Journal Of Research Technology & Engineering
www.jrte.org

Implementing Renewable Energy by considering the Greenhouse Gas Emissions

*G.H.V.I.U Vithanage, K.D Vithanage

Faculty of Technology, University of Sri Jayewardenepura
*ishuvithanage@gmail.com

Received: 01 May 2021; Revised: 15 May 2021; Accepted: 25 May 2021; Available online: 10 July 2021

Abstract: Greenhouse gases are rapidly increasing in the earth's atmosphere as a result of human activities. Many scientists already conclude that the increase in carbon dioxide, methane, and other greenhouse gases is causing global warming. This increase in greenhouse gases would contribute to even more global warming and climate change during this century. However, renewable energy sources improve energy efficiency while also allowing countries to meet their climate change targets. Hence, a prominent solution for this problem is to use renewable energy to replace fossil fuel burning. In this light, this paper focuses on the different forms of renewable energy, the importance of renewable energy in reducing emissions, the potential for pollutants emission reduction in Sri Lanka as a developing nation.

Keywords: Climate change, Fossil fuel, Greenhouse gas emissions, Renewable energy

1 INTRODUCTION

Renewable energy is defined as energy that uses energy sources continually replenished by nature, the sun, the wind, water, the Earth's heat, and plants. Renewable energy technologies transform these sources into usable forms of energy, most commonly electricity, and often heat, chemicals, or mechanical power. And, most importantly, they cause a negligible amount of climate and environmental damage.

2 TYPES OF RENEWABLE ENERGY

2.1 Solar Energy

Solar energy is one of the most potent alternative energy options as it is one of the cleanest and cheapest sources of energy. It is obtained in cyclic, irregular, and dilute form on Earth with very limited power density from 0 to 1 kW / m^2 [1]. At ground level, solar energy received is affected by atmospheric clarity, degree of latitude, etc. Solar technologies are developed to directly reach the infinite power of the sun and convert that energy to produce heat, light, and power [2]. The commonly used technologies which convert solar energy into electricity are Photovoltaics or concentrated solar power systems. Different types of solar collectors such as compound parabolic concentrator, flat-plate collector, parabolic through the concentrator, and evacuated-tube collector are available in the market [3].

2.2 Wind Energy

Recently, wind energy has become the fastest rising electricity source, at an estimated pace of over 25 percent each year [1]. Wind turbine technology is quite simple: the wind turbine blades are rotating around

a central core; the core is linked to a shaft that powers a generator to generate electricity. The wind turbine captures the kinetic energy of the wind in a rotor made up of two or more blades mechanically coupled with an electric generator [4]. The generator is installed on a large tower to boost the recovery of energy.

2.3 Hydropower

Hydropower or water power is electricity extracted from the dropping water or fast-flowing water which is then harnessed for practical usage. flowing water generates energy that can be collected and transformed into electricity. It is either hydropower or hydroelectric power. The most popular form of hydropower plant utilizes a dam on a river Store water in the tank. If the electricity demand is weak, a pumped storage plant retains energy by pumping water back to the upper reservoir. The water is released back into the lower reservoir for producing power during times of high electrical demand [5].

2.4 Bio-power

Biomass is another potential source of renewable energy. Biomass is the feedstock used for bioenergy production. Bioenergy is a familiar concept used to define energy from wheat, wood, or animal waste. These materials can be directly burnt to generate heat or electricity and be transformed into liquid biofuels.

Renewable energy emits no or low greenhouse gases. That's perfect for the environment: The combustion of fossil fuels for energy results in a significant amount of greenhouse gas emissions, leading to global warming. Many renewable energy projects result in low to no pollution, particularly after considering the technology's entire life cycle.

Renewable energy emits no or low air pollutants. That's better for our health: Renewable energy, rather than depleting natural wealth and polluting the atmosphere, follows the goals of a circular economy and is a solid engine for social and economic growth.

