




## Electricity and ICT in West Africa: Implication for Female Employment

Idowu, Omowumi Omodunni<sup>1</sup> 

1. Department of Economics, Ekiti State University, Ado Ekiti, Nigeria. E-mail: omowumi.idowu@eksu.edu.ng;
2. Afe Babalola University, Ado Ekiti, Nigeria. talk2wummie@yahoo.com.

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The importance of electricity and ICT access in achieving gender equality and sustainable development cannot be overemphasized. While ICTs tends to create opportunities for women by enabling their participation in social, political and economic processes, electricity access alleviates women's time poverty and creates opportunities for labour force participation. This study investigates this assertion by examining the effects of female access to electricity and ICT diffusion on female employment in sixteen (16) West African countries from 1990 to 2020. It disaggregates female employment into three; agriculture, industry and service. The study sources data from World Bank Data Bank and conducts both static analysis (Pooled Effect) and dynamic analysis using Panel ARDL procedures of Mean Group (MG), Pooled Mean Group (PMG) and Dynamic Fixed Effect (DFE) having confirmed the stationarity of variables. Result from dynamic analysis shows that all variables are positive and they are long run determinants of female employment in West Africa. Sectoral analysis reveals that female access to electricity discourages female employment in agriculture while it improves female employment in the service sector. On the other hand, ICT diffusion in West African countries impacts female employment negatively in the agriculture and industrial sectors but boosts female employment in the service sector. While female education is a negative determinant of female employment in the highlighted sectors of the economy in the long run, fertility has a strong and negative impact on female employment in the three sectors of the economy in the short run. It is suggested that governments in West African countries should expedite efforts in expanding female energy access through capacity building, partnership with local stakeholders and creating a conducive environment for women entrepreneurs. This will ensure a smooth energy transition in the region. Also, the agriculture sector should be formalised to encourage female employment.

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## 1. INTRODUCTION

Inclusiveness is one of the fundamental principles adopted in an effort to achieve sustainability, this means that society should leave no one behind in the processes and opportunities for development<sup>1</sup>. Women particularly should benefit from development opportunities for learning, empowerment and for connecting to social and economic networks. Women involvement in the energy sector through empowerment and in leadership positions could help in tackling energy poverty as well as accelerating transition to a zero-carbon system<sup>2</sup>. Also, the World Bank opined that empowering more women, particularly in leadership positions in energy sector is essential to meet the projected 14 million jobs needed for clean energy growth by 2030<sup>3</sup>. This study investigates female employment in West African countries. It analyses the impact of electricity and ICT on women's total employment (total employment is the aggregate of women's employment in the economy) and in the three sectors of the economy (total employment and employment in agriculture, service and industry). The study contributes to existing literature on the relationship between infrastructure and female economic participation, using a panel data between 1990 and 2020. Since there are sixteen (16) countries in West Africa, it is expected that each country is peculiar as regards women labour engagement and hence behave differently in this regard. This study therefore examines the impact of ICT and Electricity on female employment in each of the West African countries.

The analysis of ICT and energy access is central to the understanding of gender inequality and the achievement of sustainable development in an economy. While Sustainable Development Goals (SDGs) 7 and 9(c) specifically target affordable and clean energy, and access to information and communication technology for all, respectively, these two SDGs are also important for achieving gender equality (SDG 5). Access to energy and information technology coupled with essential income generating activities can play major roles in alleviating household poverty

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<sup>1</sup> Faheem Hussain, Women and ICT Frontier Initiatives: Women's Empowerment SDGs and ICT (United Nations APCICT ESCAP, 2016). [https://www.unapcict.org/sites/default/files/inline-files/Module\\_C1.pdf](https://www.unapcict.org/sites/default/files/inline-files/Module_C1.pdf)

<sup>2</sup> OECD Library, Women and SDG 7: Affordable and Clean Energy [https://www.oecd-ilibrary.org/fr/women-and-sdg-7-affordable-and-clean-energy-ensure-access-to-affordable-reliable-sustainable-and-modern-energy-for-all\\_c7cbe91b-en.pdf?itemId=%2Fcontent%2Fcomponent%2Fc7cbe91b-en&mimeType=pdf](https://www.oecd-ilibrary.org/fr/women-and-sdg-7-affordable-and-clean-energy-ensure-access-to-affordable-reliable-sustainable-and-modern-energy-for-all_c7cbe91b-en.pdf?itemId=%2Fcontent%2Fcomponent%2Fc7cbe91b-en&mimeType=pdf)

<sup>3</sup> World Bank Blog, The energy transition fuelled by women's participation and Leadership (2023). <https://blogs.worldbank.org/en/energy/energy-transition-fueled-womens-participation-leadership>

and in closing the gender gap<sup>4</sup>. Addressing gender equality and energy access present multiple developmental gains which include quality education, food security, quality health, clean water, job employment and reduced inequality<sup>5</sup>. A gender balance economy contributes in alleviating poverty, broader socio-economic development and a faster transition towards a cleaner future<sup>6</sup>. A report from a global analysis on poverty and gender inequality reveals that using a county-level data the greater the percentage of a country's population that has access to energy and ICT, the greater its gender equality irrespective of the percentage of the population that are impoverished<sup>7</sup>. More so, men and women benefit differently from energy and ICT access due to their gender roles. Women are often mainly responsible for family chores such as washing of clothes, cooking, fetching of water and cleaning, all of which are energy intensive. Dell, Peters and Wharton (2014)<sup>8</sup> opined that improved access to time saving household energy appliances tends to be more transformative for women than men. As women benefit from productive energy, opportunities for economic empowerment and resilience are sustained. This will also redress labour segregation in the energy sector and ensure new and better job opportunities for women. Nevertheless increased access to electricity may not improve women empowerment directly but with increase in female education access would be enhanced.

On the other hand, improving women's access to information and communication technology provides the economic power for new opportunities, improvement in health, poverty reduction and improvement in women's literacy rate<sup>9</sup>. Other

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<sup>4</sup> Africa Development Bank Group, Empowering women in Africa through access to sustainable energy. A desk review of gender-focused approaches in the renewable energy sector (2022).

<sup>5</sup> United Nations, Accelerating SDG 7 achievement policy brief 12. Global progress of SDG 7 – Energy and Gender (2018) <https://sustainabledevelopment.un.org/content/documents/17489PB12.pdf>

<sup>6</sup> Energia, What we do. International Network on Gender and Sustainable Energy <https://energia.org/what-we-do/why-gender-and-energy/>

<sup>7</sup> Tavaranan S, 'To have or To Have Not' In Kathleen O'Dell, Sophia Peters, Kate Wharton (eds), Women Energy and Economic Empowerment (Deloitte University Press, 2014). <https://www.theatlantic.com/sponsored/deloitte-shifts/women-energy-and-economic-empowerment/261/>

<sup>8</sup> Dell KO, Peters S, and Wharton K, Women, energy and economic empowerment: Applying a gender lens to amplify the impact of energy access (Deloitte University Press, 2014). [https://www2.deloitte.com/content/dam/insights/us/articles/women-empowerment-energy-access/DUP\\_950-Women-Energy-and-Economic-Empowerment\\_MASTER1.pdf](https://www2.deloitte.com/content/dam/insights/us/articles/women-empowerment-energy-access/DUP_950-Women-Energy-and-Economic-Empowerment_MASTER1.pdf) (accessed 30-11-2023)

<sup>9</sup> TB Ajayi, S Ehiane, and MY Olumoye, 'Information accessibility in the digital age: Empowering women for poverty eradication' (2022) 29(2) *Alternation* 161-180.

factors that can be responsible for female employment include fertility rate, population and urbanisation<sup>10</sup>.

The rest of this paper is presented as follows. Section 2 explores conceptual clarification on some related terms. Section 3 looks at existing empirical literature on the impact of ICT diffusion and electricity access on female employment while section 4 presents the model specification, data sources, and estimation techniques. Section 5 presents the trends and development of ICT and electricity access in West Africa. Section 6 is on data analysis and results while section 7 concludes and suggests key policy implications.

## 2. CONCEPTUAL CLARIFICATION

### 2.1 Information and Communication Technology (ICT)

Information and Communication Technology (ICT) is used as a broader term for Information Technology (IT), which constitutes all communication technologies such as internet, wireless network, cell phones, computers, software, middleware, video conferencing, social networking, and other media applications and services, enabling users to access, retrieve, store, transmit and manipulate information in a digital form (Food and Agriculture Organization of the United Nations, 2024)<sup>11</sup>. ICTs shape an individual's, household's, firm's or country's access to information, services, people and technology<sup>12</sup>.

