

Renewable Energy – An Eco-Friendly Alternative?

by Friederike Adra



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1. Introduction

Even though the earth continues evolving, the resources used by humans will eventually become scarce. Over decades, fossil fuels were and are still being used as the major energy source for households, industries and service providers. However, due to the limited amount of fossil fuels, energy is becoming more and more expensive, and the consequence of their consumption is having an impact on our environment and climate. The major impact is called the Greenhouse Gas Effect, which is in other words “gases that trap heat in the atmosphere”.¹

The trapped heat does not leave the earth without severe consequences. Global warming is one of the terms often used to describe the reason for many natural catastrophes. One of the major consequences resulting from the greenhouse gas effect is called Climate Change which causes the melting down of major glaciers and the poles resulting in the rise of the sea level. Due to the trapped heat, extreme weather conditions occur, such as droughts and floods.²

Due to the dangerous and life threatening factors, many countries are investing therefore in renewable energy, such as solar energy, windmills, hydropower or biomass energy. This shift to a “cleaner energy” should result in the reduction of greenhouse gases and therefore mitigating climate change.

Term definitions and examples of fossil fuels and renewable energy will be explained leading to the requirements for installing renewable energy systems. The paragraphs after will be highlighting the general advantages and disadvantages of renewable energy systems and the basic costs for private usage and government investments.

2. Fossil Fuels and the Negative Impact on our Environment

Due to the decreasing amount of fossil fuels, and the increase in their price for governments and consumers, Charles Darwin’s expression “survival of the fittest”³ would perfectly suit the ongoing competition for the remaining fossil fuels by powerful and wealthier countries. Many leading countries would interfere economically and politically in weaker and poorer economies for their rich ground on fossil fuels. But what are fossil fuels?

Fossil fuels are the remains of dead plants and animals over several millions of years. Those remains became energy resources like “coal, fuel oil or natural gas”⁴. They are easily processed and transportation is mostly done through pipes. Many people would prefer the easily

¹United States Environmental Protection Agency. Greenhouse Gas Emissions. Available on, <http://www.epa.gov/climatechange/ghgemissions/> [accessed 19th May 2014]

²British Geological Survey. Consequences of greenhouse-effect temperature rises. Available on, <http://www.bgs.ac.uk/discoveringGeology/climateChange/CCS/consequencesOfTemperatureIncrease.html> [accessed 16th June 2014]

³Encyclopaedia Britannica. Animal Behaviour. Available on, <http://www.britannica.com/EBchecked/topic/25597/animal-behaviour#ref497943> [accessed 13th May 2014]

⁴Science Daily. Fossil fuel. Available on, http://www.sciencedaily.com/articles/f/fossil_fuel.htm [accessed 13th May 2014]

combustible and cheap resources of the ground since even their extraction and processing is often very cheap.⁵ Many countries use inexperienced or uninstructed labour for the coal mines, and do not invest in proper protection and safety materials for the workers. This leads to many work accidents or explosions inside coal mines, causing several deaths among workers.⁶

Despite of the direct impact on workers' health and safety, there are also indirect impacts on human and nature. The leading environmental impact is the effect of global warming caused by the greenhouse gas emission. The trapping of many toxic gases are already becoming visible on natural disasters caused by the heating of the earth. Farmers are often experiencing the decay of their crops due to unusually extreme weather temperatures or the fall of acid rain in some areas.⁷

One leading greenhouse gas is Carbon Dioxide (CO₂), which over long term exposure can cause asthmatic diseases to many people or even result in lung cancer. One major example of the devastating amount of toxic gases is China. Due to the rapid increase of industries and the high amount of CO₂, smog has covered many industrial cities. This harmless looking fog contains many toxic gases letting people unable to breathe without a mask covering nose and mouth.⁸

The search for oil is not without a negative impact as well. Whether the drilling onshore or offshore turned out to be successful, and a big reservoir of oil was discovered, the animal and natural life would be destroyed either ways. Offshore drilling will also affect the underwater life of many animals either by reducing the livestock due to the operation of the oil rig or polluting the sea and poisoning the livestock due to oil spills. The fishing quota would reduce. Small-scale fishers would catch less or even poisoned fish resulting in the reduction of income.⁹ This poorer group of society would probably sell the poisoned fish to the customers in order to maintain their livelihood; therefore, it could also have negative health implications for a larger group of society.