Renewable electricity arrives at small expenses. This is perfect for holding competitive energy prices: Renewable resources are less impacted by global conflicts, demand fluctuations, or unexpected supply chain disturbances since they are mostly generated locally. Fig. 1 [6] shows how renewable energy costs declined rapidly over the last ten years from 2010 to 2019.

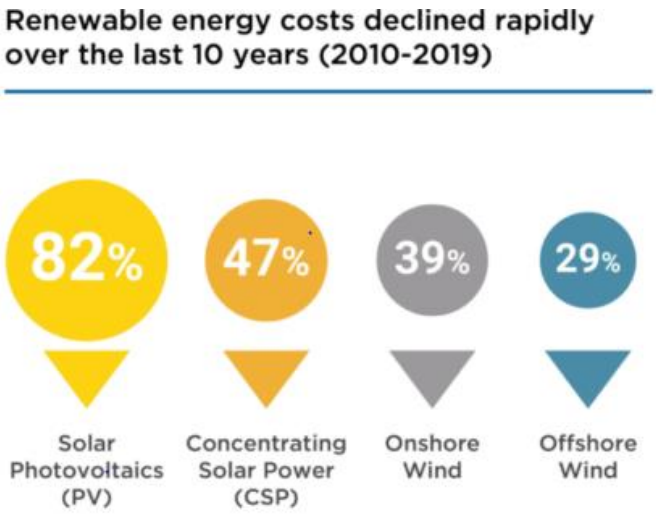

Fig. 1. Falling of power generation costs from renewable energy [6]

Likewise, there are many more reasons to use renewable energy and replace fossil fuel-based energy sources. A few more of those reasons are as follows; Renewable energy makes the energy system resilient. To avoid energy shortages, this is necessary. Renewable energy brings job creation. It is good for the community at the local level. Renewable energy is available to everyone. That's perfect for national development.

3 Renewable Energy Replaces the Fossil Fuel Based Energy Sources.

Renewable energy can be used anywhere, from power production and thermal comfort in buildings to industry and transport. Fig. 2 [6] shows the renewable share of total final energy consumption, by final energy use and how fossil fuel consumption was replaced globally in the year of 2017.

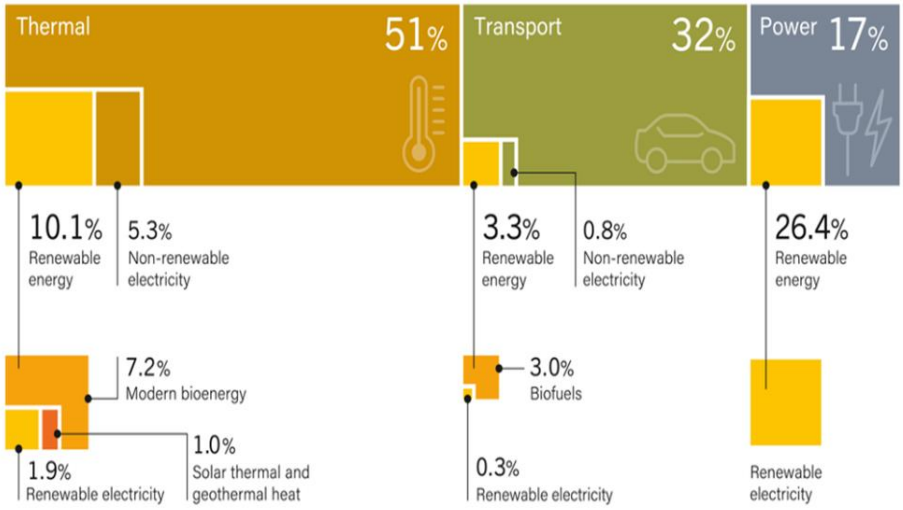

Fig. 2. Renewable share of total energy consumption, by final energy use in 2017 [6]

3.1 Heating and cooling in buildings

Examples of renewable energy being used in buildings include solar thermal water heaters, biomass boilers, and direct geothermal heat. With the use of powerful heat pumps renewable energy may also provide power. But, reducing the buildings' electricity consumption is crucial to moving to a green energy program. Therefore, a holistic solution to clean energy and energy conservation policies is important. Fig. 3 shows the renewable share of total final energy consumption in buildings in 2017 [7].