The effects of ICTs on women's empowerment can be seen in three ways; education, employment, and networking<sup>13</sup>. ICT provides women with access to education through online courses, tutorials, resources hence providing them with improvement in skills and knowledge. Secondly, it provides women with access to job opportunities particularly in fields where they are under-represented (such as e-marketing and e-commerce), thereby presenting the opportunities to start their own businesses and also advertise. It also helps in connecting with other women

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<sup>10</sup> A Mitra, and S Tripathi, 'Do more women find employment as the urban population grows?' (2024) 19(2) *Theoretical and Empirical Researches in Urban Management* 88-117.

<sup>11</sup> Food and Agriculture Organization of the United Nations, *Information and Communication Technology* (2024) <https://aims.fao.org/information-and-communication-technologies-ict>

<sup>12</sup> W H Dutton 'Computers and Society' In Neil J Smelser and Paul B Baltes (eds), *International Encyclopedia of the Social and Behavioural Sciences* (Pergamon 2001), 2480-2487. ISBN 9780080430768. <https://doi.org/10.1016/B0-08-043076-7/04321-7>

<sup>13</sup> Web World Foundation, 'ICTs for Empowerment of Women and Girls: A research and policy advocacy initiative on empowering women on and through the web in 10 countries' (World Wide Web Foundation in collaboration with SIDA, 2014) <http://webfoundation.org/docs/2015/05/WROProjectFramework.pdf>

in their fields, including opportunities to share ideas, experiences and build supportive networks<sup>14</sup>.

## **2.2 ICT Diffusion and ICT Access/Use**

ICT diffusion is the process by which ICT application is adopted and implemented by an organisation until expected users within the organisation accept and transfer their knowledge of using these ICT applications through the organisation<sup>15</sup>. ICT diffusion includes the stages of introduction, adoption, diffusion and adaptation whether that application is within the organisation or a society. According to Chen (1983)<sup>16</sup> the diffusion of technology is the process by which the use of an innovation spreads and grows. Also, Stoneman and Battisti (2010)<sup>17</sup> defined ICT diffusion as the process by which the market for a new technology changes over time and from which product and usage patterns of new product and production process result.

On the other hand, while the Organisation for Economic Cooperation and Development defined ICT access as the percentage of households who reported that they had access to the internet<sup>18</sup>, Umukoro et al (2021)<sup>19</sup> opined that ICT access is an individual unrestricted ability, right or permission to locate and use an ICT device which includes computer, mobile phones, internet for receipt, storage, processing, retrieval, consumption and sending of information<sup>20</sup>. Access includes the availability of internet and the ability to use ICT devices.

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<sup>14</sup> United Nations, *Women 2000 and beyond: Gender Equality and Empowerment of Women through ICT* (2005) <https://www.un.org/womenwatch/daw/public/w2000-09.05-ict-e.pdf>

<sup>15</sup> V Peansupap, and D H T Walker, 'Diffusion of Information and Communication Technology: A Community of Practice Perspective' In Kazi A S (ed), *Knowledge Management in the Construction Industry: A Socio-Technical Perspective* (Idea Group Publishing 2004).

<sup>16</sup> E K Y Chen, 'The Diffusion of Technology' In *Multinational Corporations, Technology and Employment* (Palgrave Macmillan 1983) [https://doi.org/10.1007/978-1-349-06106-8\\_4](https://doi.org/10.1007/978-1-349-06106-8_4)

<sup>17</sup> Paul Stoneman, and Giuliana Battisti, 'The Diffusion of New Technology' in Bronwyn H. Hall and Nathan Rosenberg (eds), *Handbook of the Economics of Innovation*, vol 2 (Elsevier 2010) 733-760,.

<sup>18</sup> Organisation for Economic Cooperation and Development, *ICT investment (indicator)* (2024). doi: 10.1787/b23ec1da-en (Accessed on 10 April 2024)

<sup>19</sup> I V Umukoro, A O Omolade-Lawal, S O Babalola, K S Akinsumbo, R M Aligwa, B A Abdul-Jeleel, 'Gender Differences in access to and use of ICTs in Nigeria' In *Encyclopedia of Information, Science and Technology* (5<sup>th</sup> edn 2021). doi:10.40181978-1-7998-3479-3.ch117

<sup>20</sup> Ibid

### 2.3 Female Employment, Electricity Access and Reliability

An important vehicle through which the benefits of electricity can materialise is through their effects on the empowerment of women within households and within their communities. Though access to electricity is imperative for local economic development, this must be accompanied by household access to affordable and reliable forms of modern energy. Households' modern forms of energy include air conditioning, water heating, lighting, cooking appliances, washing machine, clothes dryer, computers etc. Electricity access facilitates the use of energy saving household's equipment thereby improving women's time poverty by speeding up or eliminating the need for routine tasks (Clark, 2021)<sup>21</sup>. Electricity access reduces the burden of household chores and contributes to women's wellbeing and economic involvement.

Households' access to electricity is more on the demand side than the supply side of electricity, which is the community's access to electricity. Implying that what determines household access to electricity relates more to household demand factors than the supply factors. Community access to electricity determines the reliability of energy supply. This includes the electricity generation adequacy, power system infrastructure, utility financial and operational performance and energy sector regulation<sup>22</sup>. The reliability and adequacy of electricity is determined by the availability of these resources as well as the cost<sup>23</sup>.

Electricity reliability explains stable access to electricity without voltage fluctuations that is always available<sup>24</sup>. Reliability determines whether households will purchase electricity or not. The risks to the reliability of electricity supply and be in the form of black-out or partial loss of power which can limit the use of electricity appliances such as refrigerators, air conditioners. If electricity supply is reliable it encourages household demand which positively impacts female

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<sup>21</sup> Laurel Clark, 'Powering Households and empowering women: The gendered effects of electrification in sub-Saharan Africa' (2021) *Journal of Public and International Affairs* <https://jpia.princeton.edu/news/powering-households-and-empowering-women-gendered-effects-electrification-sub-saharan-africa>

<sup>22</sup> World Bank, 'Financial Viability of the Electricity Sector in Developing Countries: Recent Trends and Effectiveness of World Bank Interventions' (2016) IEG Learning Product World Bank Group. [https://ieg.worldbankgroup.org/sites/default/files/Data/reports/lp\\_financial\\_viability\\_electricity\\_sector\\_0.pdf](https://ieg.worldbankgroup.org/sites/default/files/Data/reports/lp_financial_viability_electricity_sector_0.pdf)

<sup>23</sup> World Bank, Doing Business. "Getting Electricity: Factors affecting the reliability of Electricity Supply" (2017) <https://documents1.worldbank.org/curated/en/546831513855840819/pdf/122197-WP-DB17-CS-Getting-electricity.pdf>

<sup>24</sup> M P Blimpo, and M Cosgrove-Davies, *Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact* (The World Bank 2019). <https://doi.org/10.1596/978-1-4648-1361-0>

employment<sup>25</sup>. However, household access to electricity and consumption depends on community access and it is also a function of households economic ability, the costs of energy use, socio-demographic characteristics<sup>26</sup> and environmental and climate factors<sup>27</sup>.

#### **2.4 Urbanisation and Female Employment**

Urbanisation is a shift in population from rural to urban areas. According to McGranahan and Satterthwaite, urbanisation is the net migration of people from rural to urban areas, expansion of urban boundaries and formation of new urban areas<sup>28</sup>. Urbanisation does not only bring about economic transformation, it also creates productive opportunities that can motivate women to enhance their skills level and participate in the job market<sup>29</sup>.

However, the backward bending labour supply curve indicates that women withdraw from the labour force at higher levels of income suggests that urbanisation and female employment have a nonlinear relationship. Backward bending labour supply curve is a situation that occurs when increase in wages reduces labour supply<sup>30</sup>. This means that urbanisation can affect women empowerment both positively and negatively. It is expected that urbanisation would result in greater opportunities for productive employment and also social change whereby women are pushed to pursue education and participate in remunerative activities. It creates more employment opportunities, technological and infrastructural advancements, improvement in communication and transportation, quality education and improved standard of living. The positive impacts of urbanization on women include increase in financial autonomy, lower

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<sup>25</sup> Claire Salmon, Jeremy Tanguy, 'Rural Electrification and Household Labor Supply: Evidence from Nigeria' (2016) 82 *World Development* 48-68, ISSN 0305-750X,

<sup>26</sup> R V Jones, A Fuertes, and K J Lomas, 'The socio-economic, dwelling and appliance related factors affecting electricity consumption in domestic buildings' (2015) 43 *Renewable and Sustainable Energy Reviews* 901-917. <https://doi.org/10.1016/j.rser.2014.11.084>

<sup>27</sup> A Kavousian, R Rajagopal, and M Fischer, 'Determinants of residential electricity consumption: Using smart metre data to examine the effect of climate, building characteristics, appliance stock, and occupants' behaviour' (2013) 55 *Energy* 184-194

<sup>28</sup> G McGranahan and D Satterthwaite, 'Urbanisation concepts and trends' (2014) IIED Working Paper <http://pubs.iied.org/10709IIED> ISBN 978-1-78431-063-9

<sup>29</sup> A Mitra, 'Women's Work in Response to Urbanization: Evidence from Odisha' (2019) 4(1) *ANTYAJAA: Indian Journal of Women and Social Change* 92-106 <https://doi.org/10.1177/2455632719836804>.

