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FCO_2: Green Infrastructure Supporting Indonesia Carbon Neutral 2060

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Abstract

Climate change is often a problem in almost every country. This is inseparable from the crucial problems related to climate change issues experienced by Indonesia from year to year. One of them is the issue of increasing carbon emissions caused by various energy sectors, the automotive transportation industry, and home industries. The Climate Transparency 2021 report states that although Indonesia has proposed increasing the use of renewable energy in the fields of electricity, transportation, and industry (Climate Transparency, 2021), in addition, Indonesia does not yet have a gradual strategy related to stopping the use of coal and there is no policy that is able to encourage competition between renewable energy. and coal. Indonesia is committed to the world and targets the achievement of carbon neutrality by 2060 through the submission of the Long Term Strategy on Low Carbon and Climate Resilience 2050 document to the UNFCCC which is the mandate of the Paris Agreement which has been ratified into Law no. 16 of 2016 which contains the Ratification of the Paris Agreement To The United Nations Framework Convention On Climate Change. The method used in making this paper is a descriptive method with a quantitative approach based on literature review. Where in this method describes the consequences that occur from an increase in carbon emissions, solutions in dealing with problems caused by carbon emissions. The method used in collecting data in this proposal is secondary data, namely data sourced from library materials, both from articles and official websites such as the website of the Badan Pusat Statistik Indonesia. In order to achieve Indonesia's target of carbon neutral 2060, an infrastructure innovation called FCO_2 was made which has an effectiveness of 80% in reducing carbon emissions. The carbon emission reduction system used in FCO_2 is in the form of filtration, which functions to filter the air and exhaust gases from the carbon content caused by various industrial and vehicle activities. On the other hand, FCO_2also has a part that will function in spraying disinfectant into the air to kill microorganisms, such as viruses, bacteria in the air. The disinfectant used uses natural ingredients, which are made from lime and betel leaf. In addition, so that the use of FCO2 can provide more optimal results, it is also necessary to support the government, private, and community sectors to play a major role in expanding green open space infrastructure evenly.

Keywords: Climate Change; Carbon; Filtrasi; FCO_2

1. Introduction

The purpose of Indonesia Neutral Carbon 2060 is to reduce emissions from the five sectors of energy, waste, industry, agriculture and forestry. In addition, Indonesia is committed to increasing climate resilience through economic, social and livelihood security, as well as ecosystems and landscapes. On the other hand, gas emissions have also experienced a consistent and continuous increase, resulting in an increase in the concentration of CO_2 in the atmosphere.

If carbon emissions are not handled immediately, it will result in various fatal things, one of which is climate change. Climate change will have a broad impact, such as the impact on the health of the population and the country's economy. A very fatal impact on the health of the population, namely death. Diseases that are often caused by air pollution are stroke, heart disease, lung cancer, and other chronic diseases. Meanwhile, one of the causes of the country's economic slowdown is due to disturbances in rice production, in which rice plays an important role in the country's economic stability.

Therefore, a serious handling is needed in dealing with the increase in carbon emissions, especially in Indonesia. The largest contributor to carbon emissions in Indonesia is the industrial sector in the energy and

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transportation sectors. One of the measures that can be used to reduce the increase in carbon emissions is by finding innovative tools or infrastructure and accompanied by the expansion of Green Open Spaces. As the idea we presented in the form of an environmentally friendly infrastructure called FCO_2 which has a filtration function by separating the CO_2 of exhaust gases and air that has been contaminated with carbon emissions, and a disinfectant function that is able to reduce the level of microorganisms such as viruses, bacteria in the air. especially during the post-Covid-19 (endemic) pandemic.

After holding a high-level meeting discussing climate change (COP-26, *United Nations Framework Convention on Climate Change*/UNFCCC) which was held in Glasgow, United Kingdom in October-November 2021. From the meeting resulted in a conclusion, what can be done to stop global warming. To follow up on this, Indonesia itself is required to ensure that there is a transformation of development that produces environmentally friendly products, including development that produces low carbon (*low carbon development*).

Indonesia has succeeded in mitigating greenhouse gas (GHG) emissions to prevent an increase in greenhouse gas emissions, as stated in *Nationally Determined Contribution* (NDC). It is estimated that Indonesia will reach the highest peak (*Peaking*). on greenhouse gas emissions in 2030 in the *Agriculture, Forestry and Other Land Use* (AFOLU) sector and previously managed to achieve *net zero emissions* in 2070. This is based on the policy direction towards low carbon and climate resilience as stated in the LTS- LCCR 2050 (Republic of Indonesia, n.d).