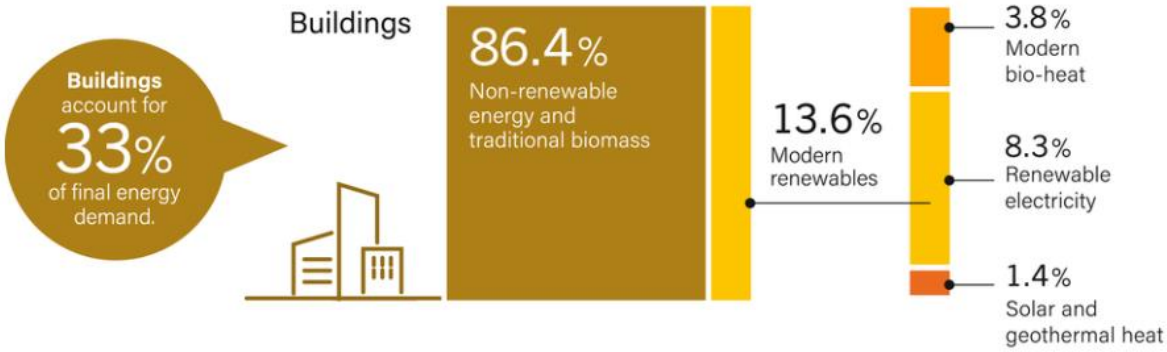

Fig. 3. Renewable share of total final energy consumption in buildings in 2017 [7]

3.2 Industry

Effect of industrialization on greenhouse gas emissions are considerably vital to minimize to maintain air quality [8]. Role of renewable energy in reducing green house gas emissions has been previously addressed

[9]. Several industries highly contribute to air pollution, such as the cement industry [10], textile industry, tire manufacturing [11], aluminium production [12], palm oil processing [13, 14], sugar production [15], agriculture industry [16, 17, 18].

Renewable energy serves about 14.5% of total commercial energy demand. Fig. 4 shows the Renewable share of total final energy consumption in industry & agriculture in 2017 [7]. Much of this renewable energy comes in the form of low-temperature fuel (below 100 °C) which is provided by bioenergy in sub-sectors such as pulp and paper and other industries that manufacture agricultural waste and residues on-site [7]. Overall, bioenergy tends to provide about 90 % of the market for heat in industry. Solar thermal and geothermal energy is primarily used for pre-heating water, drying, and producing low-temperature steam in industries such as logging, food and beverage processing, textiles, and agriculture. Renewable energy is used both for electrical end-use purposes and to satisfy the thermal demands of some manufacturing processes, for example through the usage of manufacturing heat pumps and electric arc furnaces.

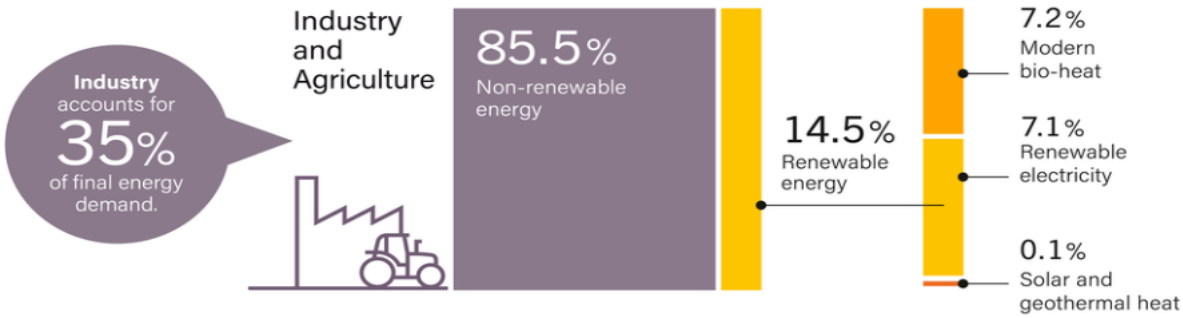

Fig. 4. Renewable share of total final energy consumption in industry & agriculture in 2017 [5]

