Introduction To The Types Of Pollutants Included In Greenhouse Gases In The Context Of Understanding And Addressing Climate Change In Penang, Malaysia.

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Abstract.

Climate change is a global challenge that requires a thorough understanding of greenhouse gas (GHG) pollutants. Gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) trap heat in the atmosphere, causing global warming with serious consequences such as extreme weather events and ecosystem disruption. The main sources of emissions come from the energy, industrial, agricultural, and land-use change sectors. This paper emphasizes that identifying the types of GHG pollutants and their characteristics is crucial for developing targeted mitigation strategies. These efforts, which include a transition to renewable energy, increased energy efficiency, and strong policy implementation, are expected to significantly reduce global emissions, stabilize the climate, and control the rate of warming.

Keywords: *Greenhouse Gas (GHG); Global Warming, Emissions and Climate Change Mitigation.*

I. INTRODUCTION

Greenhouse gases in the Earth's atmosphere trap heat, leading to global warming and climate change[1]. These gases absorb infrared radiation that is emitted from the Earth's surface after being struck by sunlight [1]. Without greenhouse gases, the Earth would be too cold to support life[1]. The primary greenhouse gases include: Carbon Dioxide (CO2) is the most significant greenhouse gas, accounting for about three-quarters of emissions [2]. It can persist in the atmosphere for thousands of years . The burning of organic materials like coal, oil, gas, wood, and solid waste is the main source of carbon dioxide emisions [2][3]. Deforestation, land clearing, and soil degradation also release CO2. Land management practices such as reforestation and soil health improvement can remove CO2 from the atmosphere [4]. In 2018, the CO2 levels reached 411 parts per million at Hawaii's Mauna Loa Atmospheric Baseline Observatory, marking the highest monthly average ever recorded [2].Methane, the primary component of natural gas, is emitted from landfills, the natural gas and petroleum industries, and agriculture, particularly from grazing animals [2][3]. Although it remains in the atmosphere for only about 12 years, it is 84 times more potent than carbon dioxide over two decades and accounts for about 16 percent of greenhouse gas emissions [2].Nitrous Oxide (N2O) accounts for a relatively small portion of global greenhouse gas emissions, about six percent. Still, it is 264 times more powerful than carbon dioxide over 20 years, with a lifespan exceeding a century[2] . Agriculture and livestock, including fertilizer, manure, and burning agricultural residues, are the largest sources of nitrous oxide emissions, along with fuel combustion [2][4].

Fluorinated Gases These industrial gases, including hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride, have heat-trapping potential thousands of times greater than CO2 and remain in the atmosphere for hundreds to thousands of years [2][3]. Although they account for only about 2% of all emissions, they are used as refrigerants, solvents, and in manufacturing, and sometimes occur as byproducts [2]. Other greenhouse gases include water vapor and ozone [2][3]. Water vapor is the most abundant greenhouse gas, but human activity contributes very little to its atmospheric concentration. Ozone can be beneficial or harmful depending on its location in the atmosphere. In the stratosphere, it blocks harmful ultraviolet light, while in the troposphere, it is a harmful air pollutant [1]. Addressing Climate Change in Penang, Malaysia like other regions worldwide, faces significant challenges related to greenhouse gas emissions and climate change [5]. The primary issues that need resolution include: Reducing Greenhouse Gas Emissions: Transportation is a significant source of air pollutants. Promoting public transportation, electric vehicles, and cycling can help reduce emissions[6].

Industries in Penang need to adopt cleaner technologies and practices to minimize their greenhouse gas emissions[4]. Land Use, Sustainable land management practices, such as reforestation and deforestation, are crucial for enhancing carbon sinks and reducing emissions from land degradation [4][5]. Adapting to the Impacts of Climate Change exacerbates land degradation through increased flooding, drought, and sea-level rise. Implementing measures to avoid and reverse land degradation is essential. Coastal Erosion: Sea level rise is intensifying coastal erosion, threatening livelihoods and infrastructure [5].Policy and Governance: Integrative Climate Impact Assessments: Conducting comprehensive assessments that consider the interactions between climate change and land use is necessary for effective policymaking. Barriers to Action: Addressing economic, political, institutional, legal, and socio-cultural barriers that hinder the adoption of sustainable practices is crucial [5]. Air Quality and Health: Air Pollution: Greenhouse gases contribute to respiratory diseases and air pollution [6]. Reducing emissions can improve air quality and public health [6]. Monitoring and Regulation: Effective monitoring of air pollutants and enforcement of regulations are necessary to ensure cleaner air [6].By addressing these issues, Penang can work towards mitigating climate change and creating a more sustainable and resilient environment [5].

