Usman et al., 2021). In 2021, Nigeria was a major suppliers of the EU's crude oil with 29 million tonnes (6.52%) and 13 billion cubic metres (Bcm) of the bloc's natural gas imports (2.04%).^{16,17} About 47% and 45% of Nigeria's crude oil and liquefied natural gas, respectively, went to the EU (EIA, 2020). Thus, a transition from fossil fuel to green energy trade relations between the EU and Nigeria is crucial to reaching commitments made under the Paris Agreement.

Decisions on phasing out fossil fuels are closely related to questions of sovereignty and justice. All African countries combined have until now only contributed 3% of cumulative global CO₂ emissions compared to the EU's 22%. Some African countries rely heavily on fossil fuels both for domestic consumption and for exports. For example, oil and gas account for a decreasing but still very substantial share of Nigeria's public revenues and foreign exchange earnings—75% and 86%, respectively (Gençsü et al., 2022). It also exports around 40% of its crude petroleum to the EU¹⁸ and will be heavily affected by the EU's decarbonisation process.

Nigeria has made political commitments to address CO₂ emissions in the energy sector: Nigeria's NDCs predominantly focus on energy as a main priority. The NA2050 and the Agenda 2063 aim to build environmentally sustainable and climate-resilient economies and communities (Goal 7) and to promote renewable energy (African Union, 2013; National Planning Commission, 2021). Further, Nigeria has proposed an energy transition plan (ETP). Nevertheless, the country continues to explore new oil fields. The Nigeria National Petroleum Corporation Limited (NNPC) unveiled the discovery of hydrocarbon deposits in commercial quantity in the Kolmani River II Well on the Upper Benue Trough, Gongola Basin, in the northeastern part of the country in November 2022. Two months later, NNPC's Group Chief Executive Officer, Mele Kyari, announced the discovery of oil in Nasarawa State which will start drilling in March 2023. Further, Total Energies, a French energy company, announced the Ntokon oil and gas discovery off the southeast coast of Nigeria in June 2023.¹⁹

Yet, phasing out fossil fuels can bring socio-economic opportunities. To accelerate the green transition, the EU-Nigeria partnership should focus on those areas of energy transition that hold the greatest co-benefits in terms of job creation and growth. Important trade-offs of fossil-fuel phase-out, such as potential job losses and stranded assets, will need to be tackled to avoid constraining other areas of development and to gain

¹⁵ EChttps://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_statistics_-_an_overview

¹⁶ EUcrudeoilimports:https://ec.europa.eu/eurostat/databrowser/view/NRG_TI_OIL_custom_8141443/default/table?lang=en

¹⁷ EUnaturalgasimports:https://ec.europa.eu/eurostat/databrowser/view/nrg_ti_gasm_custom_8142034/default/table?lang=en

¹⁸ OE<https://oec.world/en/profile/bilateral-product/crude-petroleum/reporter/nga>

¹⁹ TotalEnergies<https://totalenergies.com/media/news/press-releases/nigeria-totalenergies-makes-oil-and-gas-discovery-offshore-oml-102>

acceptance from Nigerian partners and stakeholders involved. Re-training and transitional income support, possibly financed through fuel subsidy recycling are possible instruments here.

Gas as a transition fuel

The “green” classification of natural gas at the 2022 EU-AU Summit increased interest in Africa’s gas reserves.²⁰ As Europe’s gas needs surge, African countries with the necessary infrastructure stand to benefit. With an annual growth rate of 5.6%, Africa is on track to supply about 295 billion cubic meters of gas in 2025. Its contribution to global gas production could increase from 6.4% in 2019 to 10.1% by 2050, dwarfing Europe’s projected 1.3% (Usman et al., 2021). Established exporters like Nigeria, stand to benefit from this increased European gas needs.

Nigeria’s ETP and the EU’s EGD have goals of primarily using renewable energy, but they see gas as a transition fuel. In February 2022 at the Nigeria International Energy Summit (NIES), Nigeria emphasized its strategy to regard gas as a transition fuel.²¹ Timipre Sylva, the Federal Minister of Petroleum Resources, confirmed this direction, dubbing it the “decade of gas.” Highlighting the energy deficit in Nigeria, he stressed the necessity of affordable and reliable energy in the energy transition. While both Nigeria’s ETP and the EGD prioritize renewables, they envision gas playing a supportive role.

According to Nigeria’s Renewable Energy Roadmap (REMap), the Transforming Energy Scenario (TES) indicates that the share of primary energy requirements met with renewable energy reaches 47% by 2030 and 57% by 2050, while creating numerous jobs and health benefits (IRENA, 2023b).²² Moreover, the TES envisions 62 GW (77% from renewables) and 178 GW (92% is renewable) of electricity generation capacity in 2030 and 2050, respectively. Solar PV, a “no-regrets” investment, will constitute 32 GW

in 2030 and 115 GW by 2050.²³ The REMap notes that, to meet the TES goals, Nigeria must redirect and increase investments to prevent long-lasting fossil fuel commitments, such as gas pipelines. By 2050, the TES will use over 40% less natural gas and 65% less oil than the Planned Energy Scenario (PES), implying major changes in infrastructure investments. The focus on fossil fuels as transition resources may lead to overlooked long-term implications and risks of stranded assets (IRENA, 2023b).

Meanwhile, in November 2019, EU finance ministers agreed to phase out EIB lending to unabated oil and gas projects from the end of 2021.²⁴ The Nigerian government rolled out the National Gas Expansion Program (NGEP) in December 2020 to deepen the use of natural gas at home and to make it a preferred form of cleaner, cheaper energy for both personal and industrial use (OPEC, 2021). In response to the EU stance, Nigeria’s former Vice President, Yemi Osinbajo, during a meeting with a delegation of the EU led by its Executive Vice President, Valdis Dombrovskis, advocated that the international community should preserve financing for gas projects in Nigeria and other developing countries, during the transition to net-zero emission.²⁵ He reiterated that a just transition is one that supports Nigeria’s gas exploration as transition fuel while phasing out coal and diesel.

To compensate for the slowdown in Russian gas deliveries—and to replace clean energy lost due to its shutdown of nuclear power—European countries backtracked on their clean energy ambitions. For example, Germany revived coal plants previously scheduled for closure, while Norway ramped up oil and gas production. Some European countries are even burning fuel oil again to generate electricity.²⁶ The European Commission proposed the Renewable Energy Powering Europe’s Future (REPowerEU) Plan in May 2022 with the aim to rapidly decrease the EU’s dependency on Russian fossil fuels in response

²⁰ <https://energychamber.org/aec-urges-au-and-the-africa-climate-summit-to-prioritize-labeling-natural-gas-and-nuclear-as-green-energy-renewable/>

²¹ <https://nigeriaenergysummit.com/nies-2022/>

²² Nigeria Energy Roadmap’s Transforming Energy Scenario (TES) represents what would occur under an increased renewable uptake, while the Planned Energy Scenario (PES) represents what would occur under current and planned policies.

²³ Intermsof electricity generation shares, solar contributes 70% by 2030 and 84% by 2050 under the TES.

²⁴ EIB <https://www.eib.org/en/press/all/2019-313-eu-bank-launches-ambitious-new-climate-strategy-and-energy-lending-policy>

²⁵ Premium Times <https://www.premiumtimesng.com/news/top-news/446620-osinbajo-urges-eu-not-to-stop-financing-nigerias-gas-projects.html?tztc=1>

²⁶ Foreign Policy https://foreignpolicy.com/2022/07/14/europe-africa-energy-crisis-gas-oil-fossil-fuels-development-finance-hypocrisy-climate-summit-world-bank/#cookie_message_anchor

to the hardships and global energy market disruption caused by Russia's invasion of Ukraine.²⁷ As part of the REPowerEU, Matthew Baldwin, deputy director general of the European Commission's energy department announced that the EU is seeking additional gas supplies from Nigeria, where he held meetings with officials.²⁸ He further noted that the EU imports 14% of its total LNG supplies from Nigeria and there is potential to more than double this share.

This development suggests that the EU, alongside other rich countries, have decided that the current energy emergency lets them burn whichever fuel they like, whereas poor countries are not allowed that choice at all. The Nigerian former President, Buhari, in October 2021, criticized Europe's stance, echoing what many perceive as a neo-colonialist conspiracy to keep Africans from attaining prosperity and accusing them of not always practicing what they preach with respect to global climate agenda (Buhari, 2022).²⁹ To legitimize their decision, the EU Parliament, in June 2022, backed EU rules labelling investments in gas and nuclear power plants as climate-friendly, throwing out an attempt to block the law that has exposed deep rifts between countries over how to fight climate change.³⁰

The EGD, REPowerEU, ETP champion natural gas as a transition fuel, but this perspective is not without risks for Nigeria. If Nigeria leans too heavily on gas, it may inadvertently delay its transition to renewable energy. This is concerning as global inclinations are favouring renewables. Going all-in on gas, particularly in the face of the world's push for zero emissions, has its demerits. The emerging threat of stranded assets amplifies these concerns, potentially leaving Nigeria with untapped resources and surging debts.

Solar power and green hydrogen projects in Nigeria indicate that renewables have the potential to provide affordable and clean energy on a large scale (see **Table B1**). Decentralised renewable energy production is especially capable of promoting electrification in remote areas. To tap into the green energy

potential, the EU should engage in energy partnerships with Nigeria to facilitate solar energy development through technology transfer, capacity building and much-needed investments in adequate infrastructure expansion (such as electricity grids). In that sense, cooperation programmes such as the Nigeria Energy Support Programme (NESP), established in 2017³¹, need to be substantially scaled up and the proposed "Nigerian Green Energy Project (NGEP)" under the Team Europe Initiative (TEI) is a step in this direction.

Growing role for green hydrogen

In Europe, political attention has recently focused on hydrogen and power-to-X technologies that could allow for transporting green energy over long distances. However, these technologies take time to become operational; they require well-developed local infrastructure and highly specialised skills to operate them. With its renewable wealth, Nigeria emerges as a prospective key supplier for Europe's escalating hydrogen appetite. Initiatives like the Africa-EU Energy Partnership (AEEP) and the EU's European Clean Hydrogen Alliance (ECHA) pave the way for deeper cooperation (Denton et al., 2021; Usman et al., 2021). As the EU targets 40 gigawatts of external hydrogen imports by 2030, it collaborates closely with the African Union to harness Africa's capabilities. The projected investment in this sector could soar to €75.6 billion by 2030.