<sup>30</sup> T Tabuchi, 'Backward bending labour supply and urban location' (2022) 1-28 [https://mpr.aub.uni-muenchen.de/114810/1/MPRA\\_paper\\_114810.pdf](https://mpr.aub.uni-muenchen.de/114810/1/MPRA_paper_114810.pdf)

restriction on mobility, employment opportunities and education<sup>31</sup>. On the other hand, urbanisation significantly stresses the environment leading to overcrowding, unemployment, pollution, environmental hazards, urban crimes and unrest. For the women, urbanization may destroy women social networks, which are essential for job related-information and job searching<sup>32</sup>. There are high risks of violence and constraints on employment for women in urban areas<sup>33</sup> and urbanization tends to reduce women intra-household agency and increases women's exposure to intimate sexual violence<sup>34</sup>.

## 2.5 Fertility and Female Employment

Theoretically, there exists a negative relationship between fertility and female employment<sup>35</sup>. An increase in the number of children also increases female caring responsibilities and there is a trade-off between economic productivity outside the home and fertility. Women's reproductive years coincide with their productive years and most women cannot combine the two<sup>36</sup>. However, as a country is translating to an industrialised economy increase in female employment may likely attract sustained declines in fertility rate due to lack of improvement in female education. With the value of women's time in market rate still relative to the price of goods, they then move back into paid labour force is reflected by the rising portion of the 'U' shape according to Claudin Goldin 'U' shape hypothesis<sup>37</sup>. Also, female employment is related to completion of fertility transition in developed economies<sup>38</sup>, while fertility falls as females get employed in

<sup>31</sup> G Dhamija, P Roychowdhury, PunarjiT., and B Shankar, 'Urbanization and Women Empowerment: Evidence from India' (2023) GLO Discussion Paper No. 1323, Global Labor Organization (GLO), Essen.

<sup>32</sup> G Dhamija, P Roychowdhury, PunarjiT., and B Shankar, 'What are the effects of India rapid urbanization on women's empowerment?' (2024). <https://www.ideasforindia.in/topics/urbanisation/what-are-the-effects-of-india-s-rapid-urbanisation-on-women-s-empowerment.html>

<sup>33</sup> International Institute for Environment and Development, 'Urbanization: A double-edged sword for women' (2014) <https://www.iied.org/urbanization-double-edged-sword-for-women>

<sup>34</sup> G Dhamija, P Roychowdhury, and B Shankar, 'Does Urbanization Empower Women? Evidence from India' (7 December, 2023) Available at SSRN: <https://ssrn.com/abstract=4656859> or <http://dx.doi.org/10.2139/ssrn.4656859>

<sup>35</sup> J Behrman, and P Gonalons-Pons, 'Women's employment and fertility in a global perspective (1960-2015)' (2020)<sup>43</sup> Demographic research 707-744. <https://doi.org/10.4054/demres.2020.43.25>

<sup>36</sup> Mary C Brinton, 'Babies, work or both? Highly Educated Women's Employment and fertility in East Asia' (2019)15 125(1) American Journal of Sociology 105-140 [https://scholar.harvard.edu/files/brinton/files/brinton.oh\\_ajs\\_july\\_2019.pdf](https://scholar.harvard.edu/files/brinton/files/brinton.oh_ajs_july_2019.pdf)

<sup>37</sup> C Goldin, 'The U - Shaped Female Labour Function in Economic Development and Economic History' In TP Schultz (ed), Investment in Women's Human Capital and Economic Development (University of Chicago Press, Chicago 1994).

<sup>38</sup> LL Lim, 'Female Labour-Force Participation' (2009) 195-212, United Nations



developing economies. Fertility transition describes a shift from a high fertility rate to a low fertility rate in developed countries<sup>39</sup>. Moreover, the increasing availability of part time jobs and greater access to childcare facilities enable women to combine work outside home with childcare<sup>40</sup>. Also, fertility may increase in a society where the services of nannies can be hired for women's economic participation outside homes<sup>41</sup>. Even though, these nannies are also women, they are engaging in a productive activities which also accommodate their children to be nursed by them.

### 3. LITERATURE REVIEW

This section present the empirical review of literature on the impacts of ICT and electricity on female employment. Existing literature include Efobi, Tanankem and Asongu (2018)<sup>42</sup> which investigated how improvement in information and communication technology affects formal economic participation of women in 48 African countries between 1990 and 2014 using Ordinary Least Squares (OLS), fixed effect and Generalised Method of Moments (GMM). The study discovered that increase in ICT leads to increase in female economic participation, with consistent order of increasing magnitude with phone penetration, internet penetration and fixed broadband subscription. Similarly, Ngoa and Song (2021)<sup>43</sup> examined the effect of information and communication technology on female labour force participation in 48 African countries from 2001 to 2017. The study used fixed effect and system GMM to analyse the effect of ICT use (internet and mobile phones) on female labour force participation in Africa. Findings revealed that a positive relationship exists between female labour force participation and ICT use and this relationship is enhanced by financial development and female education. In addition, in a panel data analysis of 91 countries (both developing

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<sup>39</sup> David Shapiro, 'Fertility Transition: Sub-Saharan Africa' In James D. Wright (ed), *International Encyclopedia of the Social & Behavioral Sciences* (ISBN 9780080970875, 2<sup>nd</sup> edn, Elsevier 2015) 92-98. <https://doi.org/10.1016/B978-0-08-097086-8.31096-0>.

<sup>40</sup> J-PAL Policy Insight, 'Access to Childcare to Improve Women's Economic Empowerment.' (Abdul Latif Jameel Poverty Action Lab, Cambridge 2023).

<sup>41</sup> NM Nwakeze, 'Gender and labour force participation in Nigeria: Issues and Prospects' (2010) 2, 477-492.

<sup>42</sup> U Efobi, B Tanankem, and S Asongu, 'Female economic participation with Information and Communication Technology (ICT) advancement: Evidence from sub-Saharan Africa' (2018) Working Papers of the African Governance and Development Institute No 18/005.

<sup>43</sup> Nkoumou Ngoa, Gaston Brice and Jacques Simon Song, 'Female participation in African labor markets: The role of information and communication technologies' (2021) 45(9) Telecommunications Policy.

and developed countries) Baliaoune (2021)<sup>44</sup> investigated the impact of openness and three indicators of infrastructure (access to electricity, mobile phone subscription and internet use) on female labour force participation. Instrumental variables and fixed effect estimation techniques were the estimation techniques used. The study found that trade and access to electricity have a non-linear effect and negative relationship with female labour force participation. Baliaoune's regional specific analysis showed a negative impact in MENA countries and positive impact in Latin America and Caribbean. Also, it was revealed that through interplay with trade, mobile phone or internet use boost female labour force participation.

Furthermore, Asongu and Odhiambo while investigating the effect of ICT on female economic participation in sub-Saharan Africa used GMM technique and three female economic participation indicators, which were (i) female labour force participation (ii) female employment (iii) female unemployment<sup>45</sup>. The interested ICT variables were fixed broadband subscription, mobile phone penetration and internet penetration. The study found an inverse relationship between female labour force participation and female unemployment and a positive relationship was found with female employment. Sajid, Abdullah and Chik (2020)<sup>46</sup> examined the relationship between infrastructure and female labour force participation in eight (8) developing countries (Egypt, Bangladesh, Indonesia, Iran, Malaysia, Nigeria, Pakistan and Turkey) from the period between 1980 and 2018. A principal component analysis was constructed based on 3 subcategories of infrastructure; transportation, electricity and information and communication technology (ICT) using 17 components<sup>47</sup>. Results from long run estimation of Pooled Mean Group (PMG) showed a positive relationship between female labour force participation and infrastructure in D-8 countries (i.e Developing-8 Organization for Economic Cooperation, these are Bangladesh, Egypt, Indonesia,

<sup>44</sup> M Baliaoune, Trade, infrastructure and female labour force participation in labour markets (Policy Center for the New South, RP-03/21, 2021) 1-31.

