Rethinking Sustainable Energy in Africa: Negative Impacts of Renewable Energy on Women

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Abstract

Climate change is the greatest challenge of our time, causing physical, economic, social and liability risks, among others. Alongside energy efficiency, renewable energy is one of the leading sustainable energy pathways to combat climate change, yielding a variety of interwoven environmental (e.g. the sources are not as dirty as coal and gas, and are abundantly available in Africa), economic (e.g. complementing diminishing petroleum reserves, creating local jobs, enhancing consumer choice) and social (e.g. readily accessible to people at the grassroots, facilitating community development and creating social bond) benefits. Comprehensive studies have specified its benefits in Africa (Belward *et al* 2011, 10), for instance the reduction of household carbon footprint through small-scale renewable energy (Wassie and Adaramola 2019, 377-379). However, while several studies (Thompson and others 2002; International Institute for Environment and Development 2004; Maathai 2007; Saunders 2008; UNEP Division of Communications and Public Information 2012; Scott and others 2012; Kala, Kurukulasuriya and Mendelsohn 2012; the IPCC 2014; Dassanayake and others 2018; Alagidede, Adu and Frimpong 2016) address multiple climate change impacts in Africa, they largely accept or assume renewable energy as a sustainable energy solution that has positive impacts on everyone, including vulnerable groups such as the poor, women and children. We take a step back to ask: what are the impacts of renewable energy on women in Africa?

Drawing on the literature and field experience, we find that renewable energy is not without its ills in Africa. Some studies (Karekezi and Kithyoma 2003; Vezmar *et al* 2014; Pradhnya 2015) have identified negative impacts across jurisdictions. Most do not specifically focus on women. Notable problems include flooding from hydro, destruction of habitats through bioenergy, bird accidents caused by wind turbines, soil erosion from solar, and earthquakes triggered by geothermal (see Pradhnya 2015). Combined, these negative impacts of renewable energy and others are substantially greater for women. We illustrate with livelihoods, disaster, and displacement, as recurring impacts of various renewable energies. Given these impacts, we submit that renewable energy reinforces environmental justice challenges.

Keywords: Women, Africa, Renewable Energy, Climate Change

1. Introduction

Population growth triggers energy needs, but the earth is somewhat finite (Owusu and Asumadu-Sarkodie 2016, 3) in its resources and ecological services. While some natural

resources are renewable, regeneration and renewal are difficult when overexploited. Climate change results from the unsustainable trend of resource exploitation and appropriation.

Climate change is a global problem, threatening ecosystems and biodiversity, affecting water resources, disrupting human settlements, and changing the frequency and scale of extreme weather events. There are significant consequences for food production, human well-being, socio-economic activities and economic output (OECD 2019, 1). At the root of climate change is global warming. Global warming results from anthropogenic emissions of carbon dioxide, methane and other greenhouse gases (Collier *et al*. 2008, 2). These greenhouse gas (GHG) emissions are produced when fossil fuels are produced and consumed.

To combat climate change, many of us hail renewable energy as a leading sustainable energy pathway. Truly, renewable energy is environment-friendly, having little to no emission of poisonous GHGs (Kumar 2020, 1). Going forward, it will remain an important source for power generation because we can use renewable resources again and again, so far it is at a sustainable rate. Resources such as bioenergy, hydropower, geothermal energy, solar energy, wind energy and ocean (tide and wave) (Owusu and Asumadu-Sarkodie 2016, 4) already provide 15–20% of the total world's energy. Society supports these sources for economic, social and environmental reasons (Kumar 2020, 1-2).

Nonetheless, renewable energy is without its ills, creating social, environmental, and economical problems. Hence, using literature review, documentary analysis and field experience in the Community Sustainability Global Project, we argue that despite the outstanding advantages of renewable energy sources as a sustainable energy pathway in Africa, it presents some challenges that inequitably affect women. We suggest how to mitigate these challenges through science, policy, and public action.

2. From global to local: Climate change in Africa

Climate change is one of the greatest challenges of our time. While the climate has been changing since the beginning of life, what is alarming is the speed of the change in recent years. The average growth rate of carbon dioxide has increased over the past four decades (Asumadu-Sarkodie and Owusu 2016c, 2016f), "averaging about 1.4 ppm per year before 1995 and 2.0 ppm per year thereafter" (Earth System Research Laboratory, 2015) (Fräss-Ehrfeld 2009; Owusu and Asumadu-Sarkodie 2016, 6).