To harness green hydrogen's potential, German ministries are deepening collaborations with African countries. A highlight of this partnership is the Federal Ministry of Education and Research (BMBF)-backed Green Hydrogen Atlas Africa (H₂-Atlas) project.³² It brings together German professionals and experts from 31 African nations to investigate key aspects of G-H₂ production and use. Recognizing Europe's mounting energy concerns and geopolitical shifts, the German Embassy in Nigeria and the German-Nigerian Hydrogen Office emphasize G-H₂'s role. This collaboration culminated in a dialogue at NIES 2023 in Abuja,

²⁷ EC https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131

²⁸ Reuters <https://www.reuters.com/world/africa/eu-looks-replace-gas-russia-with-nigerian-supplies-2022-07-23/>

²⁹ Newsweek <https://www.newsweek.com/climate-crisis-will-not-fixed-causing-energy-crisis-africa-opinion-1644227>

³⁰ Reuters <https://www.reuters.com/business/sustainable-business/eu-parliament-vote-green-gas-nuclear-rules-2022-07-06/>

³¹ GIZ <https://www.giz.de/en/worldwide/26374.html>

³² <https://www.h2atlas.de/en/>

focusing on a just energy transition. The overarching goal is to position Nigeria as a formidable player in the green hydrogen export market.

Germany's Chancellor, Olaf Scholz, visited Nigeria in October 2023 as part of a three-day visit to West Africa.³³ Part of his mission was to agree an energy partnership to diversify Germany's energy sources. At an economic forum in Lagos on 30th October, Scholz was quoted as follows:

"Nigeria has an ambitious plan for the energy transition,"... "And you are also well positioned to remain a key player for renewable energy and hydrogen — as well as for liquefied natural gas, which we will continue to need in the coming years until the hydrogen market is fully established."

G-H₂, while environmentally advantageous, grapples with challenges in production cost and scalability. As noted by the H₂-Atlas, producing G-H₂ in Nigeria is costlier than blue H₂ (B-H₂). The Levelized Cost of G-H₂ is between \$4 and \$17.4 per kilogramme in Nigeria, compared with between \$2.8 and \$3.5 per kg for blue hydrogen. It, therefore, appears to be uncompetitive to deploy green hydrogen currently. Such economic considerations may account for Nigeria's ETP eyeing significant green hydrogen contributions only after 2030. Africa's potential to fully exploit its G-H₂ capabilities on its own raises questions. IRENA's (2023) report highlights that renewables, though on the rise, accounted for only 20% of Africa's energy in 2018, with an anticipated leap to 48% by 2040. In 2022, Nigeria's 37 MW solar capacity was markedly overshadowed by South Africa's 6,326 MW. Notably, Nigeria's hesitancy towards ramping up solar is due to thermal plant overcapacity issues in the grid, due to distribution challenges, not demand shortage, not a demand deficit (Solar Financed Africa, 2021). Even with these challenges, the ETP earmarks substantial solar energy projects as central to Nigeria's energy transition.

Several contentious issues also exist. Exporting G-H₂ as a primary resource presents challenges, such as increasing dependence on foreign technologies and straining local land and water resources. In the absence of a robust domestic strategy, Nigeria could find its policies swayed by external influences. Moreover,

Nigeria's resources should not be exclusively used to meet Europe's energy demands. Beyond G-H₂, there is also the opportunity to consider gas as a transitional fuel. By blending H₂ with natural gas or retrofitting existing infrastructure, Nigeria can leverage current energy partnerships to increase up H₂ production. Moreover, if energy access continues to be a major problem for socio-economic development in Nigeria, the first priority of international cooperation should be to invest in meeting Nigerian domestic demands.

EU-Nigeria trade relations

As the largest market worldwide, the EU can influence global standards in production and trade. The EGD states that "as the world's largest single market, the EU can set standards that apply across global value chains." Indeed, the European single market is the biggest export market for Nigeria, and 32.3% of Nigerian exports in 2022 were to the EU-27.³⁴ Changes in EU trade policy can therefore have an enormous impact on developing countries. The EU should use its economic power to promote sustainable trade relations and value chains, but at the same time try to avoid new trade barriers and allow flexibility for countries that face difficulties in meeting these standards right away. The implementation of the EGD will have major consequences for its trade relations with Nigeria countries. Trade in resource- and CO₂-intensive sectors could decrease, whereas new trading opportunities in sectors that are vital for green transitions and circular economies could open. One key aspect is the European Carbon Border Adjustment Mechanism (CBAM). Nigerian exports of fossil-fuel energy, machinery or chemicals could be affected. Furthermore, higher environmental standards could impact on agricultural trade. The EU should aim to minimise the risk that the objective to promote sustainable trade relations translates into new trade barriers for Nigeria.

Avoiding new trade barriers

There is a risk that the EGD introduces additional non-tariff trade barriers via a carbon border tax or high environmental standards at a time when the creation

³³ DW<https://www.dw.com/en/germany-seeks-nigeria-energy-and-migration-partnerships/a-67253189>

³⁴ EChttps://webgate.ec.europa.eu/isdb_results/factsheets/country/details_nigeria_en.pdf

of the African Continental Free Trade Agreement (AfCFTA), which the Nigerian Federal Government approved the ratification of the Agreement on November 2020,³⁵ is supposed to boost trade relations (Berger et al., 2020). A CBAM is the Commission's tool to limit carbon leakage and incentivize global climate actions by taxing imports, like steel, from countries with lower carbon standards.³⁶

The introduction of the EU's CBAM presents challenges, especially for countries heavily reliant on exports to the EU. A recent study ranked Nigeria among the top-six most exposed to the EU's CBAM (Zimmer & Holzhausen, 2020) (Figure 5). Over 87% of Nigeria's exports are fossil fuel-based and will be potentially affected by the CBAM.³⁷ The secondary adverse effects on Nigeria's economy could be felt on low output, foreign exchange, employment, wages, and taxes. The mechanism could impact Nigeria's trade balance linked to EU-bound exports.

Since Nigeria might also be burdened by the CBAM, the EU proposal should take account of this concern.

Moreover, accompanying assistance measures should potentially be put in place for Nigeria (and other Low-Income Countries (LICs)). In addition, the proceeds from CBAM should be used to assist Nigeria to cut back on the carbon intensity of its economy. Furthermore, starting October 2023, the CBAM's transition phase offers Nigeria and other African countries a chance for sustained dialogue with the EU and potential technological advancement to reinforce its industrial ambitions. Yet, the CBAM's unilateral structure hints at Nigeria possibly being sidelined in the EU's decarbonization agenda, potentially leading to potential diplomatic and trade tensions.

Critical raw materials for the transition

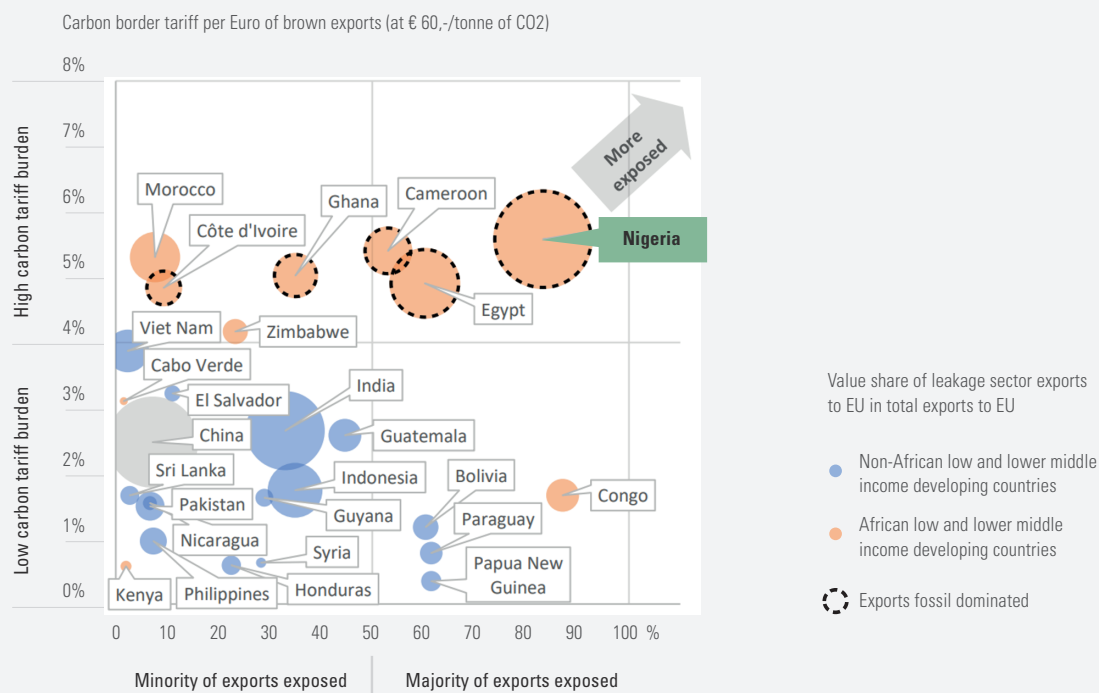
The shift towards green industrialization and digital transformation has amplified the clamour for specific

³⁵ CBN <https://www.cbn.gov.ng/MonetaryPolicy/afcfta.asp>

³⁶ EC https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

³⁷ OEC <https://oec.world/en/profile/country/nga/>

Figure 6. Exposure of lower income developing economies to EU CBAM



minerals and metals (Denton et al., 2021). In February 2023, the EC rolled out pivotal plans: the Green Deal Investment Plan (GDIP) and Net-Zero Industry Act (NZIA), both hammering on technology advances for a net-zero stance and strengthening Europe's manufacturing strength. The EGD opens opportunities to promote sustainable value chains. One sector is particularly important: Mining and resource extraction, which is of strategic importance to the EU. The EGD might champion sustainable growth, but without key raw materials, it is a distant dream. The EU's Critical Raw Materials (CRM) Act presents 30 such materials. Within the EGD, the EU aims to ensure "the supply of sustainable raw materials, in particular of critical raw materials necessary for clean technologies, digital, space and defence applications." Many of these strategic resources are available in Nigeria, for example lithium, cobalt, which are both vital for renewables and e-mobility. Through the EGD, the EU's demand for these materials will increase, which creates new opportunities for trade.