Despite those negative effects, it is important to mention that many resource rich countries "develop more slowly, are less diversified, more corrupt, less transparent, subject to greater economic volatility, more oppressive and more prone to internal conflict than non-endowed countries at similar income levels."¹⁰ Many people refer to this as the "natural resource curse"¹¹ and give examples of the situation in African oil-rich countries like Nigeria, Sudan and the Republic of Congo.

⁵ Conserve Energy Future. Fossil Fuels. Available on, http://www.conserve-energy-future.com/Advantages_FossilFuels.php [accessed 14th May 2014]

⁶ Conserve Energy Future. Fossil Fuels. Available on, http://www.conserve-energy-future.com/Disadvantages_FossilFuels.php [accessed 14th May 2014]

⁷ *Ibid.*

⁸ Beech, H. (2014). "China's Smog Is So Bad They're Now Calling It a 'Nuclear Winter'". *Time*. Available on, <http://time.com/9802/beijing-air-pollution-nuclear-winter/> [accessed 19th May 2014]

⁹ *Supra.* n.4

¹⁰ Siegle, J., ed. Khodeli, I.(2009). „Governance strategies to remedy the natural resource curse". *From Curse to Blessing? Using Natural Resources to Fuel Sustainable Development*. Blackwell Publishing Ltd, Oxford. p.45.

¹¹ Lawson-Remmer, T. (2012) "Beating the Resource Curse in Africa: A Global Effort". *Council on Foreign Relations*. Available on, <http://www.cfr.org/africa-sub-saharan/beating-resource-curse-africa-global-effort/p28780> [accessed 22th May 2014]

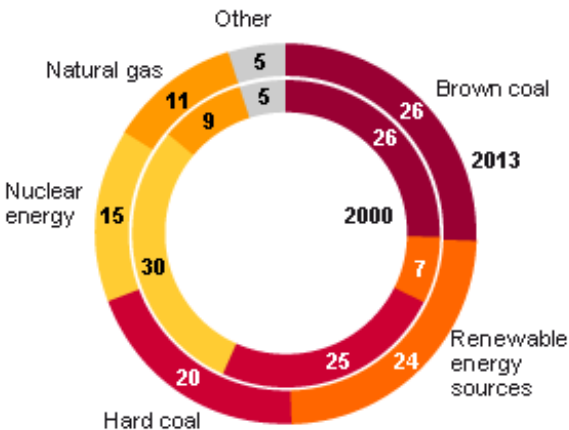
Economically, the expenses through fossil fuels are harshly increasing for states and households. The more a material is running out of availability the more expensive it becomes to search for it, collect it and then sell it to the ones in need. Fossil fuels are becoming scarce and expensive, which is being sold to households and other countries for profit. One example of the high financial burdens, countries might have is America. A report by Environment America shows that in 2006 alone, “consumers and businesses spend \$921 billion” on fossil fuels, “more than the nation spent on education or the military”.¹² This indicates the high expenses just for providing energy, and the numbers increase the more fossil fuels become scarce and more expensive. This does not just affect the energy of a household or a company, but also the goods and services created in industries through fossil fuels.

But there are ecologically friendly alternatives, which can be widely used with less threatening impacts to our climate, environment, health and economy.

3. Renewable Energy: Definitions and Examples

Many countries are nowadays investing in renewable energy sources. There are several methods in order to gain heat and electricity. Germany increased the annual production of renewable energy from 7% (2000) to 24% (2013) of the national gross electricity production.

Gross electricity production
Percentage shares



Source: AGEE -Stat and AGE B.