3.3 Transport

Energy for the transport industry accounted for nearly one-third (32%) of overall global final energy usage. Moreover, transport remains the industry with the lowest share of renewable resources, the vast majority (96.7%) of global energy transport requirements were fulfilled by oil and petroleum products (including 0.8% non-renewable electricity), with limited shares in met by biofuels (3.0 percent) and renewable energies (0.3 percent). Fig. 5 shows the renewable share of total final energy consumption in transport in 2017 [5].

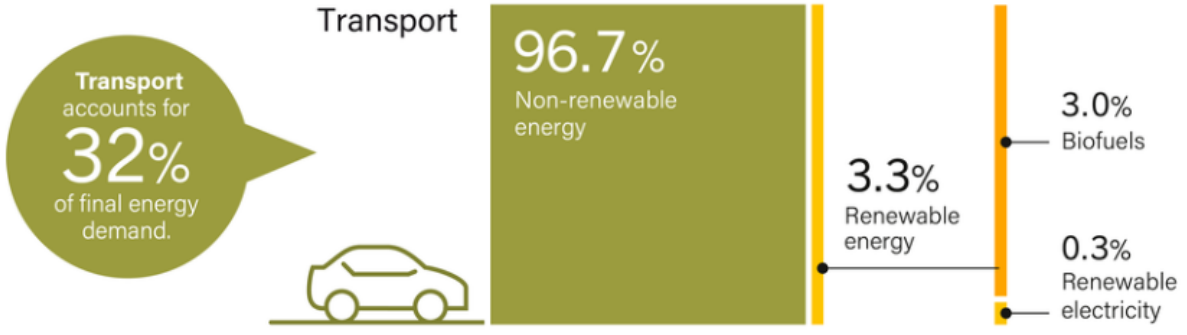

Fig. 5. Renewable share of total final energy consumption in transport in 2017 [7]

4 USE OF RENEWABLE ENERGY IN SRI LANKA

Even though Sri Lanka's carbon footprint is far less than the global average, there has been a rise in GHG

emissions with the country's current and expected economic growth, which has increased the electricity demand. Global greenhouse gas emissions of eight sectors for the year 2015 are shown in Fig. 6 [19]. And the usage of renewable energy sources is one of the most successful means of reducing emissions.

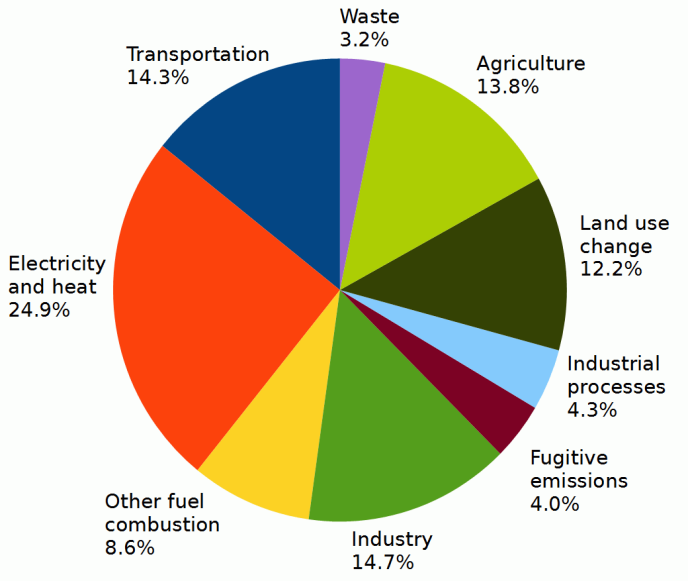

Fig. 6. Greenhouse gas emissions of eight sectors for the year 2015 [19]