Europe's increasing appetite for CRMs is a double-edged sword for Nigeria. The country, historically classified as a mere raw material supplier, is poised for more—but not without challenges. This point was further stressed by Germany's Chancellor Scholz during his Nigerian visit. He remarked that investment in Nigeria's solid minerals should go beyond just extraction.³⁸ He said:

"It is also important that we use the way of developing your economy in the fields of the minerals you have. I think that the investments into this structure must be easy, but also beneficial for your country."

"It is something that bothered me a lot in the past that sometimes it was just about extraction, which is not enough. There should be one bit more for making it feasible that some parts of the economic development can be used in the countries of origin."

While the promise of technological growth and skilled jobs looms, so do environmental threats like habitat destruction and amplifying existing vulnerabilities. And with these resources, is the EU merely moving its carbon liabilities to Africa's ledger? The geopolitical scene is dynamic, with powerhouses like China

and Europe making their moves—China, with its vast Belt and Road initiative (BRI), and Europe, with its ambitious €150 billion Global Gateway program. But Europe's African strategy is riddled with colonial legacies, inconsistent policies, and a looming question: Is the Global Gateway a genuine hand of partnership, or a manoeuvre to offset China's influence? Meanwhile, the African narrative is evolving. The continent's leaders are increasingly vocal, championing partnerships over patronage, and advocating for equitable trade dynamics, skill transfer and retention of economic value from its vast natural resources.³⁹

Nigerian leadership stance

Nigeria is the only remaining West African country that is yet to sign the Economic Partnership Agreement (EPA), which is inspired by the European Union (EU) with the aim of eliminating trade restrictions between it and ECOWAS member states. Following years of negotiations led by the EU, the EPA text was finalised in 2014 with promised benefits to developing countries like Nigeria including better access to EU markets and integration into a global economy.⁴⁰ However, with negative reactions from Nigerian manufacturers, civil society actors and trade experts citing the imbalanced benefit to European producers having unfettered access to the Nigerian market over local industries, two former Nigerian Presidents, Goodluck Jonathan and Muhammadu Buhari refused to sign the EPA.⁴¹ To fully enter into force, the Agreement will have to be ratified by the EU (which implies the consent of the European Parliament), by all EU Member States, and by at least two thirds of West African States. The country is moving towards more opening in terms of trade; in July 2019 after much hesitation, Nigeria signed the Africa continental free trade agreement. The two regional organisations in West Africa, ECOWAS and UEMOA, support the EPA.

The EU also faces significant competition with other regional players in Nigeria. In June 2023, Geoffrey Pyatt, USA's Assistant Secretary of State for Energy Resources, disclosed in an interview with BusinessDay, that part of a new strategy is that the U.S government

³⁸ Nairametrics <https://nairametrics.com/2023/10/30/investment-in-nigerias-solid-minerals-should-go-beyond-just-extraction-olaf-scholz/>

³⁹ <https://www.bbc.com/news/business-65649834>

⁴⁰ SocialAction <https://www.tralac.org/images/docs/10279/nigeria-and-eu-economic-partnership-agreement-social-action-briefing-august-2016.pdf>

⁴¹ EP <https://www.europarl.europa.eu/legislative-train/carriage/epa-with-west-africa/report?sid=7301>

is facilitating a strategic energy dialogue (SED) with stakeholders in Nigeria's energy sector to foster collaboration in advancing energy partnerships and energy transition. Further, in October 2023, at the Belt and Road Initiative (BRI) Forum, China announced agreements to increase investments in solar products, clean energy utilisation, and other infrastructural programmes.^{42,43} The European tactic of threatening to cut aid to non-compliant countries and weakening their negotiation position has been termed economic imperialism (Buhari, 2022).

In August 2022, Nigeria's former Minister of Mines and Steel Development, Olamilekan Adegbite announced he rejected Tesla Inc.'s request to mine Lithium on its soil for its products.⁴⁴ Tesla Inc is a global top manufacturer of electric vehicles, battery energy storage, solar panels, and solar roof tiles, and with operations in Europe. The Nigerian government, through its Federal Minister of Mines, wanted Tesla to build a factory in the country or at least build a plant for processing the ore, but Tesla was not keen on the idea. The country's insistence on local infrastructure as a precondition for mining rights is a testament to Africa's newfound agency—a call to rightfully harness and retain the wealth of its vast resources.

During the 2023 United Nations General Assembly (UNGA) Roundtable on critical minerals and energy transition, Nigeria's Minister of Solid Minerals, Dele Alake, highlighted the country's vast mineral wealth, essential for green industrial progress. He projects the sector will increase the nation's economy by 50% and attract foreign investors. These resources, worth more than USD\$700bn, are abundant, especially lithium in states like Nasarawa and Kwara.⁴⁵ President Bola Tinubu's administration is actively backing this sector, providing attractive incentives. This ambition is consistent with the CRM Act and Europe's plan to diversify supply partners.

Yet, challenges loom. A sizeable portion of Nigeria's resource exports (e.g., Nigeria's oil) gets refined not at home, but in the EU. Amid this, the African Continental

Free Trade Area (AfCFTA) emerges, arousing hopes of reviving African trade, emphasizing home-grown processing to elevate the continent's raw material value (Ishmael, 2021; van der Ven & Signé, 2021). Further, several intrinsic challenges emerge: Nigeria, faces limited funds, skill gaps, technology gaps, and energy access challenges. These obstacles slow the pace of resource beneficiation, potentially sidelining Nigeria from fully harnessing its mineral-based economic benefits. Furthermore, the EU's regulatory approach, which is less stringent on local content but emphasizes aiding partners like Nigeria, potentially clashes with Africa's developmental aspirations. This tension is evident in the EU's draft Critical Raw Materials (CRM) regulation, which, while supportive in theory, leaves room for ambiguity and potential conflicts with Nigeria's goals. Moreover, the EGDIP's plan to increase domestic, in-Europe processing, stands against Nigeria's ambition to generate additional value domestically and generate jobs at home.

However, resource extraction in Nigeria, for instance, has often been accompanied by serious violations of human rights and environmental standards (Les Amis de la Terre, 2011). In the Africa-EU partnership, Environmental, social and governance (ESG) considerations are crucial. Nigeria's transition minerals signal a shift from oil, promoting clean energy and diverse economy. Trustworthy supply chains in Africa's high-risk areas are a must. Past environmental or Ogoniland social challenges, notably in Nigeria's Niger Delta and linked to companies like Shell, ENI, and Total, underscore risks (Les Amis de la Terre, 2011).⁴⁶ Illegal mining plagues Nigeria, causing security, environmental, and severe health issues like lead poisoning. Prominent in the Northwest, it disturbs communities and is exacerbated by political and external factors. Moreover, Europe's rising mineral need offers technology collaboration prospects. However, it is essential to ensure equitable partnerships to avoid neo-colonial dynamics. The value of transition minerals is clear, but addressing geopolitical nuances remains critical.

⁴² <https://blueprint.ng/chinese-president-pledges-increased-investments-in-nigerias-power-sector-digital-economy/>

⁴³ ChinaConsulatehttp://lagos.china-consulate.gov.cn/eng/zlsczc/202308/t20230816_11127544.htm

⁴⁴ TeslaInc.GigafactoryBerlin-BrandenburginGermany,whereitmanufacturesModelYvehiclesandmillionsofbatterycells:<https://www.tesla.com/giga-berlin>

⁴⁵ <https://www.premiumtimesng.com/news/more-news/627158-nigeria-will-be-big-player-in-global-supply-of-critical-minerals-dele-alake.html>

⁴⁶ Therealitybehind"energysecurity"oftheEuropeanUnion:ThecaseofNigeria:https://inis.iaea.org/collection/NCLCollectionStore/_Public/50/056/50056367.pdf?r=1

Climate finance and financing EU-Nigeria cooperation

The EU is increasing sustainable investments in Africa through initiatives like the €311.26 million Global Climate Change Alliance (GCCA) and the EU–Africa Infrastructure Trust Fund. The emphasis is shifting from traditional aid to direct investments.

During the period 2010–2021, EU institutions committed 22% (or ~\$415mn) of all development finance flows to Nigeria to climate finance. The energy component constituted about 49% (or ~\$203mn) of the climate finance (Aid Atlas, 2023). Moreover, there is a clear variance between EU climate/energy finance commitments and disbursements. During the 2010–2021 period, total climate finance disbursements were only 21% of climate finance commitments, while energy finance disbursements were about 41% of commitments (see **Figure 7**). These finance flows were a combination of grants and loans. However, a recent audit report by the European Court of Auditors (ECA) indicates that the EU missed its self-imposed target of spending at least 20% of its 2014–2020 budget on climate action—suggesting that climate finance in the EU budget might have been overstated.⁴⁷ The auditors also fear that reliability issues could remain in the Commission's reporting for the 2021–2027 period,

when the EU's new climate spending target will rise to 30%.

It becomes evident that these financial means are not nearly enough to realise the ambitions for global leadership on climate change the EU has set itself in the Green Deal (Hackenesch et al., 2021).

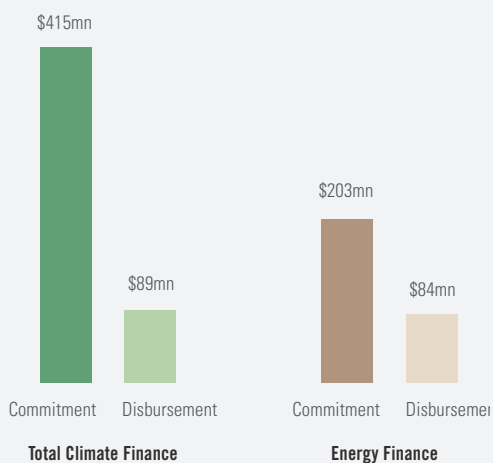
Nigeria urgently needs funding for its green transition—with a debt of over \$108 billion, as of March 2023 (Debt Management Office, 2023), showcasing the typical challenges. The country needs an estimated annual \$17.7 to deliver on the conditional NDC which far exceeds tracked climate finance in 2019/2020 of \$1.9 billion (Stout & Meattle, 2022).