© Statistisches Bundesamt, Wiesbaden 2014

Germany was even able to turn off several nuclear power plants in the past years.¹³ This firstly brought in a lot of skeptical opinions and fears of power shortages due to the infrequent amount of renewable energy sources. Yet however, due to the high amount of energy created, Germany is even able to export its energy to other countries, proving many theories about energy shortages wrong. This mainly shows that when energy is being used and stored properly, using renewable energy can be highly efficient and to an advantage for producers, consumers and nature.¹⁴ However, it is important to also mention that the need for sufficient infrastructure is a major steppingstone for the productive path of using renewable energy resources. Many developing

¹² Figdor, E. (2009). *The High Cost of Fossil Fuels*. Available on, <http://www.environmentamerica.org/reports/ame/high-cost-fossil-fuels> [accessed 19th June 2014]

¹³ Statistisches Bundesamt. *Bruttostromerzeugung 2013*. Available on, <https://www.destatis.de/DE/ZahlenFakten/ImFokus/Energie/ErneuerbareEnergien2013.html> [accessed 16th June 2014]

¹⁴ Birkenstock, G. (2012). “Power exports peak, despite nuclear phase-out”, *Deutsche-Welle*. Available on, <http://www.dw.de/power-exports-peak-despite-nuclear-phase-out/a-16370444> [accessed 19th May 2014]

countries lack the strong power net other countries have, and hence cannot distribute the energy to the households.

Renewable Energy Sources are usually referred to energy produced through sun, wind or water power. There are special ways in capturing the mentioned natural energy and transforming it into energy we can actually use at home.

3.1. Solar Energy



The widely used mechanism is the utilization of solar panels, by using the sun to generate electricity. A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of solar cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and/or solar tracker and interconnection wiring. Depending on construction, photovoltaic modules can produce electricity from a range of frequencies of light, but usually cannot cover the entire solar range (specifically, ultraviolet, infrared and low or diffused light). Hence much of the incident sunlight energy is wasted by solar modules, and they can give far higher efficiencies of illuminated with monochromatic light. Therefore, another design concept is to split the light into different wavelength ranges and direct the beams onto different cells tuned to those ranges. This has been projected to be capable of raising efficiency by 50%¹⁵. Currently the best achieved sunlight conversion rate (solar module efficiency) is around 21.5% in new commercial products typically lower than the efficiencies of their cells in isolation.

Solar panels can be installed on roofs or on the ground. Additional trackers sense the direction of the sun and tilt the modules as needed for maximum exposure to the light. There are two main types of catching solar energy easily, one which absorbs the direct sunlight and transforms it into energy, and the other method is by using the sun's heat as an energy source.

¹⁵ Max – Planck – Institute in Germany is doing research at the moment to develop a more efficient solar panel (range 50-80%)

The invention of affordable solar stoves has been used since few years in Madagascar. With only 15€ for these stoves, households use the sunlight for cooking and are even able to store energy in a battery for later use.¹⁶

Prices and Coverage	
Years to use ¹⁷	25
Coverage of households	1 (4-6 persons)
Price for investment per households	15.000 – 25.000 € (depending supplier + size of panels + battery)
Pays off in	Approximately 10 years and above
Capacity/Full-load hours ¹⁸	800-900 h per year

Advantages	Disadvantages
Resources (if well maintained) are infinite and will not extend regardless of the amount of consumption	Expensive for household
Climate friendly	Produces sufficient energy, but storage problematic (sometimes need for public energy supply)
Profitable investment	Cost of maintenance
No toxic gas production	Weather dependent
Every area has access to sunlight even if not regularly	
No noise pollution	

¹⁶ Hamm, H. (2014). "Solarkocher statt Kohleöfen". *Natur*. Available on, <http://www.natur.de/de/20/Solarkocher-statt-Kohleofen,1,,1446.html?search=solarkocher> [accessed 12th May 2014]

¹⁷ If well maintained

¹⁸ Full-load hours is the energy source's average annual production divided by its rated power. The higher the number of full load hours, the higher the production at the chosen site.

3.2. Wind Energy



Countries rich on wind often refer back to the installation of windmills on wide and open fields. Around 90 countries are supporting the consumption of electricity through windmills since a few years, and more and more countries are following this new boom of eco-friendly technology.¹⁹ Windmills can be also installed off shore, in areas using the sea and ocean wind for generating electricity. However, whether on-or-off shore, the windmills cannot be working properly when the amount of wind is either too low or too strong. Windmills are always installed in certain fields and areas, mostly far from cities and villages due to the noise pollution and the need for open fields with wind. Municipalities therefore obtain regional planning on fields away from farms and even protected areas, since windmills can become a threat to wild birds.²⁰