Today in Sri Lanka, electricity is produced mainly from coal and oil. As a nation with small established indigenous fossil fuel resources, Sri Lanka relies on imported coal and petroleum to generate electricity to meet the demand. Although Sri Lanka is currently developing the Mannar natural gas basin, its economic feasibility remains in question. The country's reliance on imported fossil fuels for producing electricity is likely to persist until renewable are incorporated and implemented on a wide scale, positioning them as feasible replacements. Fig. 7 shows the electricity generation mix of Sri Lanka in the year 2017 [20].

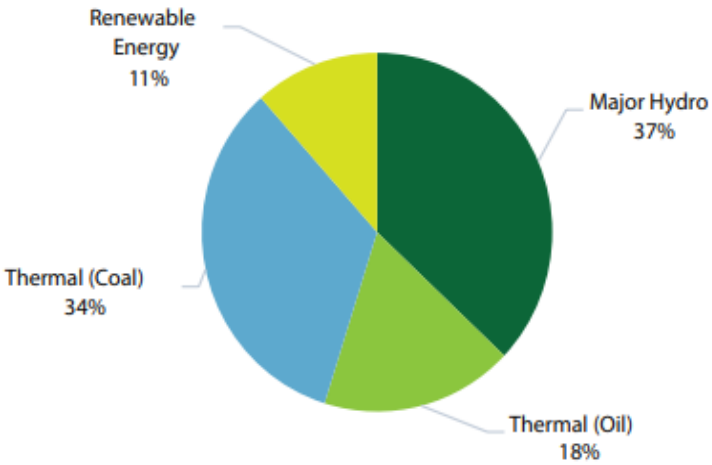

Fig. 7. The electricity generation mix of Sri Lanka [20]

5 SUGGESTIONS TO IMPLEMENT RENEWABLE ENERGY SOURCES

Since Sri Lanka lacks vast quantities of indigenous fossil fuel supplies, it is crucial to ensure its energy future. It focuses on developing and implementing indigenous, renewable energy sources to fill its ever-

increasing demand. This will minimize Sri Lanka's expenditure on imported fossil fuels, creating substantial savings that can be redirected to other development goals. Hydropower is a very developed and concentrated industry in the power sector of Sri Lanka, and the fact that the country has a substantial amount of potential sites in that regard, the total electricity demand cannot be met only by using hydropower.

5.1 The mix of solar and wind: How suitable it is to be invested in Sri Lanka

Even though Sri Lanka has ample capacity to harness wind and solar energy, being a tropical country and an island, when solar energy is not available, a proper combination is needed to meet the peak demand in the evening. A substantial amount of funding for infrastructure construction would also be required to reach 100 percent renewable energy. Capacity utilization rates of energy sources are currently much lower than traditional sources, and substantial investment would be needed. It has been estimated that the generation combination of wind and solar energy would contribute~30 percent of solar energy by 2050, while wind energy would contribute~50 percent of total production. The presumption is that by promoting the deployment of roof-top solar systems, many domestic and industrial users would be driven by solar electricity. Around the same period, though, a relatively large concentration of solar electricity is likely to deliver balancing challenges for the grid. Once storage facilities have grown to become economically competitive, demand that solar cannot satisfy would mainly be catered to by wind.

When considering solar power installation in Sri Lanka, the major challenges would be the initial cost and unavailability. Then the disposal of the solar panels would also be a challenge. But, with the development of a proper disposal solution to address disposal, solar energy could be made to use in the daytime. At night, the electricity demand can be catered with wind or hydropower, thereby making the country's energy supply a fully renewable and sustainable system of Renewable Energy in Sri Lanka. Even though Sri Lanka's carbon footprint is far less than the global average, there has been a rise in GHG emissions with the country's current and expected economic growth, which has increased the electricity demand [21]. The usage of renewable energy sources is one of the most successful means of reducing emissions.