2.1. Climate change impacts

Although the contribution of African countries to GHGs on a per capita basis is much smaller than that of industrialized regions (some projections, however, indicate a much higher contribution in the future), we already know Africa is dis-proportionately impacted. Even more worrisome is the dependence of the poor in Africa on rain-fed agriculture, which is believed to be already under threat from unpredictable weather patterns associated to climate change. The recent floods that adversely affected southern parts of Africa, among other things, indicate that the impact of climate change is already a reality in the continent (Karekezi and Kithyoma 2003, 6).

Abundant evidence from the literature and our field experience suggest that the impacts of climate change will continue to be felt profoundly in Africa for diverse reasons. We attempt to identify some of the leading reasons under the headings of geography, economics, and sociology:

(1) Geography: Africa is geographically characterised by warmer climates and vulnerable areas exposed to low rainfall, poor soils, and flood plains.

(2) Economics: Africa still excessively dependence on climate-sensitive sectors such as agriculture and fisheries.

(3) Sociology: Africa has low adaptive capacity to respond to the direct and indirect impacts of climate change due to factors such as weak economies and institutions, widespread poverty, inadequate technologies and social infrastructure, conflicts and limited human and financial capacities (ACPC 2011, 4).

2.2. Climate action

Despite the significant impacts, many African governments, stakeholders, and individuals do not take climate change seriously, although there are exceptions such as Kenya. Nonetheless, there is an overwhelming problem of ignorance and lack of interest about climate change. Our field work in the Community Sustainability Global Project[1] reveal that many Africans do not even know about climate change. Further, there are still numerous development challenges, for instance meeting basic livelihood needs, that hinder any interest in climate change.

Given the twin challenge of energy insecurity, even stakeholders and individuals that are knowledgeable about climate change may consider climate action a big ask. To take climate action seriously, Africa must meet electricity needs. The continent is the most electricity-poor region in the world: more than 600 million people lack access to electricity, and several million people are connected to an unreliable grids that fail to meet their daily energy service needs. Most African countries have average electricity access rates of about 20%, and two out of three people lack access to modern energy services (Avila *et al*. 2017, 15). Energy insecurity remains one of the biggest obstacles to climate action (Azarpour *et al.* 2013, 318).

3. The acclaimed solution to climate change: Renewable energy in Africa

Renewable energy often implies two things: renewable resources that feed renewable technologies, and renewable technologies used to process renewable resources. Renewable energy reduces GHGs while contributing to various aspects of sustainable development (Belward *et al*. 2011; Wassie and Adaramola 2019; Panwar *et al*. 2011; Owusu and Asumadu-Sarkodie 2016, 6). Specifically, by impacting human development and productivity (Asumadu-Sarkodie and Owusu 2016b), renewable energy has a direct relationship with sustainable development. As part of this relationship, it provides opportunities for energy access and security, social and economic development, and reduction of environmental and health impacts (Asumadu-Sarkodie and Owusu 2016g; Owusu and Asumadu-Sarkodie 2016, 8). Renewable energy thus offers optimal use of clean energy, supposedly with minimum secondary waste, and is sustainable for current and future economic and social needs.

We identify the major types of renewable energies in Africa: hydro, solar, wind, geothermal, biomass, and ocean energy. The emphasis is on the resources and/or technology.

3.1. Hydro

Clearly the leading renewable energy in Africa, hydropower is an essential energy source harnessed from water moving from higher to lower elevation levels, primarily involving turning turbines to generate electricity. The operation of hydropower reservoirs often interacts with multiple uses, for example flood and drought control (Asumadu-Sarkodie *et al*. 2015; Asumadu-Sarkodie *et al*. 2015), irrigation, drinking water and navigation (Edenhofer *et al*., 2011; Owusu and Asumadu-Sarkodie 2016, 5). Most Africa countries have hydropower,

[1] www.csgproject.com

making up 90% of electricity generation in Ethiopia, Malawi, Mozambique, Namibia and Zambia (Conway 2017).

Hydropower has several advantages. It is clean, promoted as an environment friendly energy option (Karekezi and Kithyoma 2003, 12). Since hydropower does not utilize or contaminate water to produce power, disruption in clean water supply is minimal. Simultaneously, the revenues attained by energy sales can be invested to provide other essential amenities, for instance potable wates supply systems, irrigation plans for food production, establishments boosting navigation, recreational facilities and ecotourism (Kaygusuz 2002; Yuksel 2010; Hopkinson *et al*. 2000; Azarpour *et al*. 2013, 319).