While fans use electricity to generate wind, the windmill does exactly the opposite. The blades of a windmill rotate once wind is present, which have a shaft connected to the generator to create electricity.²¹

Prices and Coverage	
Years to use ²²	20
Coverage of households	1000 households
Price for (government) investment	Approximately 1.7 million to 2.5 million € per unit
Pays off in	Approximately 9 years and above
Capacity/Full-load hours ²³	1700 hours/year

Advantages	Disadvantages
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¹⁹ Federal Ministry of the Environment, Nature Conservation and Nuclear Safety.(2013). Renewable Energy Sources in Figures-National and International Development. Public Relations Division of the BMU, Berlin. p.65

²⁰ *Ibid.*

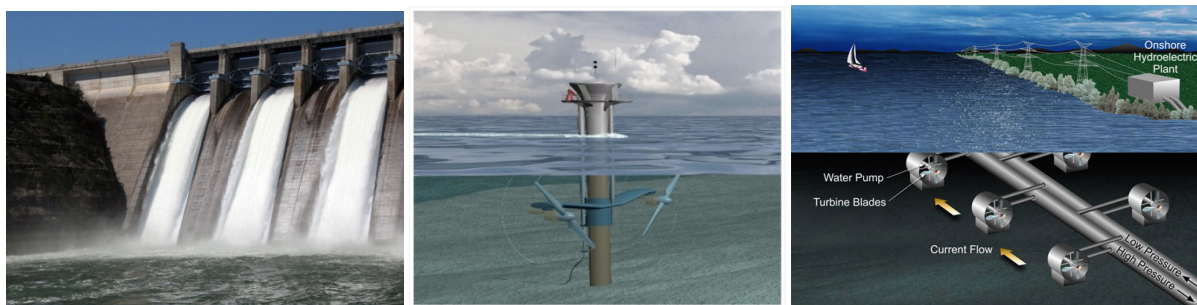
²¹ Energy.gov. How do Wind Turbines Work? Available on, <http://energy.gov/eere/wind/how-do-wind-turbines-work> [accessed 20th June 2014]

²² If well maintained

²³ Op. Cit. No. 17

Creates many job opportunities (e.g. installation, maintenance etc.)	Expensive
Climate friendly	Storage of energy
Low maintenance cost	Difficult maintenance
No air, ground or water pollution	Infrastructure to transport energy
Reduces CO2 emission	Weather dependent
Can be installed off-shore and on land	Surrounding wild life may be disturbed
Resource is infinite	Noise pollution in the installed areas
	Land disputes

3.3. Hydro Energy

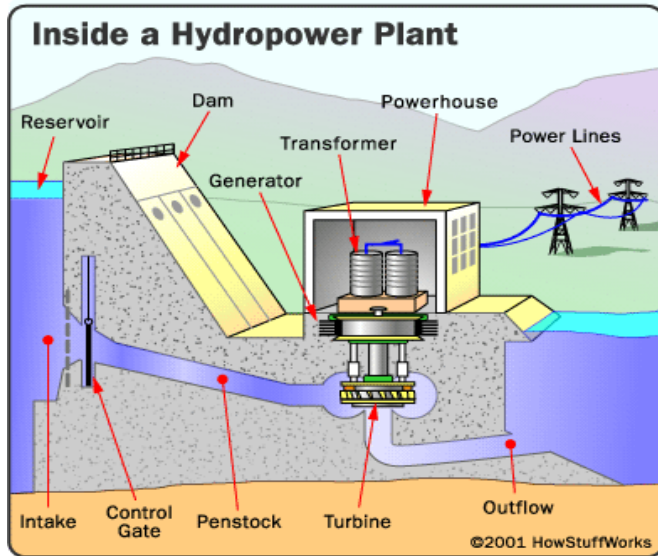


Water energy can come in different forms and variations. One type of renewable energy source is the building of **dams**, as done at the Volta River.²⁴ The first dam built in Ghana was the Akosombo Dam in 1965, followed by the Kpong Dam which was completed in 1982 and the newer Bui Dam which construction was completed in 2013.²⁵ While the Akosombo and Kpong Dams are purely hydroelectric dams, built in order to generate electricity through water power and strong flow, the Bui Dam has also other functions. Next to the generation of electricity, it also provides a certain protection from floods, provides water for irrigation and improved the fishing industry as well.²⁶ Dams transform the strong water flow through pipes into energy and provide electricity. But the strong stream can also be used in rivers by installing water wheels or the use of turbines in seas and oceans for the water current.