5.2 Reduction of Greenhouse Gas Emissions in the Transportation Sector through the Application of Renewable Energy Sources.

According to Fig. 6, it shows that the transportation sector takes third place out of all the sectors in the emission of greenhouse gases. Approximately 14.3% of the total emissions are being emitted from the transportation sector. To solve the climate crisis and global warming, we need to make the vehicles on the roads as clean as possible. Emissions from vehicles are not only bad for our planet, but they're also bad for our health. It is clear that these emissions have to be mitigated, and new improvements have to be made in the transportation sector.

5.3 Renewable Energy and Electric Vehicles.

Electric vehicles include cars, transit buses, trucks of all sizes, and even big-rig- tractor-trailers that are at least partially powered by electricity. Electric vehicles fall into three main categories such as battery electric vehicles, which is described as the electricity stored in a battery pack, plug-in hybrids, which is a combination of gasoline or diesel engine with an electric motor and rechargeable battery and finally, fuel cell vehicles which use split electrons from hydrogen molecules to produce electricity to run the motor. The electricity that charges and fuels battery-electric and plug-in hybrid vehicles must come from renewable

sources such as solar or wind; therefore, no pollution is created during the power generation and the use of vehicles. Electric vehicles should not depend on electricity generated by fossil fuels. These methods eliminate the use of fossil fuels and the emission of harmful gases.

5.4 Biodiesel Manufacturing in Sri Lanka

For the production of biodiesel as a fuel, rubber seed oil and used cooking oil can be used [22]. In Sri Lanka, cooking oil can be collected from leading restaurants as they already sell their cooking oil after cooking, and that oil is used only once for cooking purposes. A proper system must be implemented for the collection of oil from those restaurants and to produce biodiesel. Cost is also reduced when producing biodiesel from these cooking oil, and health problems are also reduced. If it becomes a success, it could be introduced to the railway industry, which uses a high amount of fossil fuels. This can reduce a considerable amount of greenhouse gas emissions. This is an excellent substitute for fossil fuels as the calorific values are also the same as the fossil fuels.

5.5 Reduction of greenhouse gas emissions through renewable energy sources

Adaptation to renewable energy sources is a must when considering the current status of the world and it is getting worse and worse the climatic changes, global warming and the pollution of the environment. The main reason behind these is the use of non-renewable energy sources such as fossil fuels. The main contributor to the greenhouse effect is the CO_2 gas and a huge amount of CO_2 is released by the burning of fossil fuels. The most practical and suitable solution for this is the introduction of renewable energies such as solar, wind, hydro, geothermal, ocean energy, etc. Energy management techniques and the contribution of it to GHG mitigation as well as carbon footprint analysis for the industries as well as for the country immediately should performed to mitigate the greenhouse gases [23, 24]. In Sri Lanka, the use of renewable energy is at a very low stage and it is about 11% out of the whole energy consumption. The major energy consumption method is done by the use of petroleum which is bad for the environment as well as the health of people. With the introduction of renewable energies like solar, wind, and hydro the energy demand still can be fulfilled. As Sri Lanka is a tropical country and an island, it is ideal to use those renewable energies if the facilities and the infrastructure are provided by the government. Ultimately the burning of coal is reduced and the emissions of harmful greenhouse gases also get reduced.

5.6. Reduction of CO2 from industrial applications

The main greenhouse gas, such as CO2 reduction, should be considered with the industrial applications [25, 26, 27]. Carbon dioxide capture by absorption process is the most viable option to perform practically and cost-effectively. At the same time, what things should do with captured carbon dioxide also has to be considered to properly mitigate the greenhouse gases [28].

7 CONCLUSION

Reducing the dependence on fossil fuels can turn the world into a whole new direction in terms of climatic change, global warming, and environmental sustainability. Burning coal to generate energy creates carbon dioxide emissions and other harmful gases and contributes to the pollution of the environment. It is the right time to focus our attention on the adaptation of renewable energy sources such as wind, solar, ocean, hydro which are sustainable and improves safer energy system usage while reducing emissions.