<sup>45</sup> S Asongu, and NM Odhiambo, Enhancing ICT for female economic participation in sub-Saharan Africa (AGDI Working Paper No. WP/22/002, African Governance and Development Institute, Yaoundé 2022)

<sup>46</sup> Sajid, Saima and Abdullah, Norehan and Chik, Abdul Razak, 'Infrastructure Index and Female Labor Force Participation in Developing-8 Countries: A Demand Side Approach' (2020) 43(2) HamdardIslamicus 1055-1081. Available at SSRN: <https://ssrn.com/abstract=4183438> or <http://dx.doi.org/10.2139/ssrn.4183438>

<sup>47</sup> (i). Air transport Frieght (ii). Air transport (registered carrier departure worldwide) (iii). Rail lines total length (km) (iv). Railways, passenger carried (v) railways, goods transported (vi). Road total network (vii). Roads paved (viii). Merchant shipping (ix) total fleet (x). Production of electricity (xi). electric power consumption (xii). Electric power transmission and and distriction losses (xiii). Mobile cellular subscription (xiv). Fixed telephone subscription (xv). Fixed broadband subscription (xvi). Internet bandwidth, international (xvii). Individual using the internet

Iran, Malaysia, Nigeria, Pakistan and Turkey)<sup>48</sup>. More so, women participation can be enhanced through provision of better transportation networks, access to electricity, ICT access and ease to workplace. In contradiction to Ngoa and Song findings in 48 African countries, wages, education, household income and cultural norms are likely constraints to female labour force participation in D-8 economies.

Winther and Matinga (2017)<sup>49</sup> investigated women employment through access to electricity. They concluded that access to electricity improves women's welfare more than it does with men, however, the impact on gender relations remains largely unclear. The unreliability of electricity was investigated in 20 selected African countries. Data was collected from GIS data on the electricity transmission network in Africa and an index was computed for variations in technical losses. The result showed that electricity shortages exert a negative impact on women's employment rate in Africa. In line with this Sedai, Vasudevan, Pena and Miller (2021)<sup>50</sup> investigated the effect of reliable electrification on gender differences on socioeconomic status in India. The study used individual fixed effects, instrumental variables and regression and it discovered that reliable energy supply improves women status relative to men through increased employment opportunities, and reduction in time allocated to home production. A study in India by Samad and Zhang (2019)<sup>51</sup> analysed the causal relationship between electricity access and women empowerment using a large gender disaggregated dataset and propensity score matching. The results from the study showed that electrification enhances all measures of women empowerment (in decision making, mobility, financial autonomy, reproductive freedom and social participation). However, for the periods (mostly 2005 and 2012) under study employment and education were major causal channels through which electrification enables empowerment. In the same year 2019 in Rwanda, the impact of electricity on women and children was examined using experimental research. The result revealed that household electrification has no effect on women paid employment. Tenezakis and Tritah<sup>52</sup> opined that women are likely to

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<sup>48</sup> D-8 Organisation for Economic Cooperation. <https://developing8.org/>

<sup>49</sup> T Winther and MN Matinga, 'Women's empowerment through electricity access: scoping study and proposal for a framework of analysis' (2017) 9(3) *Journal of development effectiveness* 389-417

<sup>50</sup> Ashish Kumar Sedai, Ramaa Vasudevan, Anita Alves Pena, Ray Miller, 'Does reliable electrification reduce gender differences? Evidence from India' (2021) 186 *Journal of Economic Behavior & Organization* 580-601.

<sup>51</sup> H Samad, and F Zhang, 'Electrification and women empowerment: Evidence from Rural India (World Bank Group Policy Research South Asia Region, Working Paper number No 8796, 2019) 1-30.

<sup>52</sup> E Tenezakis, and A Tritah, 'Power for empowerment. The impact of electricity on women and children in sub-Saharan Africa (IZA Conference Paper, 2019) 1-37.

participate in paid employment work longer hours as wage workers and in independent business. The study discovered that spillover from electrification brings boys to wage employment whereas household electrification exerts a negative impact. Rahman and Alam (2021)<sup>53</sup> discovered that access to electricity, female education, public health expenditure positively impact female life expectancy at birth.

#### 4. METHODOLOGY

This paper has examined gender, feminism, and energy transition in the Global South, which means the poorest, least industrialised and economically disadvantaged countries, located mainly in the Southern Hemisphere. It analysed the relationship between gender, feminism and energy transition, vis-à-vis different types of environmental injustice still being experienced by females in the Global South. The paper defined the relevant terms, adopted environmental justice theory as its basis and traced the history of feminism, which is the social movement that believes that women are uniquely and systematically oppressed and, as a result, advocates legal, political and economic rights and equality between men and women. Ecofeminists link climate change to masculine dominance or gender inequality and hold the opinion that global prioritisation of masculine aggression is responsible for environmental problems. The paper expatiated on this phenomenon and shows how it hampers the current energy transition agenda.

##### 4.1 Model Specification

The effects of electricity and ICT index is specified as follows:

$$FETP = f(\text{female access to electricity, ICT index}) \text{-----}(1)$$

Some other variables that can influence female total employment were also included. These are fertility, female education and urbanisation.

In functional terms,

$$FETP = f(\text{female access to electricity, ICT index, fertility, female education, urbanisation}) \text{---}(2)$$

The model is hence specified thus;

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<sup>53</sup> MM Rahman and K Alam, 'The role of access to electricity, female education and public health expenditure on female health outcomes: evidence from SAARC-ASEAN Countries' (2021).

$$FETP_{gr_{i,t}} = \alpha_i + \beta_1 FEEL_{i,t} + \beta_2 ICTI_{i,t} + \beta_3 FER_{i,t} + \beta_4 FSEDU_{i,t} + \beta_5 URB_{i,t} + \mu_{i,t} \dots \dots \dots (3)$$

Where;

- FETP – Female Employment to Total Population
- FEEL – Female Access to Electricity
- ICTI – Information and Communication Technology Index
- FER – Fertility
- FSEDU – Female Secondary Education Enrolment
- URB – Urbanisation

FETP represents the percentage of female employment in relation to the total population of age 15 and above. Employment is explained as persons of working age who, during a short reference period, were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period (i.e. who worked in a job for at least one hour) or not at work due to temporary absence from a job, or to working-time arrangements (ILO, 2020). Females from ages 15 and above are usually considered as the working-age population.

Electrification is represented by the percentage of the population with access to electricity. Female access to electricity was calculated by the percentage of female population out of total population that has access to electricity. This was calculated thus;

$$\frac{\text{Access to electricity (\% of total population)}}{\text{Female population (\% of total population)}}$$

Female access to electricity (FEEL) increases female employment will increase (apriori expectation). This is because household electrification saves time and gives women time for economic activities outside the home<sup>54</sup>. On the other hand, ICTI stands for ICT diffusion index. This was obtained using principal component analysis (PCA) of a dataset representing mobile phone subscribers per 100 people, fixed telephone line subscribers per 100 people and individuals using the internet, percentage of total population<sup>55</sup>. Fertility rate is total births per woman. This is calculated as the total number of children that would be born by a

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<sup>54</sup> T Winther, MN Matinga, K Ulrud, & K Standal, ‘Women’s empowerment through electricity access: scoping study and proposal for a framework of analysis’ (2017) 9 (3) *Journal of Development Effectiveness* 389–417. <https://doi.org/10.1080/19439342.2017.1343368>

<sup>55</sup> Principal component analysis is a statistical tool used for data reduction.

woman if she were to live to the end of her reproductive years and bear children in accordance with age specific fertility rate for the given year. Female employment decreases with increase in fertility. Female education is given as the percentage of total gross enrolment, irrespective of age, to the population group that officially corresponds to the level of education.<sup>56</sup> On the other hand, urbanisation refers to the total number of people living in urban areas and this was expressed in annual percentage growth rate. And  $\alpha$  is the country-specific intercept, while  $\mu$  was the error term, 'i' and 't' represented the country and period.

#### 4.2 Estimation Techniques

Data were collected from 16 West African countries over the period between 1990 and 2020. The data were analysed with the use of panel ARDL procedure of Mean Group, Pooled Mean Group and Dynamic Fixed Effect. Conventionally for panel Autoregressive Distributed Lags (ARDL) the order of integration must be mixed and the number of time series (T) must be greater than the number of cross sections (N). This study captures the period between 1990 and 2020 (T=31) and the total number of West African countries is sixteen (N=16), hence, T>N. In line with this, this study conducted ARDL model (MG, PMG and DFE) which provides consistent coefficients despite the possible presence of endogeneity because it includes lags of dependent and independent variables (Perasan, Shin and Smith, 1999)<sup>57</sup>. This estimation technique (Panel ARDL) was adopted by Sajid, Abdullah and Chik<sup>58</sup> while investigating the relationship between infrastructure and female labour force participation in 8 countries from 1980 to 2018. Other estimation techniques in literature include Fixed Effect (FE), Ordinary Least Square (OLS) and Generalised Method of Moments (GMM).