2. Literature Review

Climate

Change Climate Change is one of the global issues that is currently receiving attention in recent years. Climate change can occur directly or indirectly caused by human activities. Climate change can trigger high risks for regions, sectors and populations. One of the global challenges in responding to climate change is reducing greenhouse gases, which are the main cause of global warming. Environmental degradation and erosion of natural resources are expected to continue until 2050. These irreversible changes will certainly endanger life. The world will face significant climate change as a result of increasing GHG emissions by 50% to 70% due to growth in CO_2 emissions. This increase in emissions will cause an increase in temperature above the 2^{o}C threshold, affect rainfall patterns, melt glaciers and permafrost, increase sea levels, and trigger an increase in the intensity of extreme weather events, changes in environmental quality by changing the quality of water, air and food, loss of ecosystem function and human degradation which will ultimately affect human health.

National Challenges

Intergovernmental Panel on Climate Change (IPCC) has stated that Global Warming can have an impact on economic and development aspects, especially in developing countries, one of which is Indonesia. As an archipelagic country, Indonesia is one of the countries that most vulnerable to climate change, the risks faced by Indonesia are the loss of small islands and the narrowing of coastal areas caused by rising sea levels which will threaten cities on the coastline. In addition, rising sea surface temperatures can also affect changes

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in migration paths of fish and other marine biota, coral bleaching, damage to mangrove and seagrass ecosystems, and threaten marine mammal populations.

Based on Country Report 2017 data, in 2008 and 2009 sea level rise of 0.8 m resulted in seawater penetrating the coast for several kilometers in the Cirebon area and reaching losses of around Rp. 1.29 trillion per ha per year. A sea level rise of 0.01 m per year is projected to be able to inundate more than 1.7 thousand hectares of the Semarang Coastal area in 2030 with an economic loss of around Rp 6.1 trillion.

Framework for Action on Climate Change in Indonesia

The basis of Indonesia's policy in responding to environmental problems refers to Law No. 32 of 2009 on Environmental Protection and Management which emphasizes the impact of climate change on the environment (Republic of Indonesia, 2009). Through the ratification of the Paris Agreement in Law No. 16 of 2016, Indonesia is committed to participating in overcoming the impacts of climate change. Then it was strengthened by the Government Regulation No. 46 of 2016 concerning Strategic Environmental Studies (Republic of Indonesia, 2016) which was the elaboration of Law no. 32 of 2009 until it becomes a guideline for some of the substantive elements of various Regulations of the Minister of Environment and Forestry in dealing with climate change (Republic of Indonesia, 2009). Minister of Environment and Forestry Regulation No.33 of 2016 provides guidelines for both the central government and local governments in planning climate change adaptation actions which are then integrated into development plans for certain regions or sectors (Ministry of Environment and Forestry, 2016).

. Minister of Environment and Forestry Regulation No. 7 of 2018 provides guidelines for the central government, local governments, and communities regarding the scope of analysis, selection of methods, indicators, indicator data, and source data used in formulating assessments of vulnerability, risk and impact of climate change and determine the criteria for verification of the results of the vulnerability, risk, and impact of climate change studies. In addition to the policy aspect, Indonesia also runs a program called the Climate Village Program which is a joint national adaptation and mitigation movement that aims to increase understanding of climate change (including its impacts) and encourage adaptation and mitigation actions to take place at the local level (Ministry of Environment and Forestry, 2018).

Filtration

Filtration is the removal of solid particles from a fluid through a filtering medium. Filtration is a process that separates a heterogeneous mixture of fluid and solid particles using a filter medium that allows the fluid to pass through by retaining solid particles. The filtered fluid can be a liquid or a gas. The stream that escapes the filtering process can be a liquid, a solid, or both. In addition to reducing the content of solids, filtration can also reduce microorganisms, remove color, taste, odor of iron, and manganese. In the filtration process, the solid particles contained in the liquid can be separated by using a porous medium that is able to hold particles and can be passed by a clear filtrate. The porous medium is usually called the filter media. Solid particles can be very small or larger, and have a wide variety of shapes.