Yet, the ecological and socio-economic impacts of hydropower plants are significant. These plants change natural watercourses and movement paths of wildlife and fish, thus disrupting the ecosystem. Hydropower dams are also known to cause several problems, including deforestation, change in water quality and hydrology (Sovacool and Bulan 2011; Azarpour *et al*. 2013, 322). Further, there is greenhouse gas emissions and derived impacts from dam construction activities (Sovacool and Bulan 2011; Azarpour *et al*. 2013, 322). In countries where substantial plants or tree covers are flooded during the construction of a dam, there may be formation of methane gas, when plants start rotting in the water, either released directly or when water is processed in turbines (Førsund, 2015; Owusu and Asumadu-Sarkodie 2016, 6). Besides these ecological impacts, hydropower also affects communities that rely on wildlife and fish for livelihoods, and people are displaced for the construction of hydroelectric dams (Mamit 2010).

3.2. Solar energy

Perhaps next in popularity to hydro, solar energy technology comes from solar irradiance to generate electricity using photovoltaic (PV) (Asumadu-Sarkodie & Owusu, 2016d) and concentrating solar power (CSP) to produce thermal energy. Such energy could meet direct lighting needs and, potentially, produce fuels for transportation and other purposes (Edenhofer *et al*. 2011; Owusu and Asumadu-Sarkodie 2016, 7). The majority of African countries now have solar energy, but the fastest growing markets seem to be in Egypt, South Africa, Kenya, Namibia and Ghana.

Like other renewables, solar energy does not have significant environmental impact. There is hardly any CO_2 or other greenhouse gas emissions (Vezmar *et al*. 2014, 16). Also, since much of Africa has a lot of sunshine, solar energy is abundant. It could potentially be a leading alternative energy (Azarpour *et al*. 2013, 319).

However, solar energy causes soil compaction, erosion, and alteration of drainage channels. Furthermore, solar energy systems can impact the land in the process of materials extraction, exploration, manufacturing, and disposal. The most negative impact of hydropower as the giant among the renewables is flooding. When the water stored within a dam is released all at once, it can cause the river downstream to suddenly flood, resulting in the destruction of agricultural land, forest, wildlife, and land (Pradhnya 2015). Another potential problem associated with solar energy is health hazard. Solar energy panels and photovoltaic- cell fabrication use chemicals such as germanium and cadmium that are potentially harmful to human health, thus raising concerns about its application. (Azarpour *et al*. 2013, 324). Additionally, in solar energy, larger PV plants are often built on public land, including agricultural land. In that case, they may have significant impact on land, expressed in terms of flora and fauna, respectively (Vezmar *et al*. 2014, 16).

3.3. Wind

Next in line is wind energy. Wind is the movement of air in response to pressure differences within the atmosphere: pressure differences exert a force which causes air masses to move from a region of high pressure to low pressure. Harnessed through wind turbines, such

pressure differences are caused primarily by differential heating effects of the sun on the surface of the earth (Sorensen *et al.* 2009; Vezmar *et al*. 2014, 20). Like solar energy, wind energy is rising across African countries, but the leaders appear to be South Africa, Morocco, Egypt, Ethiopia, and Kenya (Tiyou 2016).

Wind energy has advantages such as low cost, cleanliness, and abundance. Unlike coal or petroleum that produces harmful gases such as CO, CO_2, NO_x and SO_x, wind energy is clean, cost-free, and abundant. There is limited transportation requirement and no need for sophisticated technology to harness wind energy (Azarpour *et al.* 2013, 318).

Nonetheless, the wind power sector has fallen under intense scrutiny in the past few years due to its impact on birds and other species. A recent review by the National Wind Coordinating Committee (NWCC) found that collisions with wind turbines and air pressure changes caused by spinning turbines resulted in several bird and bat deaths. Also, large-scale wind energy requires substantial amount of land to install related facilities, particularly the wind turbine, thus it suffers from practicality issues (Ren 2010; Azarpour *et al*. 2013, 323). Similarly, offshore wind turbines can harm marine birds (Pradhnya 2015), and wind power plants can also influence power system reliability, available transmission capacity and power system operation in general (Vezmar *et al*. 2014, 20). Additionally, the noise produced by wind energy generators is a problem, although there are legal norms on the amount of noise allowed in certain areas. They are often located only where they do not exceed the set standards (Vezmar *et al*. 2014, 20).