The Mean Group (MG) estimators separate regressions for each country and computes averages of the country specific coefficients, while Dynamic Fixed Effect (DFE) imposes homogeneity of all slope coefficients, allowing only the intercept to vary across groups. On the other hand, pooled mean group (PMG) is an intermediate estimator between DFE and MG. It has the advantage of determining long run and short run dynamic relationships.

## 5. TREND ANALYSIS ON ELECTRICITY AND ICT IN WEST AFRICA

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<sup>56</sup> Secondary education completes the basic primary education.

<sup>57</sup> MH Perasan, Y Shin, and RP Smith, 'Pooled Mean Group Estimation of Dynamic Heterogeneous Panels' (1999) 94 (446) *Journal of the American Statistical Association* 621,634.

<sup>58</sup> Saima Sajid, Norehan Abdullah, and Abdul Razak Chik, 'Infrastructure Index and Female Labor Force Participation in Developing-8 Countries: A Demand Side Approach' (2020) 43(2) *HamdardIslamicus* 1055-1081. Available at SSRN: <https://ssrn.com/abstract=4183438> or <http://dx.doi.org/10.2139/ssrn.4183438>

### 5.1 Trends and Development in Electricity in West Africa

Data on access to electricity were collected from industry, national surveys and international sources and collated by World Bank data bank (world development indicator, World Bank, 2022). Figure 1 presents the trend analysis of access to electricity in West African countries. Access to electricity is the percentage of a country's population with access to electricity. In all the sixteen countries in West Africa, the top performing countries for electrification are Cape Verde, Ghana and Senegal (Figure 1). Cape Verde has the highest electricity access of 92.4 percent of its population in West Africa in 2020. The country has been experiencing an upward trend since 2002 from 58.6 percent to 95.5 percent in 2019 and it dropped to 92.4 percent in 2020.

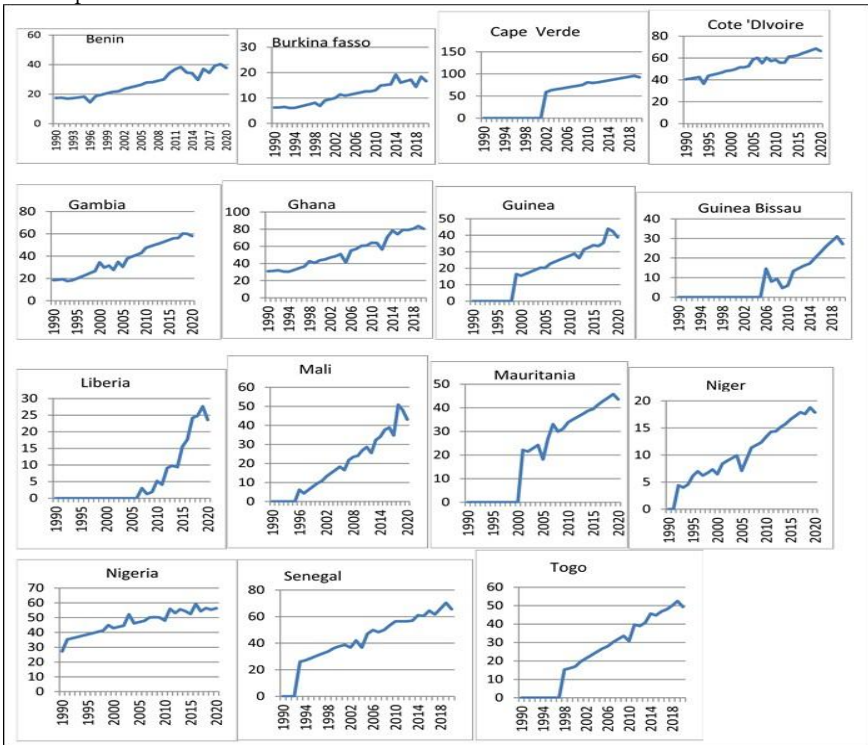


Figure 1: Trend in Electrification Accessibility in West African Countries (Percentage of Total Population)  
 Source: Author's (2024)

Cape Verde otherwise known as Cabo Verde is an archipelago consisting of 10 islands with persistent increase in both energy access and renewable energy sources<sup>59</sup>. Renewable energy accounts for about 20 percent of total supply primarily wind and solar energy<sup>60</sup>. The country has a population of 0.574 million with 81.8 percent access to clean cooking and energy access of 96.9 percent and 94.9 percent in rural urban areas respectively<sup>61</sup>. Nevertheless there are losses in the distribution grids due to the ageing power distribution network and electricity costs are extremely high<sup>62</sup>.

Identifying these limitations and the need for sustainable and cheap energy, the government embarked on an electricity sector master plan (2018-2040) designed to achieve about 50 percent renewable energy generation by 2030. Following is Ghana with an access rate of 83.5 percent in 2019 and 80.6 percent in 2020. International Trade Administration reported that thermal energy contributes most (66 percent) to Ghana power generation, fueled majorly by natural gas with little contributions from light crude oil and diesel<sup>63</sup>. After thermal energy is hydro energy which accounts for 33 percent of Ghana's power generation. Ghana supplies power to Benin, Burkina Faso and Togo<sup>64</sup>. The report also stated that as at 2021, electricity access in Ghana stood at 86.6 percent in 2021 with 50 percent access in rural and 91 percent access in urban areas. However, the country's energy sector is bedevilled by mass losses in the distribution system as a result of obsolete nature of distribution grip, accumulated short falls from power pricing, poor tariff structure, non-payment of revenue by consumers and over dependence on thermal and hydro energy sources<sup>65</sup>. In 2021, Cote d'Ivoire followed by Senegal ranked third and fourth in electricity access with 66.4 percent and 65.7 percent respectively.

<sup>59</sup> Sustainable energy for all, 'Cape Verde' (2023) <https://www.se4all-africa.org/seforall-in-africa/country-data/cabo-verde/>

<sup>60</sup> International Trade Administration 'Cabo Verde, Country Commercial Guide' <https://www.trade.gov/country-commercial-guides/cabo-verde-renewable-energy>

<sup>61</sup> Africa Energy Portal, 'Cape Verde' (2023) Africa Development Bank Group <https://africa-energy-portal.org/aep/country/cape-verde> (accessed 28-11-2023)

<sup>62</sup> African Development Bank, Republic of Cabo Verde: Cabo Verde Country Strategy Paper (CSP) 2019-2024, West Africa Development and Business Delivery Office (2019)

<sup>63</sup> International Trade Administration, 'Ghana – Country Commercial Guide. Energy and Renewables' (2023) <https://www.trade.gov/country-commercial-guides/ghana-energy-and-renewables>

<sup>64</sup> International Trade Administration. Ghana – Country Commercial Guide . Energy and Renewables (2023) <https://www.trade.gov/country-commercial-guides/ghana-energy-and-renewables>

<sup>65</sup> E N Kumi, 'The Electricity Situation in Ghana: Challenges and Opportunities' (2017) CGD Policy Paper, Center for Global Development, Washington, DC. <https://www.cgdev.org/publication/electricity-situation-ghana-challenges-and-opportunities>



On the other hand, Burkina Faso has the least electricity access of 16.7 percent, followed by Niger 17 percent and Liberia 23.6 percent. Burkina Faso with a population of 22.1 million has an energy access of 19 percent with 60 percent in urban areas and 3 percent in rural areas, while access to clean cooking is 12 percent.

All countries experienced a fall in energy access in 2020. This can be attributed to the outbreak of COVID-19 pandemic, lockdowns, disruptions to global supply chains and the resultant effects on developing economies<sup>66</sup>. All these among other factors have slowed down the progress pace in achieving SDG 7<sup>67</sup> <sup>68</sup>. Nearly 90 million people in Africa and Asia that previously had electricity access cannot afford to pay their basic energy needs (World Bank, 2022). Secondly, the war between Ukraine and Russia led to uncertainty in international oil and gas markets and kept the energy prices rising<sup>69</sup>.

Though there were unstable periods in many of these countries, these countries progressed steadily in energy access for the periods under consideration. Also, there was no data on energy access from Sierra Leone.

## **5.2 Trends in Information and Communication Technology (proxied by Mobile cellular subscriptions)**

This section presents the trends in Information and Communication Technology (ICT), proxied by mobile cellular subscriptions per 100 people. These are subscriptions to a public mobile telephone service that gives access to a Public Switched Telephone Network (PSTN) cellular technology. PSTN is a telecommunication network that enables subscribers at different locations to communicate by voice. Figure 2 shows mobile cellular subscriptions per 100 people in sixteen West African countries.