Green Infrastructure

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Green Infrastructure or green infrastructure is a spatial concept that utilizes environmentally friendly infrastructure which does not interfere with the continuity of the natural cycle of the environment. Green infrastructure in the process from the design, development, operation to maintenance stages takes into account aspects to protect, save, and reduce the use of natural resources. Green infrastructure in general has various functions including reducing rainwater runoff, filtering water pollutants, storing rainwater, saving and recycling water, refilling groundwater, saving energy, overcoming the effects of urban heat, absorbing GHG emissions, adding beauty, making places recreation, reduce soil erosion, protect habitat or ecosystem diversity, and create transportation routes. One of the important roles of green infrastructure, especially in urban areas, is to be able to increase oxygen levels and facilitate air circulation in urban areas so as to improve air quality in urban areas which are filled with emissions released by motor vehicles and industry. One example of green infrastructure that is widely applied by developed countries is the planting of trees on the side of the road or on the road divider (green street). A previus study by Horwood (2007) explains that the existence of a green infrastructure area as much as 10% is able to reduce heat temperatures up to 2.5 C.

Previous Studies

Various innovations related to filtration developed in several previous studies have become our guidelines or inspiration in initiating innovations. FCO_2 eco-friendly infrastructure. In a research article entitled *Monitoring and Filtration of Indoor Air with Plasma Technology in the New Normal* by Sidik & Ray'onaldo (2021), they found an innovation for monitoring and filtration of indoor air with arduino-based plasma technology as a microcontroller. The plasma technology used is the result of a high-voltage electric spark that forms an electrostatic discharge caused by fluid ionization, then cigarette smoke that passes through the discharge will bind to CO_2 molecules which then converted into O2. The results of his research after testing the tool in a smoking room showed that the use of the tool was very effective because it could determine the level of cigarette smoke pollution in a room and filter cigarette smoke automatically if the air pollution level was above the threshold.

Furthermore, there is also a research article entitled *Filtering System Made from Bananas for Particulate Matter Emission of PM2.5 (Particulate Matter2.5)* by Arba, et al. (n.d), they found a filter innovation dirty air in order to reduce the concentration of PM2.5 using the basic ingredients of banana midrib. Given that PM2.5 is one of the harmful emissions produced by motorized vehicles. The results of his research after testing PM2.5 measurements on two types of motors using banana midrib filtering showed that it was quite effective in reducing PM2.5 concentrations.

3. Method

This research is quantitative. Quantitative research is a method for testing certain theories by examining the relationship between variables. Usually these variables are measured using research instruments whose data are in the form of numbers and then analyzed using statistical procedures. According to Sugiyono (2017), quantitative research methods are methods that use the philosophical foundation of positivism, examine certain populations or samples, collect data using research instruments, analyzed quantitative or statistical data to test established hypotheses. Quantitative research requires assumptions to test theories deductively, prevent bias, control alternative explanations, generalize and apply them again. Quantitative research consists of

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several types of research including survey research, comparative causal studies, correlational studies, and experimental research. Therefore the retrieval of information in this study was carried out. The selected informants are the official website of the Indonesian government. The method used in data collection is carried out using libraries that are concerned with carbon emissions and carbon neutral Indonesia 2060, both books, theses, and journals, and data collection is carried out by observation, namely collecting data by systematically observing and recording kinds of data-the type of symptom being studied. Observations focused on locations that produce a lot of exhaust emissions, such as areas of highways that are congested by motorists of two-wheeled and four-wheeled vehicles and a lot of factory activity around the area. In addition, observations are also focused on the condition of green land around the area.

4. Discussion

FCO_2 can be used as anything?

FCO_2 is an environmentally friendly infrastructure that is expected to be installed on roads or places that produce high volumes of carbon. This infrastructure functions to capture and separate CO_2 from exhaust gases and air that has been contaminated with carbon emissions after which clean air or gas will be released from the carbon content. This technology is also equipped with a disinfectant system that functions to suppress the spread of microorganisms, such as viruses, bacteria in the air, in order to avoid the decline in the level of human resources in Indonesia during the Covid-19 period.

Efforts to introduce FCO_2 to the wider community?

The introduction of FCO_2 can be done by making a technology demo that will be displayed in front of the community and surrounding companies. This aims to gain support from the wider community to the local government, so that the implementation of the technology can be carried out smoothly.

Another effort that can be made to introduce FCO_2 to the wider community is by writing an article in the form of news, articles, and journals that are distributed through various digital platforms regarding the significant increase in carbon emissions and describing negative impacts such as the impact on the country's economy and the health of the population. can cause fatality. That way, information about FCO_2 will be widely spread and reach the wider community more quickly. To make a strategy in introducing infrastructure to the wider community, a SWOT analysis is used in Table 1.