²⁴ Fiagbe, Y.A.K. & Obeng, D.M. Optimum Operation of Hydropower Systems in Ghana When Akosombo Dam Elevation is Below Minimum Design Value. Available on, <http://dspace.knust.edu.gh/jspui/bitstream/123456789/1352/1/OPTIMUM%20OPERATION%20OF%20HYDROPOWER%20SYSTEMS%20IN.pdf> [accessed 20th May 2014]

²⁵ Government of Ghana. (2014). Bui And The Tale of Three Hydro Dams. Available on, <http://www.ghana.gov.gh/index.php/2012-02-08-08-32-47/features/4537-bui-and-the-tale-of-three-hydro-dams> [accessed 11th June 2014]

²⁶ Water-technology. Bui Dam Hydroelectricity Project, Bui National Park, Ghana. Available on, <http://www.water-technology.net/projects/bui-dam-hydro-power-ghana/> [accessed 20th May 2014]

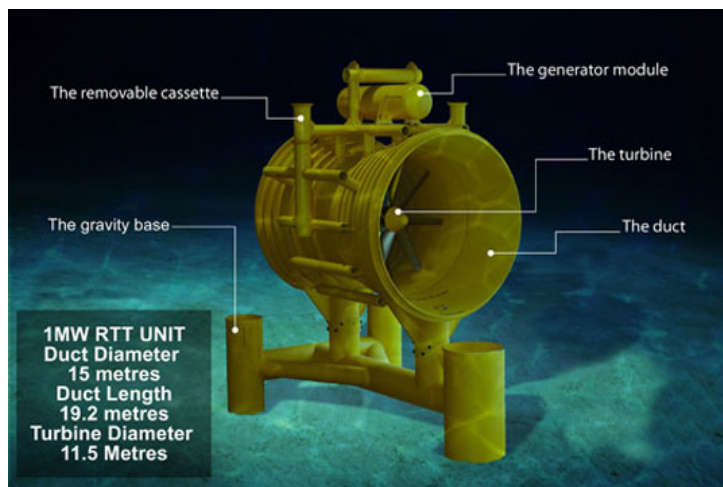


Even though the majority of dams are immense in size, their process to generate electricity is however simple. “The water in the reservoir is considered stored energy. When the gates open, the water flowing through the penstock becomes kinetic energy because it’s in motion”.²⁷ The faster and stronger the flow of the water, the more energy is generated.

There are also other ways to generate energy through water power. Wave energy, tidal energy and ocean thermal energy, however, need wide and open

areas to get its full potential.

Wave energy, as the name already points out, is energy generated through the waves. The wave flows inside a chamber connected to the turbine, and causes the turbine to rotate, generating energy. It is however not a high amount of energy, therefore it is often used to light up a light house or for the warning buoy.²⁸



Another type of energy is generated through **tidal power**. This works by tides being trapped behind a dam into a reservoir which can be let out again when the tide decreases. Another option is the installation of turbines offshore in the sea. Countries, such as France or Norway, are using tidal energy. France generates energy through tidal power which provides approximately 240,000 households with energy.²⁹

²⁷ Bonsor, K. [How Hydropower Plants Work](http://science.howstuffworks.com/environmental/energy/hydropower-plant1.htm). Available on, <http://science.howstuffworks.com/environmental/energy/hydropower-plant1.htm> [accessed 20th June 2014]

²⁸ Bellis, M. [How Tidal Power Plants Work](http://inventors.about.com/od/tstartinventions/a/tidal_power.htm). Available on, http://inventors.about.com/od/tstartinventions/a/tidal_power.htm [accessed 20th June 2014]

²⁹ Bellis, M. [How Tidal Power Plants Work](http://inventors.about.com/od/tstartinventions/a/tidal_power.htm). Available on, http://inventors.about.com/od/tstartinventions/a/tidal_power.htm [accessed 20th June 2014]

Another way to generate energy is through the temperature difference between the surface temperature and the temperature below the surface. There are many power plants around Japan and Hawaii who use the Ocean Thermal Energy Conversion in order to generate power.³⁰