II. METHODS

To address the issue of climate change through the introduction of the types of pollutants included in greenhouse gases (GHG) in Penang, Malaysia, a comprehensive and integrated solution is needed. The following are some of the solutions that can be implemented: public education and awareness, identification and monitoring of emission sources, implementation of policies and regulations, development of environmentally friendly technology, strengthening green infrastructure, adaptation and mitigation program, collaboration and partnership, capacity building and training, monitoring and evaluation system strengthening, financial and investment support, strengthening the role of the community. Target output of the activity Introduction to Types of Pollutants Included in Greenhouse Gases in order to Understand and Address Climate Change in Penang can be formulated as follows: improved participant understanding, awareness of the impact of pollutants, knowledge of pollutant sources, understanding of mitigation efforts, policy recommendations or local actions, increased community participation, documentation and dissemination, collaboration network.The research results of the activity Introduction to Types of Pollutants Included in Greenhouse Gases to Understand and Address Climate Change in Penang may include the following findings and recommendations: identification of dominant greenhouse gas (GHG) pollutant types, sources of GHG emissions, climate change impacts, level of public awareness on GHG, policy recommendations and mitigation actions, potential for collaboration and local initiatives, documentation and education, indicators of success.

Activity introduction to types of pollutants included in greenhouse gases in order to understand and address climate change in Penang :

a. Phase I Pre-implementation:

- Discussion related to the problems that occur
- Form a team of lecturers and students
- Proposal submission
- Coordinating activity time with partner vocational schools

b. Phase II Implementation:

- Oruetation
- Presentation

c. Phase III stages after field activities (evaluation):

- Evaluation activities are carried out by analyzing the results of filling out questionnaires by participants

Follow-up Plan This activity is carried out as a result of reflection on the evaluation that has been carried out to develop a plan for further activities.

III. RESULT AND DISCUSSION

The Introduction to the Types of Pollutants in Greenhouse Gases: Understanding and Addressing Climate Change in Penang, Malaysia event was held on May 3–5, 2025, at the An-Nadhoh Pinang Mainland Foundation Hall for one day, starting at 9:00 a.m. to 2:00 p.m. The activity report and financial report will be prepared from May to June 2025. This activity aims to raise public awareness about the importance of Types of Pollutants in Greenhouse Gases and how to understand and address climate change through basic introduction.Material support activities were also assisted by several students from the University of Science Malaysia (USM). The socialization material was presented in the form of PowerPoint slides and explained interactively in the form of a presentation. Each participant was free to ask questions about material they did not understand during the training. The event began with an opening ceremony, followed by the presentation of the material, and concluded with a quiz related to the material presented, as shown in Figure 1. The quiz was conducted using the Quizzis application, allowing the process to be monitored in real-time during the quiz. The final stage involved selecting the top 10 participants based on accuracy and speed in answering the quiz. The top 10 participants were awarded cash prizes whose amounts were adjusted according to their rankings. After the prize distribution was completed, the event concluded.

Fig 1. Opening of the event, Materials, and Quiz

Overall, the material presented in the socialization was very relevant and covered important topics related to greenhouse gases. The speakers, who were experienced and experts in their fields, were able to deliver the material well and answer participants' questions satisfactorily. In terms of facilities, the socialization room was spacious and comfortable enough to accommodate all participants. Supporting equipment such as projectors, sound systems, and other accessories also functioned properly. However, there were some challenges in time management, with some sessions slightly exceeding the scheduled time. Based on the evaluation results, there were several suggestions and feedback from participants, including: (1)The need for practical sessions and simulations to help participants better understand the material, (2) A longer training duration to allow for more in-depth coverage of the material.

The training method, which combines lectures, discussions, practical exercises, and simulations, facilitates a more effective and meaningful learning process. This activity supports the development of participants' competencies and skills. The final report of this activity includes an evaluation of the implementation, analysis of the results, and recommendations for improvements in the future.

IV. CONCLUSION

Community service activities on the island of Penang which are PERMAD Partners, an association of Indonesian Migrant Workers with the theme Introduction to Types of Pollutants Included in Greenhouse Gases in the Context of Understanding and Handling Climate Change, have been implemented and completed according to the target, namely providing counseling on how to overcome or handle the effects of climate change.

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