Table 1. Strengths, weaknesses, opportunities and threats to make FCO_2 a supporting infrastructure for Indonesia towards carbon neutral 2060

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OT / SW	Opportunity (O)	Threat (T)
	1. Get the support of local residents who are aware of infrastructure innovation 2. Few competitors 3. Cooperate with the local government 4. As a substitute for air that is vented to the outside so that contaminated replacement air is not drawn into the room	1. Developments in technology are more attractive to the wider community 2. Possible to require a lot of electric power 3. The equipment is placed outside the room/side of the road so that it is prone to damage due to natural/human factors
Strength (S)	**Strength and Opportunity (SO)**	**Strength and Threat (ST)**
1. There have been various previous studies in Indonesia that discussed emission filtration 2. An environmentally friendly tool because its operation does not produce outputs that can pollute the environment 3. Has two functions, namely as CO_2 and disinfectant to kill germs	1. Conduct socialization related to the design making FCO_2 and its benefits to the community to get various supports in the process of making these innovations. 2. Propose a draft for making FCO_2 into the government's strategic plan in dealing with climate change problems in Indonesia. 3. Support programs created by environmentally concerned communities by providing FCO_2 to support significant emission reductions	1. Introducing FCO_2 through modern media so that it is easily accepted by the general public 2. Cooperating with the government to participate in implementing infrastructure 3. Cooperating with the general public to participate in expanding green land 4. Highlighting the characteristics of infrastructure (FCO_2)
Weakness (W)	**Weakness and Opportunity**	**Weakness and Threat (WT)**
1. Not yet realized in real terms (still a prototype/idea) 2. Community participation in implementing infrastructure is low. 3. Lack of general public knowledge about how important it is to take measures to reduce the high number of carbon gas emissions	1. Provide knowledge to the public at large about how important it is to pay attention to each improvement carbon emissions 2. Provide space to put infrastructure to support the implementation of FCO_2	1. Conduct socialization to the community regarding FCO_2 and the urgency of the need for FCO_2 2. Collaborate with communities or *startups* which is engaged in the development of renewable energy to utilize electric power using alternative or environmentally friendly energy

From the Table 1 it can be seen strengths, weaknesses, opportunities and threats to make FCO_2 a supporting infrastructure for Indonesia towards carbon neutral 2060. From crossing SO, ST, WO, WT, several strategies were produced.

The cross of S and O produces several strategies that can support the creation of FCO_2. First, to conduct socialization related to the design for making FCO_2 and its benefits to the community to obtain various supports which can be in the form of financial assistance, facilities, and so on. Support from the

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community is very much needed for the smooth implementation of FCO_2. Second, include the implementation design of the FCO_2 in the government's strategic plan in overcoming the issue of climate change as well as so that FCO_2 can be used sustainably and evenly throughout Indonesia. In addition, it can also be done by collaborating with stakeholders who have the potential to participate in the realization of Indonesia Neutral Carbon 2060. Third, providing FCO_2 facilities which are able to support significant emission reductions in communities or organizations that have concerns in the environmental realm. The main target is a formal education community or organization which has a role in molding the character of the younger generation, including in terms of instilling environmentally friendly behavior. Statistical data from the Ministry of Education and Culture shows that throughout 2018, the number of primary and secondary school educators was around 2 million people, while the number of students was around 45 million people. Thus, the number of students can be a hope for the realization of climate change control in Indonesia through the implementation of environmentally friendly behaviour (Ministry of Education and Culture, 2018).

Then the cross of S and T produces several strategies that can support the manufacture of FCO_2. First, introducing FCO_2 through modern media through social media so that information is quickly conveyed to the public so that FCO_2 can be accepted by the general public. The use of social media can be a source of information that is easier and faster to obtain because it is easily accessible by its users, and has no limitations in accessing it. This will certainly make information about FCO_2 more quickly conveyed to the public in various regions. Second, cooperate with the government to participate in implementing infrastructure. These efforts are made so that the use of FCO_2 can provide more optimal results, it is also necessary to support the government sector to play a major role in expanding infrastructure. The government should try to overcome existing problems, including environmental problems. Third, cooperate with the general public to participate in expanding green land so that oxygen production increases so that clean air increases. Awareness of all communities towards environmental conditions is very much needed considering that currently carbon emissions are increasing so that efforts to expand green land are very much needed. Because if the air quality is bad or low, the community will also be harmed. Fourth, highlight the characteristics of the infrastructure (FCO_2), which has two functions that work as CO_2 and disinfectant to kill microorganisms, such as viruses. By highlighting the characteristics of FCO_2 , it is hoped that the community will be able to recognize the infrastructure more easily.