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<sup>66</sup> Hoang AT, Sandro Nižetić, Olcer AI, Ong HC, Chen WH, Chong CT, Thomas S, Bandh SA, and Nguyen XP, 'Impacts of COVID-19 pandemic on the global energy system and the shift progress to renewable energy: Opportunities, challenges, and policy implications' (2021) 154 *Energy policy* 112322. <https://doi.org/10.1016/j.enpol.2021.112322>

<sup>67</sup> Yuan H, Wang X, Gao L. and others, 'Progress towards the Sustainable Development Goals has been slowed by indirect effects of the COVID-19 pandemic' (2023) 4

*Communication Earth & Environment* 184. <https://doi.org/10.1038/s43247-023-00846-x>

<sup>68</sup> World Bank, 'Tracking SDG 7 – The Energy Progress Report 2022 (2022). <https://www.worldbank.org/en/topic/energy/publication/tracking-sdg-7-the-energy-progress-report-2022>

<sup>69</sup> Zhang Q, Hu Y, Jiao J. and others, 'The impact of Russia–Ukraine war on crude oil prices: an EMC framework' (2024) 11 *Humanities & Social Sciences Communications* 8. <https://doi.org/10.1057/s41599-023-02526-9>

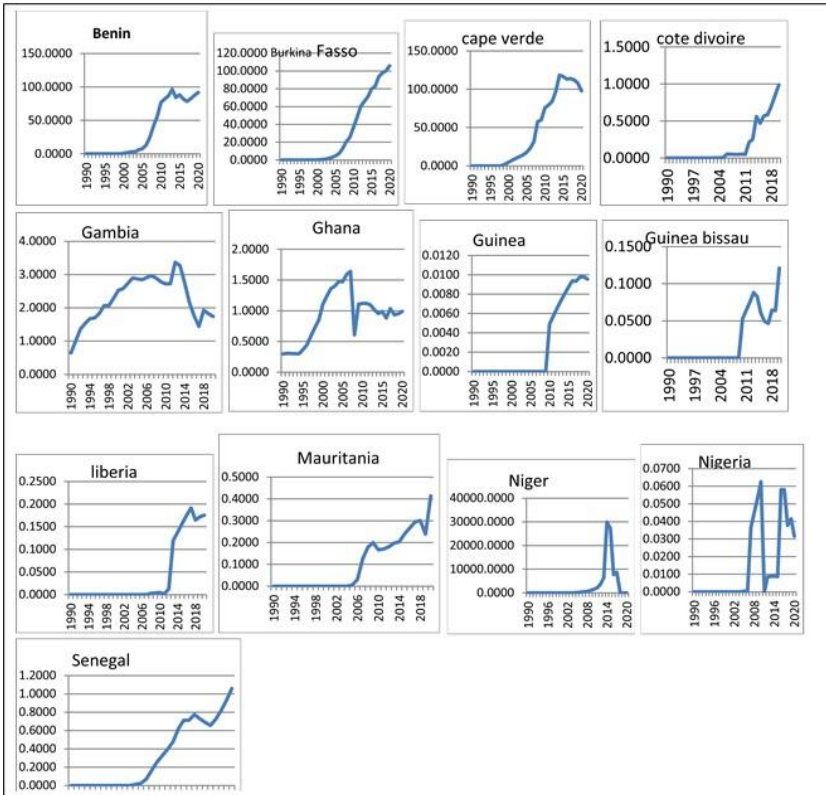


Figure 2: Trend in ICT in West African Countries

Source: Author's (2024)

Mobile cellular subscription includes the amount of postpaid subscriptions, number of prepaid accounts that are active and all mobile cellular subscriptions that offer voice communications. However, mobile cellular subscriptions excludes subscriptions through data cards, USB modems, radio paging, telepoint etc.

## 6. DATA ANALYSIS AND RESULTS

### 6.1 Preliminary analysis

#### 6.1.1 Descriptive Statistics of Variables

In Table 1, the estimated mean value, which was used to examine the nature of the data distribution, is high for Female Employment to Total Population (FETP) with about 51.608 and 46.831 for FETA, while ICTI has the lowest mean value of -5.24. Female access to Electricity (FEEL) and Information and Communication Technology Index (ICTI) have low standard deviations of 0.412 and 0.777 respectively, this reveals that both are relatively stable and they show low variability across the countries in the study. However, FSEDU and FETA exhibit high variability in the cross-sectional units, judging by their standard deviation of 22.678 and 21.954 respectively.

**Table 1: Summary of Statistics**

	FETP	FETS	FETI	FETA	FEEL	ICTI	FER	FSEDU	URB
<b>Mean</b>	51.608	37.267	9.711	46.831	0.494	-5.24E-06	5.494	17.890	3.956
<b>Std. Dev.</b>	16.024	18.560	6.368	21.954	0.412	0.777	1.213	22.678	1.486
<b>Skewness</b>	-1.2156	-0.071	0.478	-0.341	0.382	1.506	-1.340	1.593	-2.010
<b>Kurtosis</b>	4.482	2.608	2.781	2.451	2.002	4.435	7.270	5.462	19.328
<b>Jarque-Bera</b>	167.518	3.587	19.861	15.844	32.644	229.941	525.149	334.954	5843.697
<b>Probability</b>	0.000	0.166	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Source: Author's (2024)

Female Access to Electricity (FEEL), ICT Index (ICTI), Female Employment in Industry (FETI) and Female Secondary Education (FSEDU) are positively skewed while FETP, FETS FETA, FER and urbanisation are negatively skewed. The estimated kurtosis statistics of all the variables (FETP, FEEL, ICTI, FER, FSEDU, URB) were greater than 3, which indicated that their distribution was thicker, thereby implying the presence of heterogeneity in the data. The Jarque-Bera value for all the variables passed the significance test at 1 percent except FETS. This shows a normally distributed series, hence justifies the use of panel analysis for estimation of relationships because of heterogeneity in the data series.

### 6.1.2 Panel Unit Root Test

Stationary tests were conducted on all the data using Levin, Lin and Chin (a homogenous panel unit root test) and Augmented-Dickey Fuller (a heterogeneous panel unit root test) as shown in table 2. A time series is stated as non-stationary if the mean and variance of the time series are dependent over time and it is considered stationary, if the mean and variance is constant over time (Gujarati, 2004).

The results of panel unit root show that female employment as a ratio of its population (FETP), female employment in service sector (FETS), female access to electricity (FEEL) and female education enrolment (FSEDU) are stationary at first difference while female employment in industry (FETI), female employment in agriculture (FETA), ICT index (ICTI), fertility (FER) and urbanisation are stationary at level.

**Table 2: Panel Unit Root**

Variables	Levin, Lin & Chu t	Prob.	ADF	Prob	IO
FETP	-7.094	0.000	105.538	0.000	I(1)
FETA	-6.320	0.000	75.951	0.000	I(0)
FETI	-4.450	0.000	47.157	0.041	I(0)
FETS	-4.839	0.000	47.060	0.042	I(1)
FEEL	-8.414	0.000	219.039	0.000	I(1)
ICTI	-2.739	0.003	59.352	0.002	I(0)
FER	-10.252	0.000	106.492	0.000	I(0)
FSEDU	-14.359	0.000	258.227	0.000	I(1)
URB	-8.465	0.000	139.798	0.000	I(0)

Source: Author's (2024)

The stationary status of the variables in the model thus suggests that the Mean Group (MG) /Pooled Mean Group (PMG) and Dynamic Fixed Effect Autoregressive Distributed Lag (ARDL) can be employed to analyse the impact of electricity and ICT diffusion on female employment. Hence, the ARDL procedure of MG, PMG and DFE is adopted for the study.

## 6.2 Total Female Employment

### 6.2.1 Total Female Employment - Static Analysis and Results

The result from the pooled effect estimation as presented in table 3 shows that at one percent level of significant a unit increase in female access to electricity increases female total employment by 9.333 units. The implication of this is that female access to electricity improves female employment. The amount of hours to be expended on house chores are saved with energy saving equipment and machines, examples of this equipment are blender, washing machine, hence women can engage in economic activities outside the homes.

**Table 3: Static Analysis (Pooled Effect)**

Variable	Coef	Prob
FEEL	9.333***	0.001
ICTI	-1.876*	0.057
FER	-0.990	0.167
FSEDU	-0.039	0.268
URB	-0.887**	0.013

Source: Author's Computation (2024)

A unit increase in the use of ICT (such as mobile subscription) reduces female total employment by 1.876 units at 10 percent level of significance. The use of ICT by women can be seen as discouragement from entry into the labour sector. The use of ICT if not geared towards productive activities steals time and acts as a distraction from engaging in economic activities. Moreover, an increase in urbanisation discourages female employment by 0.887 units. As the society becomes urbanised or civilised, there is tendency for increase in crime and more importantly in unemployment, and unemployment could have a worker-discouraging- effect on female employment.