REFERENCES

[1] E. Çakirlar Altuntaş and S. Turan, Awareness of secondary school students about renewable energy sources, Renewable Energy, vol. 116, 741-748, 2018.

[2] S.R.G. Weliwaththage, Udara S.P.R. Arachchige, Solar Energy Technology, Journal of Research Technology and Engineering, 1 (1), 67-75, 2020.

[3]S.R.G. Weliwaththage, M. Yildirim, The Review of Innovation in Renewable Energy Sector in the World, Journal of Research Technology and Engineering, 1 (4), 117-147, 2020.

[4] Sumedha R.G. Weliwaththage, Melissa Yildirim, Gulsen Ozlem Aksac, Merve Ulku, Airborne Wind Energy Technology, Journal of Research Technology and Engineering, 2 (1), 22-29, 2021.

[5] K.A.L. Udayanga, Udara S.P.R. Arachchige, Overview of Alternative Energy Storage Systems, Journal of Research Technology and Engineering, 1 (3), 50-58, 2020.

[6] A. US and W. important?, "Why is renewable energy important? - REN21", REN21, 2020.[Online]. Available: https://www.ren21.net/why-is-renewable-energy-important/. [Accessed: 15- Jul- 2020].

[7]"RENEWABLES 2020 GLOBAL STATUS REPORT", Ren21.net, 2020. [Online]. Available: https://www.ren21.net/gsr-2020/chapters/chapter_01/chapter_01/#sub_2. [Accessed: 15- Jul- 2020].

[8] R.T. Wadanambi, L.S. Wandana, K.K.G.L. Chathumini, N.P. Dassanayake, D.D.P. Preethika, Udara S.P.R. Arachchige, The effects of industrialization on climate change, Journal of Research Technology and Engineering, 1 (4), 86-94, 2020.

[9] N.P. Dassanayake, D.D.P. Preethika, K.K.G.L. Chathumini, R.T. Wadanambi, L.S. Wandana, Udara S.P.R. Arachchige, The Role of Renewable Energy in Reducing GHG Emissions, Journal of Research Technology and Engineering, 2 (1), 12-21, 2021.

[10] Udara S.P.R. Arachchige, Alagiyawanna A.M.A.K.M, Balasuriya B.M.C.M, Chathumini K.K.G.L, Dassanayake N.P, Devasurendra J.W, Environmental Pollution by Cement Industry, International Journal of Research, 6 (8), 631-635, 2019.

[11] Udara S.P.R. Arachchige, Sithari G.M, Thalagahawaththa. T.G.A.H.R, Tharakie G.M, Tharuka K.V.H, Environmental Pollution By Tire Manufacturing Industry, International Journal of Scientific & Technology Research, 8 (9), 80-81, 2019.

[12] Udara S. P. R. Arachchige, Dinesh Kawan, and Morten C. Melaaen, Simulation of Carbon Dioxide Capture for Aluminium Production Process, International Journal of Modeling and Optimization, 4 (1), 43-0, 2014.

[13] Udara. S. P. R. Arachchige, Chiran D. M. O. Ranaraja, Nirmala W.K.J, Preethika D.D.P, Rangajith D.G.P.H, Sajath S.H.M, Impacts Of Palm Oil Industry In Sri Lanka, International Journal of Scientific & Technology Research, 8 (8), 1137-1145, 2019.

[14] Thilakarathna S.C.C, Prasad D.M.N, Ramyajith K.K.W, Ariyarathna M.A.D.G, Dissanayake M.G.D.K.B, Chiran D. M. O. Ranaraja, Udara S.P.R. Arachchige, Environmental and Social impacts of Palm oil industry in Sri Lanka, Journal of Research Technology and Engineering, 1 (3), 13-23, 2020.