Then the W and O crossing produces several strategies that are able to overcome the weaknesses that exist in FCO_2 to achieve opportunities. First, providing knowledge to the public at large about the importance of paying attention to any increase in carbon emissions whose impact can be felt in the long term such as global warming. Launching in an article on the IESR (Institute for Essential Services Reform) page, an individual's lifestyle can affect the greenhouse gas emissions produced per individual. This is because the more goods that are consumed, the more energy use will increase, especially for goods whose operation requires electric power. Considering that electricity production in Indonesia is still largely dominated by fossil fuels (diesel and coal) which can produce carbon dioxide emissions. However, it is unfortunate because there are still many individuals who do not know the amount of greenhouse gases they produce from their daily activities, starting from the use of several products, the use of electricity, transportation equipment, and so on. Second, providing space to put infrastructure in support of the implementation of FCO_2. The innovation of this air filtration tool (FCO_2) which of course has the opportunity to get support from the government in its use

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which is able to contribute to reducing carbon emissions in Indonesia. Government support in terms of ease of licensing in placing FCO_2 along the road will certainly encourage the implementation of FCO_2 to be more optimal. In addition, the optimal function of FCO_2 also needs to be supported by the provision of Green Open Space by the local government. Considering that in general, pollution is also the result of high CO2 which is not matched by the provision of open land so that it is unable to accommodate the amount of CO2 gas produced . The availability of green open space is certainly one of the important factors to balance the ecosystem, especially in urban areas.

The cross of W and T produces several strategies that can be used in preventing and overcoming the weaknesses and threats of FCO_2. First, to socialize to the community, especially to the people who are in the location around the placement of FCO_2 regarding how to treat FCO_2 and the urgency of the need for FCO_2. Socialization uses a two-way communication system by involving feedback from the community, for example if FCO_2 is considered less effective or disturbing the community. Second, collaborate with communities or startups engaged in the development of renewable energy to be able to reduce the use of electrical energy sourced from fossil fuels so as to make FCO_2 more environmentally friendly.

What makes FCO_2 has an effectiveness rate of 80%

FCO_2 has an effectiveness of 80% because FCO_2 has a carbon emission reduction system used in the form of filtration. Filtration on FCO_2 functions as an air filter from air pollution caused by various industrial and vehicle activities. As one of the developing countries with increasing industrial development, in CO_2 the atmosphere increases which has a negative impact on the health of the Indonesian people. Therefore, this filtration system is very appropriate to run so that air pollution can be filtered and produce healthier, pollution-free air. In addition, FCO_2 also has a section that functions in spraying disinfectants into the air to kill micro-organisms, such as microorganisms in the air. The disinfectant used uses natural ingredients, which are made from lime and betel leaf. That way, microorganisms scattered in the free air will be killed so that the spread of viruses such as COVID-19 will be reduced.

In FCO_2 there are 3 pipes, the first pipe is as a disinfectant channel, the second channel is to distribute air and carbon-containing residual gas. Air and residual gas containing carbon will go through a filtering stage. Filtering using mangrove wood that has been dried and activated by potassium hydroxide (KOH). Activated mangrove wood will be put into the furnace for 3 hours at a temperature of 400^{o} C which is flowed by N_2 gas with a flow rate of 8 cm. After going through a series of processes, the activated carbon will be pulverized and washed using warm aquadest. the 3rd channel serves to channel air and residual gas that has been free of carbon content, which will then be released again. A place to accommodate air and residual gas that still contains carbon with those that have been liberated from carbon content into one place but is distinguished by a barrier. The process of withdrawing and expelling air and residual gas through a propeller that has been equipped with 2 motors that are useful for driving the propeller with different functions.

5. Conclusion

FCO_2 is an environmentally friendly infrastructure that has 3 pipes with each function. The filter on FCO_2 is made of mangrove wood which has been activated by an activator solution in the form of potassium hydroxide (KOH) with various concentrations, and this process lasts for 24 hours. In addition, the addition of

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green open space is also needed to support the effectiveness of various infrastructure innovations in carrying out their functions as reducing the level of emissions carbon. For prepare the State of Indonesia towards carbon neutral Indonesia 2060, there are things that can be done, first as students who will continue this nation we can contribute in providing ideas about infrastructure for sustainable development that is environmentally friendly and can reduce emissions carbon. Second, it is necessary to realize that supporting every thought by realizing every brilliant idea of a student can have an impact on the progress of a country. Third, if the realization has been running, it can be continued by conducting trials. Fourth, after all the series is carried out, the next step is to implement the infrastructure so that the country's vision and mission can be realized smoothly and quickly.

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