The Other Side: Negative Impacts of Exploiting Renewable Energy Sources

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Abstract — The increasing demand for energy threatens the earth with climate change due to emission of greenhouse gases from the burning of fossil fuels. This has been the major driver for green energy. Renewable energy has the potential to reduce the negative effects of energy production on the environment at a global scale. However, the technology to harness the energy from renewable sources have only been well developed for the electricity market. Expanding the scope to supply other markets and sectors would lead to an increase in demand on rare earth minerals which will reciprocally create negative environmental and socio-economic impacts. In order to mitigate such impacts, strong regulatory policies will be required to control different aspects of renewable energy sources, the scale of production and footprint on the environment. Recycling renewable energy technology is a step in the right direction. However, the cost of recycling is found to be 5 times the cost of mining. This would affect the price of energy generated from renewable energy sources on a long run. A shift from fossil fuel would imply at least 20 trillion dollars in stranded assets which would trigger a financial collapse. This collapse would possibly lead to the complete loss of the oil, gas and coal industries, power producers, insurance companies and banks that hold loans for these industries.

Index Terms — Energy, Environment, Economics, Impact, Renewable.

I. INTRODUCTION

The history of energy transition is as old as industrial civilization. In less developed, agricultural economies, the basic needs of individuals are provided through simple forms of agriculture, which is in essence a method of capturing the energy generated from the sun for human use. Solar energy stored in fuel-wood or other biomass energy meets other basic needs for home heating and cooking. As economies grow, develop and become complex, the energy required to sustain the economy increases greatly. Historically, as supplies of fuel-wood and other biomass energy sources became insufficient to meet increasing demand of growing economies in Europe and the United States, there was a shift from regular fuel-wood to coal during the nineteenth century, and in the twentieth century, there came the oil and natural gas. Nuclear power was introduced into the energy mix in the 1950s.

The activities in the energy industry have direct correlation with the dynamics of the global economy. From coal production to oil and gas, the energy industry is closely related to the pulse of the economy. Many production and consumption activities involve energy as a basic input. In many national economies, increase in energy utilization is directly linked to growth in GDP. In the last century, demand for energy has grown at an average rate of 2.3%, driven by three significant issues: industrialization of western economies, expansion of global transport infrastructure and the rapid industrialization in China. The oil and gas industry, which produces the dominant energy resource, is the live wire of the industrialized world. Oil and gas products are the most versatile resources used in powering industries, they provide fuel for automobiles, ships, and airplanes. Renewable energy, which involves the production of clean and more environmentally friendly energy resources, is a growing form of energy. Energy production from hydro, wind, solar, biomass, amongst others, are part of the energy transition from the traditional fossil fuel such as coal and petroleum to a cleaner form of energy, with little or no emission of greenhouse gases. Renewable energy sources are also sustainable compared to energy from fossil fuel.

Energy transition from one fuel source to another has accompanied each phase of economic development. The current energy mix is dominated by fossil fuels (coal, oil, and natural gas). However, the beginning of a new energy era in the twenty-first century is already in progress as there is a noticeable transition of energy sources away from fossil fuels towards renewable energy. The major factors driving this transition include but are not limited to environmental concerns on climate change, limited nature of fossil fuel and supplies, prices, and advancement in technology.

Society will sooner or later adopt renewable energy since fossil fuels have limited supply and are only formed over geological time [1]. Fossil fuel reserves may be extended by developing new methods and technologies for extraction, but the need to decrease the negative effects of fossil fuel on climate change is a more immediate problem than the depletion of fossil fuel. However, it has been argued that renewable energy (i.e., solar power, hydro power etc.) is fairly developed majorly because most of its application is in areas of electricity generation.

Although renewable energy is a cleaner form of energy, the dark sides to renewable energy sources have not received considerable attention. This study analyses the negative impacts of the exploitation of renewable energy sources on the environment, society and the global economy.

II. LITERATURE REVIEW

The Renewable Energy Standard Offer Program (RESOP) was introduced in November 2006 to make it easier for small renewable energy generating facilities to participate in the
electricity supply system by the Ontario Power Authority (OPA), Canada. It introduced a 20 year feed in tariffs for hydro, wind, solar (PV) and biomass projects. In 2009, in order to support renewable energy production and promote energy conservation, the Green Economy Act was passed, and it was introduced to the Ontario Legislature, in Canada on February 23, 2009 [9]. Green energy is a form of energy derived from sources that are with little or no pollution and are considered eco-friendly. Green energy involves harnessing energy from natural resources like sunlight, wind, rain, tides, plants, algae, geothermal heat, etc. These sources can be renewed and are believed to have little or no impact on the environment. These energy resources are renewable, meaning they are naturally replenished. The different types of renewable energy technologies include: Solar energy, Wind energy, Hydropower, Bio-energy, Geothermal energy, etc.