### 6.2.2 Total Female Employment - Dynamic Analysis and Result (Pooled Mean Group)

Since the number of observations is relatively lesser than the number of years. This study adopted also the Mean Group, Pooled Group and the Dynamic Fixed Effect to explore the dynamic nature of the variables that determine the effects of ICT and electricity on female labour employment in West African countries. The constraint of common long run coefficient from MG yielded higher standard errors (see appendices) and speed of adjustment. This is expected since MG is less

restrictive, and thus potentially inefficient. In testing the hypothesis of slope homogeneity, we use the Hausman (1978) test. The P-values of the Hausman test for PMG and MG shows preference for PMG as this is found to be consistent and efficient under long run slope homogeneity. Also, the Pooled Mean Group (PMG) estimator is then compared with Dynamic Fixed Effect (DFE) estimator, and Hausman test is applied to test the difference. The P-values of the Hausman test for PMG and DFE is less than 0.05 (0.000), this shows the rejection of the null hypothesis. And hence, preference is given to PMG estimator as the efficient estimator. The PMG result is hence presented in table 4.

**Table 4: Pooled Mean Group Analysis of Female Employment**

Variable	Long Run		Short Run	
	Coef	Prob	Coef	Prob
Feel	0.986***	0.000	2.231	0.252
Icti	0.202***	0.000	-1.666	0.469
Fer	0.489***	0.000	2.056	0.789
Fsedu	0.004*	0.062	-0.021	0.251
Urb	0.028***	0.001	1.974	0.140
ECT	-	-	-0.944	0.000***

Source: Author's Computation (2024)

. Note: \*\*\*, \*\*, \* indicate significant at 1 percent, 5 percent, and 10 percent respectively

While all short run estimates show no significant relationship with female employment, the long run result shows that all the variables have positive and significant relationship with female employment at one percent except female education that is found significant at 10 percent. Also, a unit increase in female access to electricity (FEEL) leads to 0.986 unit increase in female employment (FETP). A unit increase in ICT index leads to 0.202 unit increase in female employment. Moreover, a unit increase in fertility and urbanisation leads to 0.489 unit and 0.028 increase in female employment respectively.

The Error Correction Model (ECM) reveals that error correction term is significant, and it shows negative value for all variables. This confirms co-integration relationship according to Engel and Granger (1987). In addition the

ECT incorporates the long run information and shows that any deviation from long run expected values is adjusted by 94.4 percent annually.

### 6.3 Country Specific Analysis for Total Female Employment

The country specific analysis of female employment is presented in table 5. Female access to electricity (FEEL) is negative and significant in country 6 (Guinea Bissau) implying that a unit increase in female access to electricity decreases female employment in Guinea Bissau by 0.612 units, however in Liberia a positive and significant relationship is found in Liberia. A unit increase in female access to electricity increases female employment by 1.991 units in Liberia.

**Table 5: Country Specific Estimates of female employment**

Country	ECT	D <sub>1</sub> _feel	D <sub>1</sub> icti	D <sub>1</sub> _fer	D <sub>1</sub> _fsed u	D <sub>1</sub> _urb
1_Benin	-0.819*** 0.000	2.126 0.795	12.094*** 0.002	51.142*** 0.000	0.005 0.848	9.449*** 0.000
2_Burkina Fasso	-0.926*** 0.000	9.753 0.836	-9.334 0.816	40.273 0.453	-0.292 0.451	6.549* 0.088
3_Cape Verde	-0.585*** 0.000	-0.066 0.937	8.625*** 0.000	6.142* 0.052	-0.004 0.724	-3.735*** 0.000
4_Cote'Dvoire	-0.987*** 0.000	1.532 0.206	0.189 0.645	-3.320 0.190	0.009 0.456	-7.570*** 0.000
5_Gambia	-0.990*** 0.000	-0.389 0.858	6.609*** 0.000	-0.996*** 0.000	-0.020 0.319	2.376*** 0.007
6_Ghana	-1.008*** 0.000	0.017 0.996	-15.271*** 0.000	-96.578*** 0.000	-0.178 0.344	8.587 0.217
7_Guinea	-0.999*** 0.000	-0.868 0.128	2.118*** 0.000	-0.201 0.843	-0.000 0.917	1.096*** 0.009
8_Guinea Bissau	-0.999*** 0.000	-0.612** 0.012	-0.140 0.254	0.201*** 0.000	-0.002 0.682	0.024 0.508
9_Liberia	-0.990***	1.991**	1.577***	0.215***	-0.001	0.003

	0.000	0.040	0.000	0.006	0.657	0.805
10_Mali	-0.982*** 0.000	-1.771 0.293	-3.835*** 0.000	-0.023 6.861	0.009 0.346	1.805** 0.015
11_Mauritania	-1.007*** 0.000	-7.328 0.245	-16.791*** 0.000	0.511 0.520	-0.014 0.842	1.474 0.309
12_Niger	-0.929*** 0.000	28.574 0.277	-3.904 0.662	21.538 0.160	-0.074 0.875	-1.380 0.302
13_Nigeria	-0.983*** 0.000	2.864 0.628	-18.920*** 0.000	0.829** 0.025	0.056** 0.041	14.088*** 0.001
14_Senegal	-0.971*** 0.000	-0.433 0.823	5.175* 0.062	-3.525** 0.018	-0.003 0.780	-1.130 0.540
15_Sierra Leone	-0.947*** 0.000	-	-0.188 0.979	10.325 0.586	0.010 0.803	0.416 0.796
16_Togo	-0.984*** 0.000	0.303 0.827	5.342*** 0.000	6.388** 0.028	-0.114 0.524	-0.472 0.503

Source: Author's Computation (2024)

. Note: \*\*\*, \*\*, \* indicate significant at 1 percent, 5 percent, and 10 percent respectively

In addition, the information and communication index (ICTI) is significantly related to female employment in all the countries except six (6) countries. Estimates from Burkina Faso, Côte D'Ivoire, Guinea Bissau, Niger, Senegal and Sierra Leone show that ICT index is not a significant determinant of female employment in these countries. Fertility as an important determinant of female employment is positively significant in Benin, Guinea Bissau, Liberia, Nigeria and Togo. Intuitively, in these countries women see the need to work outside the home as the number of their children increase. In all the sixteen West African countries, female education is significant only in Nigeria. A unit increase in female education in Nigeria increases female employment by 0.056 units. In Benin, Gambia, Guinea, Mali and Nigeria, an increase in urbanisation increases female employment, while in Cape verde and Cote D'Ivoire a unit increase in urbanisation decreases female employment by 3.735 units and 7.570 units respectively.

#### 6.4 Result on Disaggregated Female Employment



Here, female total employment in West African countries was disaggregated into three, namely; female employment in the agricultural sector, female employment in industry and female employment in the service sector.

In agriculture sector, a unit increase in female access to electricity increased female employment in the agricultural sector by 15.363 units. However, information and communication diffusion has a negative impact on female employment in the agricultural sector. A unit increase in ICT diffusion leads to 5.418 decrease in female agricultural employment. Fertility on the other hand exerts a positive impact on female employment in agriculture. A one unit increase in fertility increases female employment in agriculture by 7.989 units. This is because an agrarian economy gives women time for other activities particularly care giving and child rearing. The opportunity cost of not working outside the agrarian economy becomes greater as women get more educated, hence the negative impact of female education on female employment in agriculture.

**Table 6: Static Analysis for Categories of Employment (Pooled Effect)**

	FETA	FETI	FETS
	Coef.	Coef.	Coef.
Feel	15.363*** 0.000	1.117*** 0.000	5.363* 0.051
Icti	-5.418*** 0.000	-0.941*** 0.000	0.553 0.689
Fer	7.989*** 0.000	0.419*** 0.000	0.780 0.353
Fsedu	-0.099** 0.032	0.029*** 0.000	0.280*** 0.000
Urb	-0.633 0.180	-0.044*** 0.000	-0.185 0.729

Source: Author’s Computation (2024)

. Note: \*\*\*, \*\*, \* indicate significant at 1 percent, 5 percent, and 10 percent respectively

On the other hand, the pooled effect result for female employment in industry (FETI) in West African countries shows that women employment in the industrial sector increases as females have access to electricity. A one unit increase

in female access to electricity increases women employment in industry by 1.117 units. And as fertility or female education increases female industrial employment increases. However, ICT index and urbanisation are negative determinants of female industrial employment. These two outcomes negate the priori-expectations of ICT index or urbanisation positive relationship with female employment in industry.

The result from the service sector shows that all these variables do not have a significant impact on female employment in the service sector except female education. A unit increase in female education encourages female employment in the West Africa service sector by 0.280 units.