3.4. Geothermal

The earth has layers that withhold heat and other geological processes that produce energy. Geothermal energy involves harnessing such energy produced and stored below the surface of the earth (Turcotte and Schubert 2002; Azarpour *et al*. 2013, 320). Kenya is the leading geothermal jurisdiction, Ethiopia also generates power from geothermal, and others such as Tanzania, Comoros, Eritrea, Djibouti, Rwanda and Uganada have done some exploration (Yee 2018).

Geothermal energy exploitation has numerous advantages over other energy sources. Among the benefits of geothermal energy are the near zero emissions (true for modern closed cycle systems that re-inject water back to the earth's crust) and limited surface space requirement. Geothermal power plants require approximately 11% of the total land used by coal fired plants and 12-30% of land occupied by other renewable technologies (Karekezi and Kithyoma 2003, 10).

The top problem with geothermal energy is that it is erratically spread, scarcely concentrated, and, generally, at depths very far to be industrially exploited (Azarpour *et al*. 2013, 320). Also, geothermal sites may contain poisonous gases that can escape when holes are being drilled in the earth's surface (Pradhnya 2015). Geothermal power plants use fluids drawn from the deep earth, which may carry a mixture of polluting gases, notably carbon dioxide (CO_2), hydrogen sulphide ($H2_S$), methane (CH_4) and ammonia (NH_3). These pollutants along with the one generated while washing the absorptive contribute to global warming, acid rain, and noxious smells (Vezmar *et al*. 2014, 21). Also, when drilling to gain access, there are impacts on natural habitat. Geothermal energy stations, under extreme circumstances, can cause earthquakes (Pradhnya 2015). Scenic places that would otherwise be reserved as recreational parks would have to make way for plant construction. The risk of land subsidence is another matter that demands a scrutinized investigation prior to the construction of geothermal plants (Moriarty and Honnery 2010). In the event of landslide or subsidence, the constructed plant, human operators, and local inhabitants would be in jeopardy (Azarpour *et al*. 2013, 325).

3.5. Biomass

Biomass energy, often shortened as bioenergy, is renewable energy from biological resources. There is a large range of biomass, including forest by-products such as wood residues, agricultural residues such as sugar cane waste, and animal husbandry residue such as cow dung. Biomass energy processes produce fuel as by-product, residue, or waste product from the biomass sources. Presently, global production of biofuels is comparatively low but continuously increasing (Ajanovic 2011; Owusu and Asumadu-Sarkodie 2016, 6). Many African countries have ongoing bioenergy projects, for instance initiatives in Ethiopia, Ghana, Kenya, Tanzania and Uganda (Lynd et al 2015).

Biomass energy has been touted as an environmental-friendly energy source as it produces a much lower emission. Low input energy required to process it would also increase its feasibility in terms of economic viability (Azarpour *et al*. 2013, 323). Perhaps the leading criticism is that it reduces resources available for food, but there are those who also think otherwise (Urban and Mitchell 2011).