Biomass is fuel derived from wood, crops, crop residues, animal waste and other organic matters. The use of bioenergy can be traced back to early man, since the discovery of fire. Many of the world's population make use of wood, straw, charcoal, or animal dung as fuel [3]. Bioenergy accounts for 10% of the primary energy supply of the world. Through the application of chemical processes, biomass can be turned into vegetable oils, ethanol, and methanol for fuel. Also, methane gas is also generated by the anaerobic decomposition of biomass.

Solar energy is obtained from harnessing the heat from the sun. The sun provides energy to all the living creatures on earth. The sun produces almost 10,000 times more energy than the earth can produce in the 21st century [9]. The heat from the sun can be converted into energy directly using two forms of technologies: Solar Photovoltaic (PV) and Solar Thermal.

Hydro power contributes the largest source of electricity in the world compared to other renewable energy sources [10]. In 2008, it accounted for about 16% of global energy sources, and it is still the leading contributor to electricity till date compared to other renewable energy sources. In many areas of the world, hydro power has already been extensively developed. The best hydro power sites have both high head and high flow. Although the energy potential of such sites is finite, they generate large amounts of electricity at relatively lower cost.

Wind power has been used since ancient times. If cited properly, electricity production cost from windmills is close to the cost of electricity from coal and nuclear power. Wind power is generated by the energy in moving air. This energy varies to the third power of wind velocity. Therefore, doubling wind velocity results in 8 times more potential energy; tripling wind velocity results in 27 times more energy [1]. Increasing the potential energy implies lower cost for a given quantity of energy.

Geothermal energy, as the name implies, is energy which is obtained in the form of heat generated from the radioactive decay of materials below the earth crust. The first geothermal power plant was built on 4 July 1904 at the Larderello dry steam field in Tuscany, Italy. The US National Renewable Energy Laboratory (NREL) reported that hot dry rock resources can generate about 4 million megawatts of electricity, which is more than all the electricity demand of the US in 2010 [7].
Pimentel compared electricity generated with solar photovoltaic (PV) panels to electricity generated in a power plant fueled by forest wood chips. The study found out that for each unit of electricity generated from solar panels, 71 times more area of land for biomass forest is required. However, solar electricity generation was more expensive [8].

Despite the drive for renewable energy, they have only been well developed for electricity generation. Solar and wind require that natural gas plants, hydro-electric dams, batteries or some other form of power be available at an instant when the wind stops blowing and the sun stops shining. Due to the unreliability and inability for renewable energy sources to completely substitute derivatives from petroleum, societies may not be in a haste to adapt to renewable energy.

### III. THE DARK SIDES OF RENEWABLE ENERGY

The dark sides of renewable energy refer to the negative impacts from the exploitation of renewable energy sources. These negative impacts can be broadly categorized into environmental and socio-economic impacts.

#### A. Environmental Impacts

In order to harness energy from renewable energy sources, a lot of metals and materials are required. A car battery weighs about 1,000 pounds. Fabricating one requires digging up, moving and processing about 500,000 pounds of raw materials. All the mineral products and metals needed to make wind turbines and solar panels rely on mining and these mining activities, from the processing stage to the finishing of the final products, are powered by fuels derived from crude oil.

To meet the goals to go “green” may likely cause a rare earth emergency as increase in demand for green energy requires a corresponding increase in mining for rare solid minerals. These minerals are used for the manufacturing of components required for wind turbines, solar panels, batteries, etc. Table 1 shows the minerals required and the uses in manufacturing these components.

Most of these minerals are harmful and may cause respiratory problems and irritation when contacted, ingested or inhaled. A spike in demand for metals could drain the planet’s reserves. About 60% of cobalt comes from the Democratic Republic of Congo, whose which has been charged for using child labour in unsafe mines. The production level of lithium and nickel would increase to about 280% and 136% respectively if renewable energy was to contribute 100% of the energy mix [4]. Recycling is recommended but expensive. Recycled cobalt cost 5 times more than newly mined cobalt. In 2019, two dams collapsed in Vale’s Brumadinho mine, Brazil, killing 247 workers and local residents, with 23 still missing. This increase in the exploitation of rare solid minerals and the accidents that occur there-from are directly or indirectly linked to the drive to increase renewable energy utilization.