International bodies play a key role in driving green industrialization and finance, but Nigeria receives a minimal share of global renewable funding, with much still going to fossil fuels (Ishmael, 2021). Clean energy investment, at \$798 million, is overshadowed by fossil fuel financing. From 2016 to 2021, Nigeria ranked second in financed fossil-fuel projects. A single LNG project there secured USD 2.77 billion, surpassing the entire climate finance tracked in 2019/2020 (Stout & Meattle, 2022). Meanwhile, Nigeria's goal of 30% renewable energy by 2030 is further impeded by scattered climate funds and the high costs of renewable projects, nearly double the European average (Steffen, 2020).

Other tensions in Africa and the EU relationship

Low-carbon development can sometimes prioritize 'green' over 'justice', overlooking Nigeria's diverse development stages and adaptation needs (Denton et al., 2021). Aligning with local aspirations and emphasizing African leadership is essential for justice. Europe's role in Africa's significant illicit financial losses means the EU can assist in curbing this trend. Exploitative practices, including those from European firms, have cost Africa US\$1.3 trillion from 1980–2018 (Denton et al., 2021). These activities undermine the continent's wealth and health. The EGD's 2050 goal should consider historical emission disparities, and given Africa's past undue exploitation, the EU-Africa partnership must prioritize a "just transition" for a fair green industrialization.

Figure 7. EU Climate Finance Commitment vs Disbursement to Nigeria, 2010–2021



Source: Authors' compilation based on data from Aid Atlas (2023).

⁴⁷ European Court of Auditors (ECA) <https://www.eca.europa.eu/en/Pages/news.aspx?nid=16559>

OPPORTUNITIES

Nigeria's pledge to join hands with the rest of the world to combat climate change by shifting to green energy through diversification of its economy to align with the global climate goal outlined in the Paris Agreement is aligned with the EU's EGD and Fit-for-55 package. In 2022, the EU and its member states and the European Investment Bank launched a 1.3 billion Euro Nigerian Green Energy Project (NGEP) under Team Europe Initiative (TEI). The NGEP presents the overarching umbrella approach that guides the EU to enhance partnership with Nigeria and ensure greater development effectiveness and impact. In line with the EU's Green Deal, the Green Economy Initiative will support the Nigerian government's efforts to diversify the economy by combining support to enhance access to renewable energy for productive uses and boosting the development of the agricultural sector. Ms Inga Stefanowicz, EU Team Leader, Green and Digital Economy in Nigeria, said the European Investment Bank (EIB) and the European Development Financial Institutions would assist various players in the value-chains in the energy and agricultural sectors. Already existing TEI initiatives cover the themes of the Green Economy, Peace and Governance, and Supporting Young Entrepreneurs (European Union, 2021, 2022). The cooperation aims at boosting sustainability and job creation opportunities, especially so for the ever-growing youth demographic.

The energy security interests of the EU in Nigeria relate to the high potential for renewable energy, trade and investment, regional integration and cooperation and innovation and technology. The EU has advanced technology for which they are interested in opening new markets. The AfCFTA is one of the AU flagship projects under the ten-year implementation plan of its Agenda 2063. The main objective is to create a single market for goods and services with free movement of people and investments, thus expanding intra-African trade across the continent, enhancing competitiveness, and supporting economic transformation in Africa. Nigeria approved the ratification of the Agreement in November 2020.⁴⁸ With regard to external cooperation, the AfCFTA strengthens the capacities of African companies to access and supply world markets. Consequently, the AfCFTA would

provide Nigeria with improved access to the EU market on Nigerian exports of goods while Nigeria would gradually open its market to EU imports.

It sets the ground for creating new economic opportunities, with targeted cooperation to enhance Nigeria's economic development and renewable energy sector. The EU has a wealth of experience in digital technology and platforms that enhance efficiency, transparency, and accountability in the renewable energy sector and could share best practices with Kenya. There is the possibility of collaborating in research and development of new technologies and solutions for renewable energy technologies.

Globalization processes have deepened the relationship between Nigeria and the EU. Nigeria is likely to be among the next group of countries to seek international finance for a Just Energy Transition, after South Africa with support from the EU and the US—in other words, a Just Energy Transition Partnership (JETP). This is mainly because of its ambitious climate goals including: reducing the emission of greenhouse gases by 47% compared to business as usual (Federal Ministry of Environment, 2021); commitment to achieve 100% electrification by 2030; and the high share of renewable energy in the generation mix. Nigeria still has challenges of transitioning away from fossil fuels, especially oil which could generate negative impacts on the environment and the local communities in the form of GHG emissions. Nigeria is also exposed to price volatility associated with the reliance on exported crude petroleum and importation of refined petroleum products transport and industrial use. Thus, a JETP agreement for a just energy transition in Nigeria would involve mobilizing financing for appropriate investments, developing the external market for energy products, and ensuring technology transfer (Nweke-Eze, 2022). This would ensure energy sovereignty with a focus on universal access to low-cost, low-carbon energy services and the economic empowerment of citizens and the competitiveness of industry. The landmark 2023 Africa Climate Summit in Nairobi targeted a renewed African climate strategy. Facing a choice between green energy and fossil reserves, protests rallied against "energy neocolonialism," urging that African resources benefit its people. The summit birthed the

⁴⁸ CBN <https://www.cbn.gov.ng/MonetaryPolicy/afcfta.asp>

Nairobi Declaration, signifying Africa's united voice and climate aspirations in global green agenda.⁴⁹ For Nigeria, Cross Boundary Access (CB Access) and ENGIE Energy Access (ENGIE) announced they began construction of the first batch of mini-grids and are expecting mini-grids to begin coming online later this year, as part of their historic agreement to finance and build USD\$60 million of mini-grids in Nigeria, aiming to power 150,000 Nigerian residents.

Capacity development and job creation issues are key. Nigeria's booming youth population confronts considerable unemployment challenges. However, green industrialization, offers vast employment prospects. To capitalize on this, Nigeria needs the EU's technical, financial, and technological assistance. Nigeria, for instance, experiences a skills deficit in areas like renewable energy (Seplat, 2019; World Economic Forum, 2023). Notably, Nigeria also benefits from initiatives like the Digital4Development, enhancing its digital growth (Denton et al., 2021). Nigeria's vast renewable energy potential positions it as a green hydrogen production hub, though this requires enhanced worker training, policies, and a hydrogen strategy. The West African Science Service Center on Climate Change and Adapted Land Use (WASCAL), funded by the German Federal Ministry of Education and Research with 15 West African nations (including Nigeria) and Germany, partners on the Green Hydrogen AtlasAfrica project.⁵⁰ This initiative studies Africa's green hydrogen potential. Moreover, WASCAL provides graduate training, like the International Master's Programme in Energy and Green Hydrogen, to equip the next generation to tackle West Africa's energy and climate challenges.⁵¹ Job sustainability in Nigeria revolves around securing the right funding. By endorsing public-private collaborations, governments pave the way for progress. For context, every US\$1 million in green energy outpaces job creation in traditional sectors (Emenekwe, Onyeneke, et al., 2022; UNDP and ILO, 2021). This green emphasis, vital for young workers, beckons EU involvement.

CHALLENGES

Gaps in human capacity and skills in some aspects of green economy and industrialization require both the private and public sectors to work together and bridge this gap through collaboration with the education sector and institutions of learning. The low demand for off-grid technologies and lack of awareness among the citizens about the effectiveness of off-grid solutions have a lot to contribute to the hindrance of demand creation (All-On & BCG, 2021). Many potential consumers still have the mentality that solar power cannot provide adequate electricity. This has resulted in demand and supply side challenges that have prevented the renewable sector from attaining its potential with the consequential outcome that fossil fuel is still viewed as a legitimate source of energy in Nigeria (Owebor et al., 2021).

Most small and medium enterprises struggle to access international funds, hindering local competition. Off-grid technologies remain costly, with significant reliance on Chinese solar imports. Presently, limited standards exist for green technologies, limiting technology adoption. Some efficiency standards for appliances are emerging. EU's influence on African trade means Africa's exports are swayed by EU decisions and standards, impacting export markets and creating both benefits and disadvantages while promoting a green production approach.

Nigeria, like many nations, does not fully factor in external costs of eco-friendly technologies and practices, diminishing demand for green alternatives. There's a call for policies like green infrastructure spending and environmental taxation. From an investment perspective, While Nigeria's laws treat foreign and national investors equally, challenges persist. These include corruption, ambiguity over foreign companies' capital, land ownership issues, sluggish judiciary, high unemployment, poverty, security concerns, ethnic tensions, and high costs for skilled labor and energy, compounded by inadequate infrastructure.

Moreover, Nigeria's energy transition grapples with conflicts and trade-offs while addressing poverty

⁴⁹ https://unclimatesummit.org/nairobi-declaration-africas-demands-and-aspirations-in-the-climate-fight/?utm_source=twitter&utm_medium=paid%20social&utm_campaign=traffic-uncs%20articles&utm_content=typ-link%20media__adn-acs%2015__aud-4.1

⁵⁰ <https://wascal.org/>

⁵¹ <https://wascal.org/renewable-energies/>

and climate needs. Power dynamics dictate which energy sources and technologies are favored, often aligning with influential domestic and global entities. International donors and businesses, advocating for

low-carbon paths and green growth, heavily influence the solar and G-H₂ sectors. Their support often aligns with government priorities emphasizing market-based energy solutions.

RECOMMENDATIONS AND WAY FORWARD FOR EU-AU COOPERATION ON GREEN INDUSTRIALIZATION AND ENERGY TRANSITION

As already noted, the huge technical, financial and governance requirements of the green industrialization agenda mean that only a multi stakeholder effort can guarantee its success. This is more so given that Nigeria just like several other African countries has failed to industrialize despite previous effort. The new effort will have to be more integrated and coordinated, balancing the interest of each party and defining the role they have to play. We consider four key stakeholders that have a strong role in ensuring the success of the green industrialization agenda and the role they will play in each development objective.

Innovative Financing Mechanisms

Nigeria

- ▶ Explore options to deepen Nigeria's green bond market activities, specifically for financing green industrial projects, and enhance monitoring, reporting and verification (MRV) mechanisms for funded projects.
- ▶ Establish a national green venture capital fund, inviting global investors to support innovative green startups.