Nonetheless, most of the suitable land for biomass production is already in use (Ajanovic 2011) for agricultural and other purposes. Large land areas are needed to grow biomass, with a direct impact on the eco-world (herbicides, pesticides, fertilizers) (Ministry of Economy of the republic of Croatia 2014). Using tree or tree products to create bioenergy comes with its own set of problems. To collect enough lumber, substantial forest land needs to be cleared, which again causes topical changes, trigger direct and indirect land-use change (Searchinger *et al*. 2008; Lapola *et al*. 2010; IEA: Bioenergy 2009: Schubert *et al*. 2009), disrupts animal habitat (Pradhnya 2015), biodiversity loss (Lee and Islam 2008; Hennenberg *et al*. 2010) and water supply availability (Berndes 2002; Gerbens-Leenes *et al*. 2009; Tilman *et al*. 2009), and increases agricultural products cost and risks of food security (Tilman *et al*. 2009; Pimentel *et al*. 2009; Action Aid 2010; Wolf *et al*. 2003; Cotula *et al*. 2008; Azarpour *et al.* 2013, 320). Diversion of crops or land into bioenergy production can affect food commodity prices and food security (Headey and Fan 2008; Owusu & Asumadu-Sarkodie 2016, 6-7). Also, like orthodox agriculture and forestry systems, bioenergy can worsen soil and vegetation degradation related with the overexploitation of forests, too exhaustive crop and forest residue removal, and water overuse (Koh and Ghazoul 2008; Robertson *et al*. 2008). Additionally, bioenergy feedstock is often unacceptable for cultivation in urban centres (Vezmar *et al*. 2014, 17-18). Further, bioenergy plants have direct emissions of greenhouse gases and particulate matters. The amount of produced CO_2 is equivalent to consumption in the process of photosynthesis. Additionally, noise pollution and unpleasant smell may also result from machines and operations in the plants (Vezmar *et al*. 2014, 17-18). The combustion of biomass could possibly produce air pollutants, especially, in the form of nitrogen oxides (NO_x), and particulates such as soot and ash at a larger magnitude than fossil fuel (Stupak et al. 2007; Azarpour *et al*. 2013, 323). Then, some of the bioenergy resources used for producing electricity are crops, forest products, agricultural waste, and urban waste. The bioenergy feedstock and the way it is harvested can negatively impact land use along with global warming emissions (Pradhnya 2015).

3.6. Ocean (Tide and Wave)

Surface waves are created when wind passes over water, in this instance a big body of water such as an ocean. The faster the wind speed, the longer the wind is sustained, the greater distance the wind travels, the greater the wave height, and the greater the wave energy produced (Jacobson and Delucchi 2011; Owusu and Asumadu-Sarkodie 2016, 7). Because of increased access to the ocean, coastal locations would benefit more from ocean energy. Ocean energy is not yet significantly developed in Africa, although West Africa is often identified as a region with high ocean energy potential.

4. The limitations to renewable energy in Africa: Impacts on women *(in progress)*

Renewable energy is largely seen as an ideal solution to climate change and other environmental problems. Communities also benefit from renewable energy development for a variety of reasons, most notably the potential to mitigate energy insecurity and support economic development. Understandably, we often overlook the serious drawbacks of these promising renewable energy sources and technologies. Unsurprisingly, there is little understanding of how the drawbacks affect specific vulnerable groups such as children, women, and the poor. We suggest that, like climate change, some of the renewable energy drawbacks that we have identified have differential impacts on various stakeholders, raising environmental justice concerns.

We discuss the drawbacks of renewable energy as affecting women. We organize the drawbacks into three major themes that recur in the previous section: livelihoods, disasters, and displacement. While these drawbacks affect other stakeholders as well, they are arguably more significant for women.

4.1. Livelihood

Women are homemakers and caregivers in most African communities. Flooding, habitat destruction, soil erosion and other renewable energy impacts could make it more difficult for women to get resources such as firewood, crops, medicinal plants, and water to take care of their families. Specific technologies pose diverse challenges.

African women use biomass for cooking, heating, and other household tasks. Hydropower, solar energy, wind energy and bioenergy projects variously lead to deforestation, land change, change in water quality and hydrology (Sovacool and Bulan 2011; Azarpour *et al*. 2013, 322). They make it more difficult for women to access biomass and other resources. Women would have to travel far to find biomass such as firewood.

Installing hydropower dams may also change natural watercourses and movement paths of wildlife and fish. Women also rely on wildlife and fish to provide for their families. Hydropower also leads to flooding. When the water stored within a dam is released all at once, it can cause the river downstream to suddenly flood, resulting in the destruction of agricultural land, forest, wildlife, and land (Pradhnya 2015). Ultimately, such flooding affects resources that women rely on.

Health hazards from solar energy add to the care-giving burden of women, even if such do not affect women directly. Solar-energy panels and photovoltaic cell fabrication use chemicals, including germanium and cadmium, that are potentially harmful to human health (Azarpour *et al*. 2013, 324). Solar panels and photovoltaic cells are increasingly located close to homes, which are susceptible to the health impacts. Where family members are affected, women would have the additional responsibility to take care of them.

4.2. Disasters

Many renewable energy technologies come with disaster risks. Perhaps the most known disasters are from hydropower. When the water stored within a dam is released, it often causes flooding. Floods destroy agricultural land, forest, wildlife, and land (Pradhnya 2015). Women play an important role in managing disasters, including family members, in Africa.

4.3. Displacement

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