Prices and Coverage		
	DAM	TIDAL POWER
Years to use ³¹	Decades/hundreds of years (if well maintained, e.g. dams in Spain and Japan)	25
Coverage of households	245.000 households (with 4000 kW per year each) or 490.000 households (with 2000 kW per year each)	1250 households
Price for investment	US\$ 622 mill. (Bui Dam, Ghana)	1.7 million € per unit
Pays off in	Depending on generation of power and income for sold electricity	Approximately 10 years and above
Capacity/Full-load hours ³²	5000-6000 hours/year	5000 hours/year

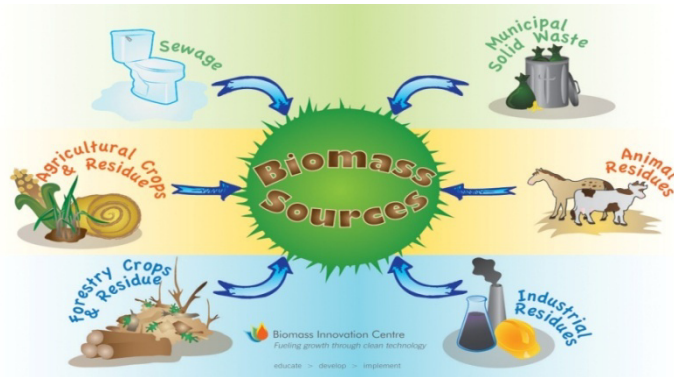
Advantages	Disadvantages
Long term profit	Cost of building dams, Cost of equipment and machines
Climate friendly	Equipment might change water flow
No water pollution	Structural change through installation of required infrastructure
No dangerous work place for labour	Cost of maintenance
Helps reduce greenhouse gas emission	Flow/tide/wave dependent Wildlife disturbed by turbines under water

³⁰ *Ibid.*

³¹ If well maintained

³² Full-load hours is the energy source's average annual production divided by its rated power. The higher the number of full load hours, the higher the production at the chosen site.

3.4. Biomass Energy



Biomass is one of the renewable energy resources many countries have been using since a longer time, since its energy is provided through the process of photosynthesis in plants. The energy is generated in biomass power plants by burning down crop residues, manure, forest residues or even urban wastes. Biomass resources can come in the form of solids, liquids and even gases. The burning of methane for example as a source for energy reduces the landfill gases and is hence considered a cleaner alternative than fossil fuels.³³ However, if bio power is not properly managed, the energy generated through biomass can turn into a negative impact on our environment. The amount of water consumed and the air pollution produced through biomass resource can become very damaging.^{34 35}

The process for generating energy through biomass is generally an easier process than the other already discussed types. Photosynthesis is one of the key players in the materials used to generate energy, since it captures the sun's energy and hence releases this energy when it is being burned in the biomass power plants.³⁶

Prices and Coverage

Years to use ³⁷	As long as there are materials to use, lifetime of plant 20 years
Coverage of households	e.g. approximately 25.8% of households in Germany alone (several plant)
Price for government investment	Several million € (depending on size of plant)

³³ Union of Concerned Scientists. How Biomass Energy Works. Available on, http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-biomass-energy-works.html [accessed 20th June 2014]

³⁴ *Ibid.*

³⁵ More information on biomass energy provided by the German Government can be found here: http://www.bmel.de/SharedDocs/Downloads/EN/Publications/BiomassActionPlan.pdf?__blob=publicationFile

³⁶ *Ibid.*

³⁷ If well maintained

Pays off in	Between 5.4 years and 7 years ³⁸
Capacity/Full-load hours³⁹	Between 5000 hours/year and 8000 hours/year ⁴⁰

Advantages	Disadvantages
Resources (if well maintained) are infinite and will not extend regardless of the amount of consumption	Produces a small amount of CO2 emission
Low cost	Increases the price for wheat and corn
Well utilized resource	Land needed to produce biomass
Most plentiful resource	High cost of transportation
Can be used in different forms (liquid, solid or gas)	Competition for land use
Not weather dependant	
Reduction of landfill disposals	
10 MW biomass power project can create approximately employment for 100 workers during the 18-month construction phase, 25 full-time workers employed in the operation of the facility, and 35 persons in the collection, processing, and transportation of biomass material.	