### Table 1: SOME MINERALS AND THE USES IN MANUFACTURING OF RENEWABLE ENERGY COMPONENTS

<table>
<thead>
<tr>
<th>Elements/Solid Minerals</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica, Silver, Tellurium, Gallium, Cadmium, Boron, Minerals, Copper, Indium, Selenium, Silica</td>
<td>Solar cells and thin film solar cells</td>
</tr>
<tr>
<td>Iron ore, Coal (coke), Molybdenum</td>
<td>Steel</td>
</tr>
<tr>
<td>Clay, Limestone, Sand, Gravel, Gypsum Molybdenum Copper Phosphate rock Aluminum, Bauxite, Lithium Arsenic, Gallium Titanium dioxide Lead, Lithium Zinc Cobalt</td>
<td>Cement and concrete Photovoltaic cells Wiring Phosphorus Aluminum Solar Panels Batteries Galvanizing Magnets</td>
</tr>
</tbody>
</table>

Huge wastes are left during decommissioning of renewable energy plants. The average lifespan of a wind turbine is 20 to 25 years. Researchers estimate the U.S. will have more than 720,000 tons of blade material to dispose of over the next 20 years. Solar panels generally last about 20-30 years. When solar panels are damaged due to storms or hurricanes, they leave a large amount of waste. There will be an estimated 60 million tons of cumulative solar photovoltaic waste by 2050. Added to the waste footprint left on the environment are issues of noise pollution, aesthetic and visual impact, air and water quality reduction and natural resource depletion which renewable energy mix share in common with the fossil fuel family.

#### B. Socio-economic Impact

Raw materials for wind and solar are mined in more than 60 countries. Mineral’s extraction already exact significant cost on people and the environment, fueling conflict and human rights violations, massive water pollution, and wildlife and forest destruction. Wind farms kill birds and bats, and affect fishing activities when they are built offshore, while solar power plants ignite bird killing about 1,000 birds per year [5]. According to office of Energy Efficiency and Renewable Energy, a US Department of Energy Agency, wind energy can have adverse environmental impacts, including the potential to reduce, fragment or degrade habitat for wildlife, fish, and plants [12]. Land use estimate for solar plants is averagely 3.5 to 10 acres per megawatt for utility-scale PV systems, while the estimate is between 4 and 16.5 acres per megawatt for Concentrated Solar Plant (CSP). A report published by Union of Concerned Scientists in the United States, on the Environmental Impact of Solar Power shows that CSP plants that use wet-recirculating technology with cooling towers withdraw between 600 and 650 gallons of water per megawatt-hour of electricity produced [11]. Hydro energy sources cause environmental and social threats such as damage to wildlife habitat and water quality, obstruction of fish migration pathways and cause limitations to the recreational benefits of rivers. Dams constructed for
hydro energy can also create friction between nations, an example being the current tension between Egypt and Ethiopia regarding the dam constructed by Ethiopia on the Nile river for generation of electricity.

Time is not on the side of fossil industries and this represents a significant threat to the global economy. The city of Berkeley, California, U.S. has banned new natural gas hookups in new buildings; and there are dozens of other cities exploring similar prohibitions. There would be a big challenge if financial institutions stop funding fossil fuel companies or projects. According to John Fullerton in his article “Big Choice”, some of the wealthiest companies and some countries with the biggest sovereign wealth funds in the world have huge fossil fuel assets on their balance sheets [6]. A shift from these fossil assets would imply at least 20 trillion dollars in stranded assets which would trigger a financial collapse. Such financial collapse would be greater than the 2008 financial collapse caused by the stranding of 2.7 trillion USD mortgage assets. If this occurs, it will possibly lead to the complete loss of the oil, gas and coal industries, power producers, insurance companies and banks that hold loans for these industries.

The dark sides of renewable energy utilization come with significant cost implications. For instance, as stated above, windmills and photovoltaic (PV) installations result in huge wastes during decommissioning, at the end of their useful life. There are significant costs associated with managing the resultant wastes, either through recycling or complete disposal. The economic impacts arising from the damage to the ecosystem (fish, birds, bats, impact on land and water, etc.) are huge if reversible, and may sometimes be irreversible. The depletion of the rare solid minerals exerts pressures on other sectors of the economy that compete for these minerals. In terms of human health, coming in contact with some of these minerals and the collapse of renewable energy facilities are hazards that could lead to illness, accidents and/or deaths, with significant cost implications.

IV. CONCLUSION AND RECOMMENDATION

Renewable energy has the potential to minimize the overall impact that the energy industry has on the environment, especially its contribution to climate change. However, the renewable energy industry causes reasonable negative impacts on people and the environment. Such impacts, arising from the activities in the industry, have significant financial implications. The technology to harness energy from renewable sources have only been well developed for the electricity market. There is currently a strong drive to increase renewable energy electricity generation capacity and to expand the scope beyond electricity generation. Such increase in capacity and increase in scope will place an increasing demand for rare solid minerals and invariably impact negatively on the environment, society and affect the economics of production. Mitigating these impacts will require a proper plan and policy to control supply, regulate decommissioning and encourage recycling of renewable energy products which may also affect the cost of supply in the long run.

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REFERENCES