[15] Udara S.P.R. Arachchige, Heshanka S, Udakumbura M.G.P.M, Peiris H.I.S, Bandara A.M.P.A, Nishantha P.G.U, Sandeepa A.W.S, Ruvishani L.S, Jinasoma P.N.D, Pathirana N.M.H, Ekanayaka S.S, Sugar Production Process in Sri Lanka, Journal of Research Technology and Engineering, 1 (1), 38-47, 2020.

[16] Sithari G.M, T.G.A.H.R Thalagahawaththa, Tharakie G.M, Udara S.P.R. Arachchige, Greenhouse gas emission and mitigation measures of agriculture in Sri Lanka, Journal of Research Technology and Engineering, 2 (1), 107-115, 2021.

[17] K.K.G.L. Chathumini, N.P. Dassanayake, D.D.P. Preethika, R.T. Wadanambi, L.S. Wandana, Udara S.P.R. Arachchige, Agriculture and Greenhouse Gas Emissions, Journal of Research Technology and Engineering, 2 (2), 22-31, 2021.

[18] Vithanage K.D, Vithanage G.H.V.I.U, AGRICULTURAL IMPACT ON GREEN HOUSE GAS EMISSIONS, Journal of Research Technology and Engineering, 2 (2), 40-48, 2021.

[19] C. Mgbemene, C. Nnaji and C. Nwozor, Industrialization and its Backlash: Focus on Climate Change and its Consequences, Journal of Environmental Science and Technology, 9 (4), 301-316, 2016.

[20] A. Withanaarachchi, L. Nanayakkara and C. Pushpakumara, Mitigating Climate Change via Non- Conventional Renewable Energy: Case of Sri Lanka, Journal of Clean Energy Technologies, 3 (5), 372-377, 2015.

[21] L.S. Wandana, R.T. Wadanambi, D.D.P. Preethika, N.P. Dassanayake, K.K.G.L. Chathumini, Udara S.P.R. Arachchige, Carbon Footprint Analysis: Promoting Sustainable Development, Journal of Research Technology and Engineering, 2 (1), 73-80, 2021.

[22] P.R.A.U. Sampath, S.P.A.G.L. Samarakoon, F. M. Ismail, S.H.P. Gunawardena, Biodiesel production from high FFA Rubber Seed oil, 14TH ERU SYMPOSIUM, 2008: FACULTY OF ENGINEERING, UNIVERSITY OF MORATUWA, Sri Lanka, 2008.

[23] Sithari. G.M, T.G.A.H.R.Thalagahawaththa, Tharakie. G.M, Green House Gas Accounting - Energy Management, Journal of Research Technology and Engineering, 2 (2), 32-39, 2021.

[24] L.S. Wandana, R.T. Wadanambi, D.D.P. Preethika, N.P. Dassanayake, K.K.G.L. Chathumini, Udara S.P.R. Arachchige, Carbon Footprint Analysis: Promoting Sustainable Development, Journal of Research Technology and Engineering, 2 (1), 73-80, 2021.

[25] Udara S. P. R. Arachchige, Rasenthiran K, M.A.L. Lakshan, M.K. Lakshitha Madalagama, P.R. Prabhath Pathirana, P.W. Sakuna Sandupama. Simulation of carbon dioxide capture for industrial applications. Energy Reports, 6): 659-663, 2020.

[26] Udara S. P. R. Arachchige, M. C. Melaaen. Aspen plus simulation of CO2 removal from coal and gas fired power plants. Energy Procedia 23: 391-399, 2012.

[27] Udara S.P.R. Arachchige. Carbon dioxide capture by chemical absorption: energy optimization and analysis of dynamic viscosity of solvents (Ph.D. thesis), University of South-Eastern Norway; ISBN: 978-82-7206-516-3, 2019.

[28] Udara S. P. R. Arachchige, Sakuna Sandupama P.W, What To Do With CO2? Storage Vs. EOR Vs. CO2 As A Chemical Feedstock, International Journal of Advanced Research and Publications, 3 (5), 104-109, 2019.