Referring back to Ghana, it is obvious that the intention exists for using renewable resources, and that needed energy is available. Installing the tools for generating electricity for many households and companies through solar energy, wind, water, or biomass needs close observation however, on where to appropriately installing the panels, mills, turbines and power plants.⁴¹ Considering the high state of mismanagement and inefficient funds, it will probably be not easy to finance this eco-friendly technology and hence provide people with electricity. The installation of the renewable resource tools would not only cost a fortune for the object itself, but also the deployment. The first step of observing different areas for different types of potentials is already being conducted by the Ghana Energy Commission with support from the United Nations Environment Program (UNEP) for on-and off shore wind energy.⁴² After Ghana's

³⁸ Rossi di Schio, C. Technical and economic aspects of Biomass fuelled CHP plants based on ORC turbogenerators feeding existing district heating networks. Available on, http://www.turboden.eu/en/public/downloads/09A06400_paper_orc_turboden_clotilde.pdf [accessed 23th June 2014]

³⁹ Full-load hours is the energy source's average annual production divided by its rated power. The higher the number of full load hours, the higher the production at the chosen site.

⁴⁰ Supra No. 33

⁴¹ West, L. Top 7 Renewable Energy Sources. Available on, http://environment.about.com/od/renewableenergy/tp/renew_energy.htm [accessed 19th May 2014]

⁴² Arrakis Group. Renewable Energy- what is Ghana's wind power potential?. Available on, <http://www.arrakis-group.com/energy/renewable-energy-what-is-ghanas-wind-power-potential/> [accessed 19th May 2014]

Parliament passed the Renewable Energy Bill in November 2011, many people became enthusiastic about the future of Ghana regarding electricity and the environment. According to the Solar and Wind Energy Resource Assessment (SWERA), solar energy technologies to produce hot water throughout the year became a very useful equipment in Ghana. “The Ministry of Energy estimates that over 6,000 solar systems have been installed in the country.”⁴³

4. General Advantages and Disadvantages of Renewable Energy

Since the use of renewable energy is a rather new development, it carries the weight of critics and careful long term observation.

Many advantages and disadvantages have already been pointed out under each section of renewable energy resources discussed above. Below are few *general* advantages and disadvantages which are related to all the mentioned types of resources.

<u>Advantages</u>	<u>Disadvantages</u>
No dangerous work places for workers anymore (such as coal mines, oil drilling stations etc...)	High cost of equipment, tools and machines
Resources are infinite and will not finish regardless of the amount of consumption	Equipment has to be spread on wide areas
No political and economical conflicts regarding rare fossil fuels (petroleum, coal, etc...) ⁴⁴	Competition for land and empty areas ⁴⁵
Does not produce toxic gases, reduction of smog	Structural change ⁴⁶

5. Renewable Energy in Ghana

As mentioned above, Ghana already started investing in renewable energy even if it is still in a slow process. Aside from the Bui, Kpong and Akosombo Dams in Ghana, the first Solar Power

⁴³ *Ibid.*

⁴⁴ Siegle, J., ed. Khodeli, I.(2009). „Governance strategies to remedy the natural resource curse”. From Curse to Blessing? Using Natural Resources to Fuel Sustainable Development. Blackwell Publishing Ltd, Oxford. p.49.

⁴⁵ Arrakis Group. Renewable Energy- what is Ghana’s wind power potential?. Available on, <http://www.arrakis-group.com/energy/renewable-energy-what-is-ghanas-wind-power-potential/> [accessed 19th May 2014]

⁴⁶ Natur. (2013). Die Kehrseite der grünen Energien: Alles hat seinen Preis. Available on, <http://www.natur.de/de/20/Die-Kehrseite-der-gruenen-Energien-Alles-hat-seinen-Preis,1,,1320.html?search=kehrseite> [accessed 9th May 2014]

Plant was introduced at Navrongo, in the Upper East Region of Ghana in May 2013.⁴⁷ The Navrongo Solar Power Plant cost the Volta River Authority an estimated 8 Million US Dollar budget.⁴⁸ It is already reported that the plant is not working efficiently. Problems have occurred while storing energy and delivering energy to the households.