African Union

- ▶ Collaborate with the African Development Bank to design specialized financial instruments promoting green industrial ventures.
- ▶ Collaborate with international financial organizations to advocate for debt relief or restructuring for African states, enabling more fiscal space for green investments.

European Union

- ▶ Design a dedicated EU-Africa Green Industrialization Investment Platform, pooling resources and expertise for large-scale sustainable projects.
- ▶ Encourage European private sector involvement in financing African green industrial ventures, ensuring mutually beneficial terms

Solar Energy

Nigeria

- ▶ Incentivize private sector investment in solar energy through Public-Private Partnership (PPP) models tailored for solar infrastructure development.
- ▶ Collaborate with international solar tech firms for technology transfer, ensuring Nigeria benefits from the latest in solar advancements.

African Union

- ▶ Establish a centralized solar data repository, offering insights on solar potential, challenges, and success stories across the continent.

European Union

- ▶ Collaborate on joint research initiatives focused on next-generation solar technologies, creating synergies between African and European research institutions.
- ▶ Dedicate funds specifically for the deployment of pilot solar projects in Africa, focusing on novel technologies and integration methodologies.

Hydrogen

Nigeria

- ▶ Prioritize research into cost-effective green hydrogen production methods, aiming for economic parity with gray hydrogen.
- ▶ Plan a phased integration of hydrogen into the power mix, starting with pilot projects in strategic locations before 2030, laying the groundwork for broader adoption post-2030.

African Union

- ▶ Establish a Pan-African Hydrogen Alliance to consolidate resources, knowledge, and strategies, positioning Africa as a significant player in the global hydrogen market.

European Union

- ▶ Enhance collaboration between EU countries and Nigeria, focusing on shared R&D projects to discover innovative methods of green hydrogen production.
- ▶ Support Nigeria in developing a framework for the potential export of green hydrogen to European countries, ensuring a consistent supply chain

Governance and Participation

Nigeria

- ▶ Establish institutional governance framework including systematic coordination of the private and public sectors, international development institutions and foreign partners.
- ▶ Developing clearly defined objectives and the role to be played by each stakeholder. Clearly defined green industrialisation strategy that eliminates duplicity of roles between government, private sector and international partners.

African Union

- ▶ Developing oversight strategies that will check corruption, and political distortions of the country's governance framework.

European Union

- ▶ Supporting the governance framework established by the Nigerian government by aligning their role to fit in.

- ▶ Developing oversight strategies that will check corruption, and political distortions of the country's governance framework.

Green Industrialization and Job Creation

Nigeria

- ▶ Design vocational training programs focused on skills required for green industries.
- ▶ Offer tax incentives and other benefits to industries that prioritize green practices and job creation.

African Union

- ▶ Develop a pan-African green job certification standard, promoting a consistent quality of green jobs across the continent.
- ▶ Coordinate with labor organizations to ensure that the transition to green industries is just and inclusive.

European Union

- ▶ Support African states in developing employment strategies tailored for green industrialization.
- ▶ Collaborate with African institutions to establish EU-Africa green job exchange programs, allowing knowledge and skill transfer.

Technology and Capacity Enhancement

Nigeria

- ▶ Collaborate with global tech hubs to cultivate centers of green tech innovation within Nigeria.
- ▶ Launch a nationwide program to upskill the workforce in green technologies and sustainable industrial practices.

African Union

- ▶ Spearhead an Africa-wide technology exchange program, enabling member states to share breakthroughs and best practices.
- ▶ Partner with global tech institutions to introduce advanced training programs tailored to Africa's green industrialization needs.

European Union

- ▶ Facilitate a Europe-Africa Green Tech Alliance, fostering joint R&D initiatives and technology commercialization.
- ▶ Support the establishment of EU-Africa green tech incubators, accelerating startups' journey from concept to market.

Strategic Trade Partnerships and Market Access

Nigeria

- ▶ Pursue green trade agreements, emphasizing the export of value-added green products rather than raw materials.
- ▶ Establish a Green Export Promotion Council to identify and tap into emerging global green markets.

African Union

- ▶ Advocate for the inclusion of green goods in Africa's preferential trade agreements, both intra-Africa and with external partners.
- ▶ Launch an African Green Product Certification, ensuring quality and promoting trust in African green goods on the global stage.

European Union

- ▶ Implement a "Green Corridor" for African green goods, offering expedited customs processing and reduced tariffs.
- ▶ Collaborate with African institutions to organize high-profile B2B green trade fairs, spotlighting African innovations in European markets.

Sustainable Infrastructure and Regional Integration

Nigeria

- ▶ Prioritize the development of eco-industrial parks, attracting green businesses with shared sustainable infrastructure.
- ▶ Launch a Green Infrastructure Challenge, inviting innovative solutions for sustainable urban and industrial development.

African Union

- ▶ Champion an Africa-wide green infrastructure development plan, emphasizing cross-border projects that promote regional integration.
- ▶ Establish a Continental Green Infrastructure Knowledge Exchange, fostering best practices and shared learning among member states.

European Union

- ▶ Support the establishment of EU-Africa Green Infrastructure Consortia, pooling resources for transformative sustainable projects.
- ▶ Share expertise on sustainable urban planning and eco-industrial park development, tailored to Africa's context.

REFERENCES

- African Union. (2013). *Agenda 2063: The Africa we Want*. Addis Ababa, Ethiopia: African Union Commission.
- African Union. (2022). *African Union Climate Change and Resilient Development Strategy and Action Plan (2022-2032)*. Addis Ababa, Ethiopia: African Union Commission.
- Agbo, E. P., Edet, C. O., Magu, T. O., Njok, A. O., Ekpo, C. M., & Louis, H. (2021). Solar energy: A panacea for the electricity generation crisis in Nigeria. *Heliyon*, 7(5), e07016. <https://doi.org/10.1016/j.heliyon.2021.e07016>
- Aid Atlas. (2023). *Finance flows from EU Institutions (excl. EIB) to Nigeria for Climate Mitigation during 2002–2021*. <https://aid-atlas.org/>
- All-On, & BCG. (2021). *Socio-economic case for deepening solar PV deployment in Nigeria Content Summary*. https://www.all-on.com/media/publications/_jcr_content/par/textimage_1526415615_925717370.stream/1638346992149/eb7c154019eb5e6263180ff88dd7370d58373b3c/abridged-socio-economic-case-for-deploying-off-grid-solar-pv-in-nigeria.pdf
- Aryee, A., Rehoboth, S., Anene, E. C., & Akomolafe, D. (2022). *Techno-Economic Feasibility Study: Green Hydrogen Production for Use in Off-Grid Applications, Lagos - Nigeria*.
- Berger, A., Brandi, C., Stender, F., Brown, E. K., Apiko, P., & Woolfrey, S. (2020). *Advancing EU-Africa cooperation in light of the African Continental Free Trade Area*. <https://ettg.eu/wp-content/uploads/2020/09/ETTG-EU-Africa-Cooperation.pdf>
- Buhari, M. (2022). *It's time for a new economic deal between the EU and Africa*. <https://www.politico.eu/article/its-time-for-a-new-economic-deal-between-the-eu-and-africa/>
- Chanchangi, Y. N., Adu, F., Ghosh, A., Sundaram, S., & Mallick, T. K. (2023). Nigeria's energy review: Focusing on solar energy potential and penetration. *Environment, Development and Sustainability*, 25(7), 5755–5796. <https://doi.org/10.1007/s10668-022-02308-4>
- Debt Management Office. (2023). *Nigeria's Total Public Debt Portfolio as at March 31, 2023*. <https://www.dmo.gov.ng/debt-profile/total-public-debts/4324-nigeria-s-total-public-debt-as-at-march-31-2023/file>
- Denton, F., Forkuor, G., Nkem, J., Bombande, M.-A., Qondi Moyo, S., Yeboah, T., & Arko, T. (2021). *Bridges of Opportunity: Partnering for Africa–Europe Green Development*. Tokyo: UNU-INRA. <http://collections.unu.edu/view/UNU:8127#viewAttachments>
- EIA. (2020). *Country Analysis Executive Summary: Nigeria*. https://www.eia.gov/international/content/analysis/countries_long/Nigeria/NigeriaCAXS_2020.pdf
- Emekwe, C. C., Okereke, C., Nnamani, U. A., Emodi, N. V., Diemuodeke, O. E., & Anieze, E. E. (2022). Macroeconomics of decarbonization strategies of selected global south countries: A systematic review. *Frontiers in Environmental Science*, 10. <https://doi.org/10.3389/fenvs.2022.938017>
- Emekwe, C. C., Onyeneke, R. U., & Okereke, C. (2022). *Economic analysis of inclusive green recovery and transition opportunities in Nigeria's energy sector: A policy brief*. Centre for Climate Change and Development (CCCD), Alex Ekwueme Federal University Ndufu-Alike, Ebonyi State, Nigeria.
- Energy Transition Office. (2022). *Nigeria's pathway to achieve carbon neutrality by 2060*. <https://energytransition.gov.ng/>
- European Commission. (2019). *Gas for Climate: Job creation by scaling up renewable gas in Europe*. <https://gasforclimate2050.eu/wp-content/uploads/2020/03/Navigator-Gas-for-Climate-Job-creation-by-scaling-up-renewable-gas-in-Europe.pdf>
- European Commission. (2021). *Multiannual Indicative Programme (MIP) for 2021–27*. https://international-partnerships.ec.europa.eu/system/files/2022-01/mip-2021-c2021-9273-nigeria-annex_en.pdf
- European Commission. (2023). *A Green Deal Industrial Plan for the Net-Zero Age EN*. European Commission. https://commission.europa.eu/document/41514677-9598-4d89-a572-abe21cb037f4_en
- European Union. (2021). *EU Projects with Nigeria*. https://www.eeas.europa.eu/nigeria/eu-projects-nigeria_en?s=114
- European Union. (2022). *Team Europe Initiative's 'Investing in Young Businesses in Africa' launched in Lagos*. https://www.eeas.europa.eu/delegations/nigeria/team-europe-initiative-s-'investing-young-businesses-africa'-launched-lagos_en?s=114
- Federal Ministry of Environment. (2021). *Nigeria's First Nationally Determined Contribution (NDC): 2021 Update*. Federal Ministry of Environment. https://climatechange.gov.ng/wp-content/uploads/2021/08/NDC_File-Amended-_11222.pdf
- Gençsü, I., Walls, G., Picciariello, A., & Alasia, I. J. (2022). *Nigeria's energy transition: reforming fossil fuel subsidies and other financing opportunities*.
- GIZ. (2015). *The Nigerian Energy Sector: An Overview with a Special Emphasis on Renewable Energy, Energy Efficiency and Rural Electrification* (2nd ed.). Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.
- Global Green Growth Institute. (2021). *Green Recovery and Climate Action: Assessing Green Jobs from Renewable Energy and Forestry Investments for Developing and Emerging Economies*. Seoul, Republic of Korea: Global Green Growth Institute.
- Government of the Republic of Namibia. (2022). *Namibia: Green Hydrogen and Derivatives Strategy*.
- Hackenesch, C., Högl, M., Knaepen, H., Iacobuta, G., & Asafu-Adjaye, J. (2021). *Green Transitions in Africa–Europe relations: What role for the European Green Deal?* <https://ettg.eu/wp-content/uploads/2021/04/ETTG-paper-22Green-Transitions-in-Africa-Europe-relations22-pdf.pdf>
- Hako, N. (2022). *Green Hydrogen Export Opportunities in Africa Show Endless Promise*. <https://www.esi-africa.com/energy-efficiency/green-hydrogen-export-opportunities-in-africa-show-endless-promise/>
- IRENA. (2021). *Making the breakthrough: Green hydrogen policies and technology costs*. International Renewable Energy Agency, Abu Dhabi, United Arab Emirates. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Nov/IRENA_Green_Hydrogen_breakthrough_2021.pdf?la=en&hash=40FA5B8AD7AB1666EECBDE30EF-458C45EE5A0AA6
- IRENA. (2023a). *Renewable Capacity Statistics 2023*. International Renewable Energy Agency (IRENA). Abu Dhabi, United Arab Emirates. www.irena.org
- IRENA. (2023b). *Renewable Energy Roadmap: Nigeria*.
- Ishmael, L. (2021). *Beyond Aid: Making the EU Strategy with Africa work for Africa*. Munich: Hanns-Seidel-Stiftung e.V. https://www.policycenter.ma/sites/default/files/2022-02/AA_89_EU_Afrika_englisch_%284%29.pdf
- Karkare, B. P., & Medinilla, A. (2023). *In search of shared benefits : Europe and Africa in a global green transition*. 345.
- Les Amis de la Terre. (2011). *The reality behind EU "energy security": The case of Nigeria* (La Realité Derrière La "sécurité Energetique" de l'Union Européenne Le Cas Du Nigeria). http://inis.iaea.org/search/search.aspx?orig_q=RN:50056367
- Malik, A., Bertram, C., Kriegl, E., & Luderer, G. (2021). Climate policy accelerates structural changes in energy employment. *Energy Policy*, 159, 112642. <https://doi.org/10.1016/j.enpol.2021.112642>
- National Planning Commission. (2021). *Nigeria Agenda 2050*. Federal Ministry of Finance, Budget, and National Planning. Abuja, Nigeria. <https://nationalplanning.gov.ng/wp-content/uploads/2023/05/Nigeria-Agenda-2050-Report-Corrected.pdf>