The Panel-ARDL procedure for categories of employment all follows the Pooled Mean Group estimation technique and these are displayed in table 7. The long run estimates for Female Employment in Agriculture (FETA) shows that all variables are significant and they are negative determinants of FETA except fertility (FER) that is positive and significant. Female access to electricity (FEEL), Index for Informational and Communication Technology (ICTI), Female Education (FSEDU) and Urbanisation (URB) are negative determinants of female employment in agriculture. A unit increase in female access to electricity and a unit increase in ICT index decrease female employment in agriculture by 4.482 units and 2.117 units respectively. A one unit increase in female secondary education enrolment (FSEDU) and urbanisation decreases female employment by 0.019 units and 0.289 units respectively.

**Table 7: Dynamic Analysis for Categories of Employments (Pooled Mean Group)**

	<b>FETA</b>	<b>FETI</b>	<b>FETS</b>
	Coef.	Coef	Coef
<b>Long run</b>			
Feel	-4.482*** 0.000	0.007 0.916	6.788*** 0.000
Icti	-2.117*** 0.000	-0.140*** 0.000	1.851*** 0.000
Fer	5.229*** 0.000	0.203*** 0.000	-4.315*** 0.000

Fsedu	-0.019** 0.016	-0.002*** 0.000	-0.023*** 0.000
Urb	-0.289*** 0.000	-0.026*** 0.000	0.309*** 0.000
<b>Short run</b>			
D1_feel	6.342 0.111	2.875 0.130	0.628 0.786
D1_icti	5.163 0.408	0.024 0.989	20.132*** 0.000
D1_fer	-38.569** 0.041	-32.347*** 0.005	-97.089*** 0.003
D1_fsedu	-0.049 0.226	-0.001 0.926	0.027 0.110
D1_urb	0.140 0.959	-0.323 0.507	-0.906 0.779
ECT	-0.848*** 0.000	-0.877*** 0.000	-0.972*** 0.000

Source: Author's Computation (2024)

. Note: \*\*\*, \*\*, \* indicate significant at 1 percent, 5percent, and 10 percent respectively

Results from the industrial sector reveal that all variables significantly impact female industrial employment except female access to electricity. While ICT diffusion, female education and urbanisation have a negative impact on female employment in industries, fertility positively impacts female industrial employment. Moreover, female access to electricity, ICT diffusion and urbanisation positively impact the service sector. A unit increase in FEEL, ICTI and URB increases female employment in the service sector by 6.788 units, 1.851 units and 0.309 units respectively.

The short run analysis shows that fertility has a significant negative impact on female employment in all the sectors of the economy. A unit increase in fertility leads to 38.569units, 32.347unit and 97.089 units decrease in female employment

in agriculture, industry and service sector respectively. In addition, ICT diffusion has a positive impact on female employment in the service sector in the short run.

## 7. DISCUSSION OF FINDINGS AND IMPLICATIONS

The results from this study have strong implications for empirical analysis and policy making. Pooled results from static analysis showed that female access to electricity has a positive and significant impact on female employment in West Africa, while ICT diffusion impacts female employment negatively. Under the dynamic analysis of female employment, all variables (FEEL, ICTI, FER, URB, FSEDU) positively impact female employment. It means that as female access to electricity increases, female employment also increases. This is because household electrification releases females from home production and encourages small and medium scale enterprises<sup>70</sup>. It is widely debated that ICT facilitates the inclusion of low skilled workers and marginalised groups such as the female gender. It encourages remote work, flexible work arrangement and career development. This was corroborated by Shuangshuang et al (2023) while investigating the interconnectivity between digitalization and female labour force participation in BRICS economies<sup>71</sup>. The Shuangshuang et al's result revealed a positive impact of digitalization on female labour force participation. In addition, the positive impact of fertility on female employment could be due to a variety of factors, including greater access to child care facilities, the possibility of remote and flexible work arrangement, part-time jobs, availability of hired nannies<sup>72</sup>. The opportunity of getting a better job becomes greater as female education increases, hence female employment increases with increase in female education<sup>73</sup>.

In addition, sectoral analysis shows that female employment in agriculture decreases with increase in female access to electricity and ICT diffusion. This can

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<sup>70</sup> Dell KO, Peters S, and Wharton K, Women, Energy and economic empowerment: Applying a gender lens to amplify the Impact of Energy Access (Deloitte University Press 2014). Retrieved from [https://www2.deloitte.com/content/dam/insights/us/articles/women-empowerment-energy-access/DUP\\_950-Women-Energy-and-Economic-Empowerment\\_MASTER1.pdf](https://www2.deloitte.com/content/dam/insights/us/articles/women-empowerment-energy-access/DUP_950-Women-Energy-and-Economic-Empowerment_MASTER1.pdf) (accessed 30-11-2023)

<sup>71</sup> Shuangshuang Y, Zhu W, Mugha N, Aparcana S I, and Muda I 'The Impact Of Education And Digitalization On Female Labour Force Participation In BRICS: An Advanced Panel Data Analysis' (2023) 10(1) Palgrave Communications 1-9.

<sup>72</sup> Yarger J, & Brauner-Otto SR, 'Women's Work Characteristics And Fertility Expectations' (2024) 43(26) Population Research and Policy Review 1-21 <https://doi.org/10.1007/s11113-024-09866-7>

<sup>73</sup> Heath R, and Jayachandran S, 'The Causes and Consequences of Increased Female Education and Labor Force Participation in Developing Countries' (2017) NBER Working Paper Series (WP 22766). <http://www.nber.org/papers/w22766>.

be attributed to the non-formalization of the agricultural sector, which makes it less attractive for employment. However, because of the nature of this sector, women could combine work with housework, childbearing and caregiving. Increase in ICT diffusion decreases female employment in West African industries as a result of lack of representation, gender bias, and lack of required skilled and technical know-how to work in industries. In addition, female employment increases with increase in urbanisation. In the service sector female employment increases with increase in female access to electricity and ICT diffusion. Female employment decreases with increase in female education for all sectors of the economy (agriculture, industry and service). This can be linked to the effect of brain drain in Africa economies, the non-formalization of the agricultural sector, and the lack of required skills needed in industry and service sectors<sup>74</sup>. Also, females in households with high income may not want to work outside their homes. This supports the finding by Das et al. (2015)<sup>75</sup>, which opined that females in households with higher per capita spending are less likely to work.

On country specific analysis, female employment increases with increase in female access to electricity and ICT diffusion in Liberia. These relationships are reinforced by the positive impact of female education and fertility. Also, the effect of female access to electricity on female employment was negative in Guinea Bissau. Women in Guinea Bissau cannot get jobs without the permission of their husbands and there is no legislation in place on sexual harassment in work places<sup>76</sup>. There are no established penalties and civil remedies on sexual harassment.

On the other hand, ICT diffusion was significant in 9 countries out of the sixteen countries examined. This indicates that ICT diffusion plays an important role in determining female employment in these economies.

## **8. CONCLUSION AND POLICY RECOMMENDATIONS**

The study concludes that female access to electricity and ICT diffusion are positive determinants of female employment in West Africa. Results from disaggregated data of female employment shows that ICT diffusion discourages female employment in agriculture and industrial sectors while it increases female

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<sup>74</sup> White S, and Aylward D, Formalisation of Smallholder Agriculture and Agri-Business: Scoping Study on Formalisation of the Agriculture and Agribusiness Sectors (Business Environment Reform Facility 2016).

<sup>75</sup> Das S, Jain-Chandra S, Kochhar MK, and Kumar N, Women Workers in India: Why so Few Among So Many? (IMF Working Paper 15/55, 2015).

<sup>76</sup> World Bank, Women, Business and the Law 2022: Regional Profile Western and Central Africa (2022). [https://wbl.worldbank.org/content/dam/sites/wbl/documents/2021/02/2022.3.31\\_WBL\\_Regional%20Profile\\_WCA.pdf](https://wbl.worldbank.org/content/dam/sites/wbl/documents/2021/02/2022.3.31_WBL_Regional%20Profile_WCA.pdf)

employment in the service sector. In addition, female education is a negative determinant of female sectoral employment. While fertility is negative in the short run for sectors, it impacts agriculture and industrial sector positively, and service sector negatively.

Country specific analysis shows that female access to electricity is positively and negatively significant for Liberia and Guinea Bissau respectively. Evidence of its impact is not clear for other countries in West Africa. Moreover, ICT diffusion is a positive determinant of female employment in five (5) countries; Benin Republic, Gambia, Guinea, Liberia and Togo, while it is negative for Ghana, Mali, Mauritania, and Nigeria. Hence, improving female access to electricity and ICT, and breaking the glass ceiling in policy formulation are important for a fair and inclusive energy transition.

Based on these findings, it is recommended that governments should expedite efforts in female electrification and ensure bridging the gender gap. Secondly, the government should try to maximise benefits from ICT diffusion particularly in the industrial and agricultural sectors. Education is a lever in an economy and as such the government should ensure that its human resources are fully maximised.