Another big investment planned is the Pwalugu Multipurpose Hydropower Dam, in the Upper East region at the White River in Ghana. The construction of this project will start in 2017 and is planned to finish in 2022.⁴⁹ The Pwalugu Dam is considered to function as a multipurpose dam for several purposes, such as for generating electricity as the major function, and for flood control. The construction and operation of the dam will provide many job opportunities as planned. It will however also affect the surrounding environment with traffic noise, dust and exhaust emissions. Many people might feel threatened by that and have to relocate, for which the Volta River Authority plans on consulting the public and raise awareness of the project, its benefits and its effects.⁵⁰

Renewable energy is one arguable topic on whether it could succeed in Ghana or not. Many steps are however being taken and using renewable energy would mean the prices of electricity and heat would decrease, since the energy comes from an infinite source. Electricity would not only become cheaper, but also more regularly provided than at the current state. It is in fact an expensive investment for the government and the investor companies, but with the financial support coming from developed countries it is not farfetched. Even solar street lights are being used in several areas in Ghana, and seen as a step forward to an eco-friendlier country.⁵¹

In order to promote and invest in renewable energy resources, and support our climate, several countries hence donate or support foreign governments in financing and training to take the step towards an eco-friendly environment. One major investor in Ghana is Germany. In the previous year, Germany has boosted Ghana's energy sector with 1.8 million Euro via the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) after the ratification of the Renewable Energy Act in 2011.⁵² The German-Ghanaian bonds grow stronger through the frequent financial investment in biomass projects and climate change opportunities as well.⁵³ It is important to mention that financial support and investment alone cannot aid the environment and help the Ghanaian climate if there are no awareness campaigns and projects

⁴⁷ Volta River Authority. (2013). VRA Inaugurates first Solar Power Plant. Available on, http://www.vraghana.com/media/2013/may/news_04.php [accessed 30th June 2014]

⁴⁸ *Ibid.*

⁴⁹ Government of Ghana. (2013). Construction Of Pwalugu Dam Begins In 2017. Available on, <http://www.ghana.gov.gh/index.php/2012-02-08-08-32-47/general-news/4154-construction-of-pwalugu-dam-begins-in-2017> [accessed 30th June 2014]

⁵⁰ Volta River Authority. Pwalugu Multipurpose Dam. Available on, http://vraghana.com/about_us/images/pmd_project_brochure.pdf [accessed 30th June 2014]

⁵¹ Ministry of Energy and Petroleum. (2013). Energy Sector in Retrospect: 2013 Achievements and Challenges. Available on <http://www.energymin.gov.gh/?p=2001> [accessed 25th June 2014]

⁵² Ministry of Energy and Petroleum. (2013). Renewable Energy Sector Gets 1.8M Euro from Germany. Available on, <http://www.energymin.gov.gh/?p=1854> [accessed 27th May 2014]

⁵³ SpyGhana. (2012). German Bank to invest \$40m in Ghana renewable energy. Available on, <http://www.spyghana.com/german-bank-to-invest-40m-in-ghana-renewable-energy/> [accessed 28th May 2014]

provided. People have to become aware of the dangerous impact fossil fuels have on a long term, and how important it is to shift slowly to renewable energy resources.

6. Conclusion

While technology and science are advancing more and more over time, the step for making use of them in favor of our earth should be as important. The existing potential for a clean consumption and resource extraction is given by nature and neither harms humans and animals, nor would it ever end up compared to fossil fuels. Developed countries are already taking the initiative for renewable energy sources, and are creating different tools which cost millions (if not billions) of Euro just to aid the earth, environment and climate against toxic gases.

Ghana has shown commitment to renewable energy and has to evaluate which energy resources are cost-effective and the best with regards to the circumstances of the country. The only hindrance of using more renewable energy resources in future could be the finances to install these technologies.

The four main sources discussed are solar, wind, water and biomass energies and the necessary technology for each category. The main part of the article is to highlight the different advantages and disadvantages discussed lately on renewable energy sources, and what impact they have on nature compared to the use of fossil fuels. The paragraph after that, mentions the renewable energy resources with regard to Ghana and the options how to slightly start using renewable energy resources.

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