- NERC. (2020). *NERC Annual Reports and Accounts, 2020*. Abuja, Nigeria: Nigerian Electricity Regulatory Commission. <https://nerc.gov.ng/index.php/library/documents/func-startdown/919/>
- Nweke-Eze, C. (2022). *Just energy transitions and partnerships in Africa: a Nigeria case study*. Integrated Africa Power (IAP). Bonn, Germany. https://www.iddri.org/sites/default/files/PDF/Publications/Catalogue/Iddri/Rapport/Ukama_NIG_v05.pdf
- Observatory of Economic Complexity. (2023). *Nigeria: Trends in Trade Flows*. Economic Complexity. <https://oec.world/en/profile/country/nga?latestTrendsFlowSelectorNonSubnatLatestTrends=flow0#Profile>
- Okereke, C., Coke, A., Geebreyesus, M., Ginbo, T., Wakeford, J. J., & Mulugetta, Y. (2019). Governing green industrialisation in Africa: Assessing key parameters for a sustainable socio-technical transition in the context of Ethiopia. *WORLD DEVELOPMENT*, 115, 279–290. <https://doi.org/10.1016/j.worlddev.2018.11.019>
- OPEC. (2021). *Nigeria and OPEC: 50 Years of Partnership*. Vienna, Austria: Organization of the Petroleum Exporting Countries.
- Owebor, K., Diemuodeke, E. O., Briggs, T. A., & Imran, M. (2021). Power Situation and renewable energy potentials in Nigeria – A case for integrated multi-generation technology. *Renewable Energy*, 177, 773–796. <https://doi.org/https://doi.org/10.1016/j.renene.2021.06.017>
- Ram, M., Osorio-Aravena, J. C., Aghahosseini, A., Bogdanov, D., & Breyer, C. (2022). Job creation during a climate compliant global energy transition across the power, heat, transport, and desalination sectors by 2050. *Energy*, 238, 121690. <https://doi.org/https://doi.org/10.1016/j.energy.2021.121690>
- REA. (2021). *Market Study to Support the Nigeria Electrification Project*. <https://nep.rea.gov.ng/Market-Study-to-Support-the-Nigeria-Electrification-Project.pdf>
- Rutovitz, J., Dominish, E., & Downe, J. (2015). *Calculating global energy sector jobs 2015 methodology update 2015*. Prepared for Greenpeace International by the Institute for Sustainable Futures, University of Technology Sydney.
- Seplat. (2019). *Seplat Petroleum Development Company Plc Annual Report and Accounts 2019*. <https://www.seplatenergy.com/media/2hgafrrn/sep-ar19-20-04-21-special-feature.pdf>
- Solar Financed Africa. (2021). *Solar Projects in Nigeria: 10 Largest Solar Power Plants in MW*. <https://solarfinanced.africa/solar-projects-in-nigeria-10-largest-solar-power-plants/>
- Steffen, B. (2020). Estimating the cost of capital for renewable energy projects. *Energy Economics*, 88, 104783. <https://doi.org/https://doi.org/10.1016/j.eneco.2020.104783>
- Stout, S., & Meattle, C. (2022). *Landscape of Climate Finance in Nigeria*. <https://www.climatepolicyinitiative.org/wp-content/uploads/2022/10/Landscape-of-Climate-Finance-in-Nigeria.pdf>
- Sy, M. (2020). Where the Sun Shines. *Finance & Development*, 0057(001), A016. <https://doi.org/10.5089/9781513528830.022.A016>
- UNDP and ILO. (2021). *Nigeria Green Jobs Assessment Report: Measuring the Socioeconomic Impacts of Climate Policies to Guide NDC Enhancement and a Just Transition*. United Nations Development Programme (UNDP).
- Usman, Z., Abimbola, O., & Ituen, I. (2021). *What Does the European Green Deal Mean for Africa?* Washington, DC: Carnegie Endowment for International Peace. https://carnegieendowment.org/files/202110-Usman_etal_EGD_Africa_final.pdf
- van der Ven, C., & Signé, L. (2021). *Greening the AfCFTA: It is not too late*. Washington, DC: Africa Growth Initiative at Brookings. <https://www.brookings.edu/wp-content/uploads/2021/09/21.09.15-Greening-the-AfCFTA.pdf>
- World Economic Forum. (2023). *Mobilizing Investments for Clean Energy in Nigeria: Community Paper*. https://www3.weforum.org/docs/WEF_Mobilizing_Investment_for_Clean_Energy_in_Nigeria_2023.pdf
- Zimmer, M., & Holzhausen, A. (2020). *EU Carbon Border Adjustments and Developing Country Exports: Saving the Worst for the Last*. Allianz Research. https://www.allianz.com/content/dam/onemarketing/azcom/Allianz_com/economic-research/publications/specials/en/2020/november/2020_11_17_EU_CBAM_and_developing_country_exports.pdf

Appendix

Appendix A: Renewable Energy Potentials in Nigeria

Table A1. Summary of Renewable Energy Potentials in Nigeria

Resource	Potential	Comments
Large Hydropower	11,250MW	1,900MW exploited
Small Hydropower	3,500MW	64.2MW exploited
Solar	4.0kWh/m ² /day – 6.5kWh/m ² /day	Significant potentials for solar infrastructure; both for on-grid and off-grid use
Wind	Average of 2-4m/s @ 10m hub height	Moderate wind potentials in the country
Biomass	Municipal waste	18.5 million tonnes produced in 2005 and now estimated at 0.5kg/capita/day
	Fuel wood	43.4 million tonnes/year of fuel wood consumption
	Agricultural residues	91.4 million tonnes/yr. produced
	Energy crops	28.2 million hectares of arable land; 8.5% cultivated

Source: Nigeria Agenda 2050, p. 97

Figure A1. Nigeria - Solar irradiation and PV power potential maps

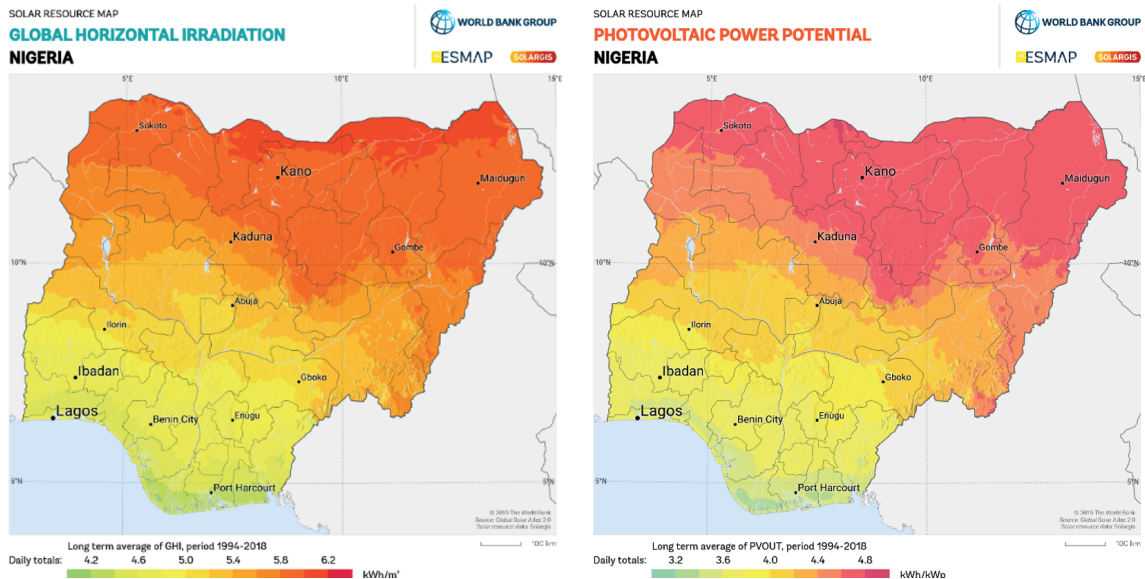


Table A2. Initiatives (industrial plans, energy/climate policies, strategies, and regulations) relevant to green transition

Year	Policies/Regulations	Description (relevance for Solar/hydrogen)	SDGs	AU	EU
2012	Renewable Energy Master Plan (REMP) Update	<ul style="list-style-type: none"> A comprehensive plan to increase the role of renewable energy in Nigeria's energy mix It proposed specific share of RE as 13%, 23%, and 36% in 2015, 2025, and 2030, respectively. It did not specify the expected contributions of each RE source 	7	AUA63	EGD
2014	Nigeria Industrial Revolution Plan (NIRP) Objective	<ul style="list-style-type: none"> Based on the plan, by 2017, manufacturing's share of GDP was expected to have increased from 4% to 6%, with a goal of surpassing 10% by 2015. The goal of the Nigeria Industrial Revolution Plan is to accelerate the country's industrialization process by focusing on areas where Nigeria has a comparative advantage, including the agro-allied sectors, the metals and solid minerals industry, the oil and gas industry, construction, light manufacturing, and services. 	7,8,9,13	AUA63	EGD
2015	National Renewable Energy and Energy Efficiency Policy (NREEEP)	<ul style="list-style-type: none"> Defines a guide to achieve a 16% share of renewable energy in electricity generation by 2030. The policy also sets specific deployment target for solar at 5.9% in the country's energy 	7,8,9,13	AUA63	EGD
2015	Nationally Determined Contribution (NDC)	<ul style="list-style-type: none"> Nigeria's NDCs are its global commitment to sustainable development measures that limit the rate of global warming and negative impacts of climate change. Some strategic measures that the revised NDC enshrined to meet the conditional NDC target include: (i) Work towards Off-grid solar PV of 13GW (13,000MW); (ii) 2% per year energy efficiency (30% by 2030); (iii) Improve electricity grid 	3,6,7,9,11, 13,	AUA63	EGD
2015	Renewable Energy Sourced Electricity Feed-In-Tariff (REFIT)	<ul style="list-style-type: none"> These regulations require prioritizing the purchase of 50% of the REFIT-mandated renewable energy electricity capacity. They stimulate private investment through a unique tariff framework for renewables but only apply to projects with a capacity between 1 and 30 MW. 	7,8,9,11, 12,13	AUA63	EGD
2016	National Renewable Energy Action Plan (NREAP)	<ul style="list-style-type: none"> It serves to implement the renewable energy component of the NREEEP Includes policies and measures to support off-grid renewable energy (e.g., solar) growth such as soft loans with low interest rates, subsidy of up to 30% of initial costs, etc. 	7,9,11,12, 13,15	AUA63	EGD
2016	National Energy Efficiency Action Plan (NEEAP)	<ul style="list-style-type: none"> Outlines energy efficiency targets Includes measures such as replacement of kerosene lanterns with solar lighting kits and training programs for staff of Standard Organization of Nigeria (SON) on test methods of off-grid efficient lighting 	7,8,9,11, 12,13	AUA63	EGD
2016	Rural Electrification Strategy and Implementation (RESIP) Plan of Nigeria	<ul style="list-style-type: none"> Plan by the REA to increase rural electrification in Nigeria Includes stand-alone solar systems and mini-grids in rural electrification targets and projects which will encourage their development and rollout by communities and private enterprises 	3,4,7,8,9, 11	AUA63	EGD
2016	Minigrad Regulation Provides the framework for the registration and operations of all mini-grids with capacity of up to 1MW		7,9,11,13	AUA63	EGD
2016	Sustainable Energy for All Action Agenda (SE4All-AA), Federal Ministry of Power	<ul style="list-style-type: none"> The key objectives of the SE4All initiatives globally are to ensure universal access to modern energy services, double the global rate of improvement in energy efficiency, and double the share of renewable energy in the global energy mix by 2030 	7,9,11,13	AUA63	EGD
2017	Eligible Customer Regulation	<ul style="list-style-type: none"> Electricity customers with an energy demand > 2MWh/h per month can directly buy power from a grid-connected generating companies (GENCO), at a price that was mutually agreed 	7,9,11,17	AUA63	EGD
2017	NEC Mini-Grid Regulations, NERC	<ul style="list-style-type: none"> These regulations are the overarching document governing the development of mini-grid electricity generation (0-100 KW – 1 MW) in Nigeria The regulation is designed to accelerate the electrification of unserved and underserved areas especially rural and peri-urban communities, and minimizes major risks associated with mini-grid investments and simplifies the process for private sector participation 	7,9,11,13	AUA63	EGD
2017	Economic recovery and Growth Plan (ERGP)	<ul style="list-style-type: none"> initiatives and strategies related to renewable energy in the broader context of promoting economic growth and sustainable development. It includes a Medium-Term Plan for 2017 – 2020, that builds on the Strategic Implementation Plan (SIP) for the purpose of restoring economic growth. 	9,11,13	AUA63	EGD
2020	Nigeria Electricity Regulatory Commission (NERC) Guidelines on Distribution Franchising	<ul style="list-style-type: none"> Defines a framework for approving franchising agreements under the distribution sector; outlines four franchising models recognized by NERC 	7,9,11,13	AUA63	EGD
2020	Nigeria Economic Sustainability Plan (NESP)	<ul style="list-style-type: none"> The NESP aims to promote the use of renewable energy sources to spur economic growth, including initiatives such as installing 5 million solar home systems 	2,3,8,10,11,13	AUA63	EGD
2020	National Gas Expansion Programme (NGEP)	<ul style="list-style-type: none"> The NGEP was launched to deepen the use of natural gas at home and to make it a preferred form of cleaner, cheaper energy for both personal and industrial use 	7,8,9,11,12,13,	AUA63	EGD, REPowerEU

2021	Nationally Determined Contribution (NDC) 2021 Update	<ul style="list-style-type: none"> Some strategic measures that the revised NDC enshrined to meet the conditional NDC target include: (i) installation of 13GW of off-grid solar energy solutions (ii) 30% of grid-connected electricity generation from renewable energy, (iii) reduction in energy intensity by 2.5%, annually, across all sectors 	3,6,7,9,11,13,15	AUA63	EGD
2021	National Climate Change Policy (NCCP)	<ul style="list-style-type: none"> A policy framework towards addressing the challenges and impacts of climate change in Nigeria's. It prescribes sectoral and cross-sectoral strategic statements and actions, within a medium term time framework, between 2021 and 2030, for pursuing a climate resilient national sustainable development. 	6,7,9,12,15	AUA63	EGD
2021	Nigeria Agenda (NDP) 2050	<ul style="list-style-type: none"> It is the successor plan to the Economic Recovery and Growth Plan, ERGP, 2017-2020. It is a medium-term plan is to bring out 100 million Nigerians out of poverty in a period of ten years. During the planned period, the government's key priorities will be sectors that can create jobs and have positive impacts on other areas including critical infrastructure like power and alternative energy, rail systems, road networks, and housing. 	8,9,11,13	AUA63	EGD
2021	Medium term Plan (NDP) 2021-2025			AUA63	EGD
2022	Energy Transition Plan (ETP)	<ul style="list-style-type: none"> The ETP explores Nigeria's journey to net zero, with a focus on the renewable transition. The ETP is very ambitious on renewables. For example, net zero by 2060 required 200GW of solar, which meant around 7-8GW per year. 	7,13	AUA63	EGD
2022	Long-term Low Emissions Development Strategy (LT-LEDS)	<ul style="list-style-type: none"> The LT-LEDS is a Nigerian strategy developed (under the Paris Agreement Article 4.19) to lower emissions to net zero by 2060. In the LT-LEDS, an economy-wide decarbonisation approach was considered, including both energy and non-energy sectors. The LT-LEDS reports the energy profile, emissions trajectory, employment rate and other macroeconomic indices that are consequences of any of the explored scenarios 	7,9,11,13,	AUA63	EGD
2022	National Energy Policy (NEP) – Revised	<ul style="list-style-type: none"> The revised NEP aims to develop Nigeria's capability and capacity in solar energy utilization, and to use solar energy as the dominant energy option in rural and peri-urban areas with higher solar energy potential. It also aims to develop the market for solar energy technologies and services, complimented by developing local manufacturing capabilities for solar energy conversion technologies 	7,11,13	AUA63	EGD
2022	Germany-Nigeria Hydrogen (H ₂) Diplomacy/Office	<ul style="list-style-type: none"> Nigeria is keen on exploring the possibilities that the nascent hydrogen economy could create for our energy transition. Its objective is to network decision-makers, experts, and companies from both countries and to offer expert advice on the opportunities and challenges posed by the hydrogen economy. 	7,9,11,13	AUA63	EGD
	African Union		SDG	Nigeria	EU
2013	Agenda 2063: The Vision for 2063	<ul style="list-style-type: none"> The Vision of the African Union is to become an integrated, prosperous and peaceful Africa, driven by its own citizens and representing a dynamic force in international arena Goal 1.4: A high standard of living, quality of life and well-being for all citizens Goal 1.2: Well educated citizens and skills revolution in science, technology, and innovation (STI) Goal 1.3: Transformed economies; STI-driven industrialization and economic diversification Goal 1.7: Environmentally sustainable and climate resilient economies and communities Goal 2.3: Worldclass infrastructure criss-crosses Africa Goal 6.2: Engaged and empowered youth and children Goal 7.1: Africa as a major partner in global affairs and peaceful co-existence Goal 7.2: Africa takes full responsibility for financing her development goals 	1-13 1, 2, 8, 11 4 8, 9 6, 7, 13, 15 9 4, 5 17 10, 17	Nigeria Agenda (NDP) 2050, Economic recovery and Growth Plan (ERGP) National Gas Expansion Programme (NGEP), Nigeria Industrial Revolution Plan (NIRP) Objective National Energy Policy (NEP) – Revised, Nigeria Industrial Revolution Plan (NIRP) Objective Nigeria Agenda (NDP) 2050, Nigeria Industrial Revolution Plan (NIRP) Objective, National Gas Expansion Programme (NGEP) ETP, National Climate Change Policy (NCCP), Nationally Determined Contribution (NDC) 2021 Update Nigeria Agenda (NDP) 2050, Nigeria Industrial Revolution Plan (NIRP) Objective Nigeria Industrial Revolution Plan (NIRP) Objective ,Nigeria Agenda (NDP) 2050 Nigeria Industrial Revolution Plan (NIRP) Objective, Germany-Nigeria Hydrogen (H ₂) Diplomacy/Office Renewable Energy Sourced Electricity Feed-In-Tariff (REFIT), Nigeria Industrial Revolution Plan (NIRP) Objective	European Green Deal (EGD), Just Transition Mechanism Just Transition Mechanism, Joint European action for more affordable, secure and sustainable energy European Green Deal Investment Plan (EGDIP), European Green New Deal (EGD), Green Deal Industrial Plan 2030 Climate Target Plan, Critical Raw Materials (CRM) Act, Net-Zero Industrial Act European climate law, Just Transition Mechanism Proposal of a new EU framework to decarbonise gas markets, promote hydrogen and reduce methane emissions, European Green Deal (EGD) Green Deal Industrial Plan, European Green Deal Investment Plan (EGDIP) REPowerEU, Proposal of a new EU framework to decarbonise gas markets, promote hydrogen and reduce methane emissions European Green Deal Investment Plan (EGDIP), European Green Deal (EGD)

2022	African Union Climate Change and Resilient Development Strategy and Action Plan (AUCCCRDSAP) (2022-2032)	<ul style="list-style-type: none"> A climate strategy under the AU Agenda 2060 that envisions a sustainable, prosperous, equitable and climate-resilient Africa A comprehensive framework aimed at addressing the challenges of climate change in Africa. 	1-13	ETP, National Climate Change Policy (NCCP), Nationally Determined Contribution (NDC) 2021 Update	2030 Climate Target Plan, Green Deal Industrial Plan, Net-Zero Industrial Act, Just Transition Mechanism
	European Union		SDG	Nigeria	AU
2019	European Green Deal (EGD)	<ul style="list-style-type: none"> European Green New Deal (EGD) 	1-13	NDC, NA2050, MTNDP, ETP,	AUA63
2020	European climate law	<ul style="list-style-type: none"> To ensure a climate neutral European Union by 2050 		NCCP	African Union Climate Change and Resilient Development Strategy and Action Plan (AUCCCRDSAP) (2022-2032)
2020	European Green Deal Investment Plan (EGDIP)	<ul style="list-style-type: none"> This plan consists of three key elements Increased funding of at least €1 trillion over the next decade to support sustainable through the EU budget and related tools, primarily InvestEU. The establishment of a framework to encourage both private investors and the public sector to engage in sustainable investments. Assistance for public administrations and project initiators in developing and implementing sustainable projects. 	7,13	H ₂ Hydrogen Office, Nigeria Agenda (NDP) 2050, ETP, National Gas Expansion Programme (NGEP)	African Union Climate Change and Resilient Development Strategy and Action Plan (AUCCCRDSAP) (2022-2032)
2020	Just Transition Mechanism	<ul style="list-style-type: none"> Key tool to ensure that the transition towards a climate-neutral economy happens in a fair way, leaving no one behind 	7,13	ETP, NDC(Revised), Renewable Energy Master Plan (REMP) Update	AUA63, African Union Climate Change and Resilient Development Strategy and Action Plan (AUCCCRDSAP) (2022-2032)
2020	2030 Climate Target Plan	<ul style="list-style-type: none"> To raise the EU's ambition on reducing greenhouse gas emissions to at least 55% below 1990 levels by 2030 	13	ETP, National Climate Policy (NCP), National Climate Change Policy (NCCP)	African Union Climate Change and Resilient Development Strategy and Action Plan (AUCCCRDSAP) (2022-2032)
2021	Proposal of a new EU framework to decarbonise gas markets, promote hydrogen and reduce methane emissions	<ul style="list-style-type: none"> To establish a market for hydrogen, create the right environment for investment, and enable the development of dedicated infrastructure, including for trade with third countries. 	9,13	Germany-Nigeria Hydrogen (H ₂) Diplomacy/Office, ETP	AUA63
2022	REPowerEU	<ul style="list-style-type: none"> Joint European action for more affordable, secure and sustainable energy 	7	ETP, National Gas Expansion Programme (NGEP)	AUA63, African Union Invest EU Climate Change and Resilient Development Strategy and Action Plan (AUCCCRDSAP) (2022-2032)
2023	Green Deal Industrial Plan	<ul style="list-style-type: none"> To enhance and protect European industrial competitiveness and manufacturing capacity throughout its transition to climate neutrality 	9,12,13	ETP, National Energy Policy (NEP) – Revised, Nigeria Agenda (NDP) 2050	AUA63
2023	Net-Zero Industrial Act	<ul style="list-style-type: none"> To scale up the manufacturing of clean technologies that support the clean energy transition and release extremely low, zero or negative greenhouse gas emissions 	11,12,13	Long-term Low Emissions Development Strategy (LT-LEDS), National Energy Policy (NEP) – Revised	AUA63
2023	Critical Raw Materials (CRM) Act	<ul style="list-style-type: none"> To ensure EU access to a secure and sustainable supply of critical raw materials 	8,9,12	Nigeria Industrial Revolution Plan (NIRP) Objective	AUA63

Sources: (African Union, 2013, 2022; Energy Transition Office, 2022; European Commission, 2023; GIZ, 2015; National Planning Commission, 2021; Owebor et al., 2021)(Aryee et al., 2022)

Appendix B: Jobs in the transition

Table B1. Landmark solar and hydrogen energy projects in Nigeria

Project name (Location)	Capacity	Sponsor(s)	Investment amount	Target
Solar				
Energizing Education Programme (EEP) - Phase I	28.5 MW	Federal Government of Nigeria (through Green Bonds issue)	NA	9 Federal Universities and One University Teaching Hospital
Energizing Education Programme (EEP) - Phase II	28.5 MW	The World Bank partnership with the FGN	\$105 million	Seven Federal Universities and Two University Teaching Hospitals
Energizing Education Programme (EEP) - Phase III	11 MW	African Development Bank (AFDB) partnership with the FGN	\$123 million	Eight Federal Universities
Lagos State Solar Project	600 MW	Lagos State Government and the World Bank	Between \$350 million and \$700 million	Commercial and industrial (C&I) rooftop
Kano Solar Power Plant – Kumbotso, Kano	10 MW	Nigeria Sovereign Investment Authority (NSIA), Federal Government of Nigeria, Kano State Government, and Kumbotso Local Government Area (LGA)	\$16 million	Local industries and other consumers
Hydrogen				
Transcorp Ughelli Power	Generates hydrogen locally from the electrolysis of water and deploys it for cooling due to the enormous heat emitted by the windings of its heavy generators			
NewX	Actively developing blue and green hydrogen projects.			

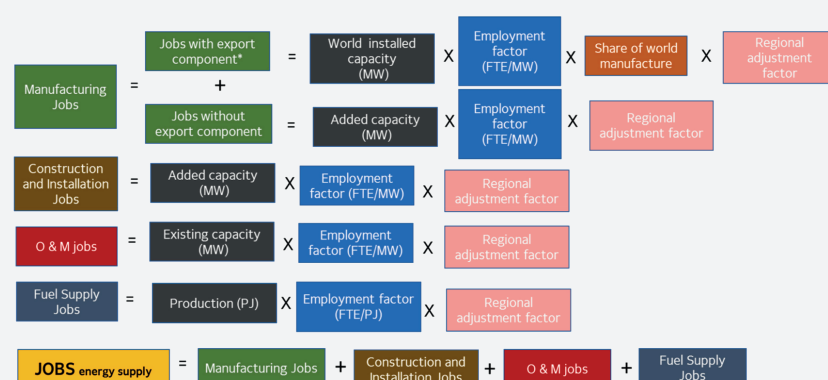
NA means not available

<https://www.brookings.edu/articles/the-promise-of-african-clean-hydrogen-exports-potentials-and-pitfalls/>

<https://www.pv-magazine.com/2022/06/22/nigerian-state-to-install-600-mw-of-ci-solar-in-pursuit-of-1-gw-goal/>

(Aryee et al., 2022)techno

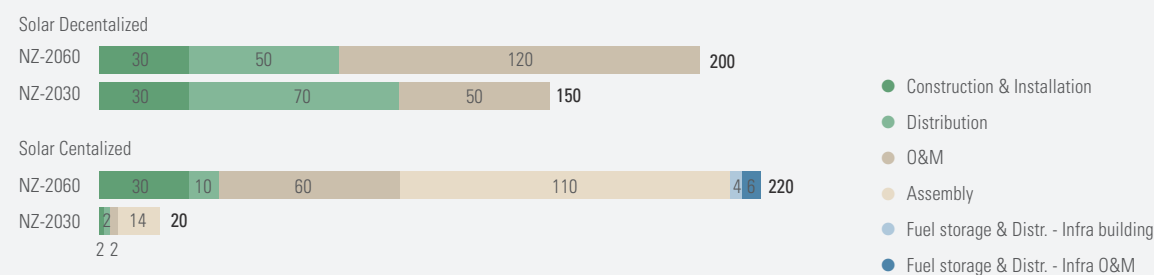
Figure B1. Evolution of the installed capacity in MW



Source: Malik et al. (2021) based on Rutovitz et al. (2015)

Figure B2. Power sector incremental job creation in Nigeria's ETP, compared to 2020

Thousand FTE jobs compared to 2020



Note: Fuel storage & Distr. - Infra building includes battery and hydrogen

Source: Authors' compilation based on information from the ETP

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