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Knowledge Management System for tracking of Greenhouse Gases

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ABSTRACT

Data science is one of the emerging fields in the computer science involving the extracting of insight from information assets for various level of collaboration and decision making. One of the key applications of data science is the solving of environmental impact of climate change which has significantly affected small islands developing states in the Caribbean and Pacific nations. This paper will discuss the creation of a Knowledge Management System (KMS) as a mechanism for the storage of information in the Measurement, Reporting, and Verification (MRV) in Trinidad and Tobago. The primary purpose of the MRV is the tracking of Greenhouse Gases (GHG) this is achieved through the suppliers or stakeholders of data entering the GHG information either from calculations on activity data and/or meters available at the facility areas. This system captures the data and utilizes business intelligence techniques to gain insight into information such as determining reasons for reductions. The KMS is also utilized for data and information such as GHG emissions, document management and workflow processing of the GHG inventory cycle for the country.

Keywords: Knowledge Management System, GHG emissions, MRV system

INTRODUCTION

The United Nations Framework Convention on Climate Change (UNFCCC) was first established in 1992 and focused largely on facilitating the intergovernmental climate change negotiations. It also supports a complex architecture of bodies that serve to advance the implementation of the Convention, the Kyoto Protocol and the Paris Agreement [1]. As a Party to the UNFCCC and a ratified signatory to the Paris Agreement [2] Trinidad and Tobago has committed to the following in its Nationally Determined Contribution (NDC): (a) An overall reduction in cumulative emissions from its three major emitting sectors (power generation, transport and industry) by 15% by 2030 from business-as-usual (BAU), equivalent to 103 MtCO₂e, conditional on international financing; (b) Unconditional reduction in public transportation emissions by 30% or 1.7 MtCO₂e compared to 2013 levels by December 31, 2030 [3] [4].

To realize these goals by 2030 one initiative undertaken by the Trinidad and Tobago was the creation of a Knowledge Management System (KMS) which forms part of the central repository for the

¹ business-as-usual baseline case as the level of emissions that would result if future development trends follow those of the past and no changes in policies take place.

² Metric tons of carbon dioxide equivalent. A metric measure used to compare the emissions from different greenhouse gases based upon their global warming potential (GWP). The carbon dioxide equivalent for a gas is derived by multiplying the tons of the gas by its associated GWP.

information and data related to the MRV System (see Figure 1 for relationship of MRV and KMS) [5]. The National MRV System is intended to facilitate the collection, analysis and transparent reporting of accurate and reliable information and data on GHG emissions, efforts to mitigate them and resources devoted to enabling these efforts. Emissions data include all GHG emissions by sources and removals by sinks [6].

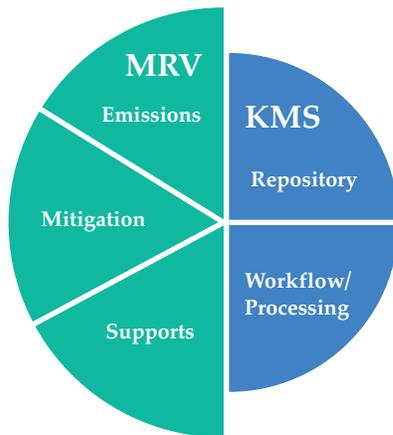


Figure 1: MRV and KMS Relationship

This paper will discuss the KMS components which includes the information and data components (GHG emissions and document management), workflow and reporting. The key benefits of the KMS is shared repository for data and reporting. On the other hand, the challenge is the lack of the experts in data and legal framework. In the last section of this paper, the conclusion is described summarizing the system and the future work associated with an integrated Caribbean hub and new adaptation modules are considered.

2.0 KMS COMPONENTS

As the central repository for data of the MRV System within Trinidad and Tobago the KMS was designed with three tiers namely an information and data area, processing of information and reporting. The design

of the KMS was based on a management system design in which information and data areas contained two key areas GHG emissions related data and documents (for example policies, procedures, and methodologies) [7]. The workflow or processing of information describes the process flow of information through the MRV System. The reporting section describes the information system reporting framework and technology.

2.1 INFORMATION AND DATA AREAS

2.1.1 GHG EMISSIONS RELATED DATA

Emissions related data which includes all GHG emissions by sources and removals by sinks, and is to be provided by relevant stakeholders is stored within the KMS as shown in Figure 2. Additional data such as mitigation efforts encompass strategies, policies and actions and their impact on GHG emissions and sustainable development (co-benefits). Support comprises international and/or domestic resources and capacity building (financial, technical, etc.) that are utilized in the implementation of emission reduction measures.

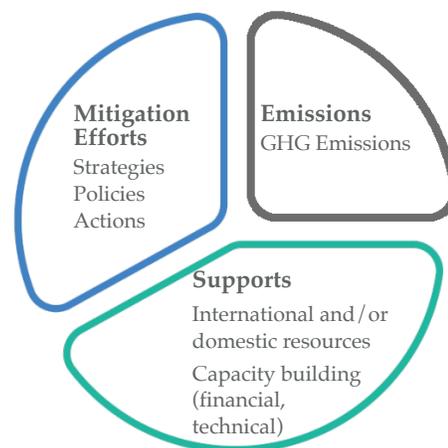


Figure 2: MRV data elements



To standardize data collection of GHG, the Intergovernmental Panel on Climate Change (IPCC) Inventory Software [8] was utilized as part of the system this is shown in Figures 3 and 4. This software allows for the entry of activity data by the stakeholder and the relevant associated calculations and this data is submitted to the KMS for processing.

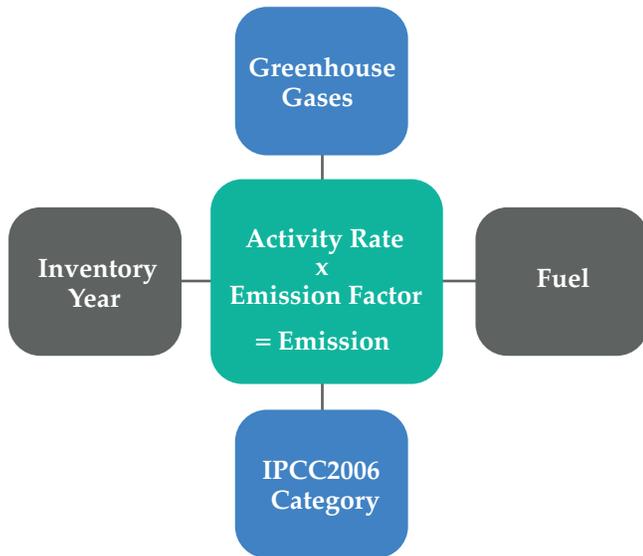


Figure 3: IPCC Data Model

2.1.2 DOCUMENT MANAGEMENT

The document management aspect of the KMS serves as a repository and approval process for documents associated with the Emissions, Mitigation, and Supports. An example of documents stored for Emissions include assumption sheets and procedures for Stakeholders. Mitigation information includes any documents related to the mitigation efforts such as project documents. The Supports entity contains documents related to climate financing and technology advances.

2.2 WORKFLOW OR PROCESSING OF INFORMATION

The business process flow shown in Figure 5 describes the overall process for the KMS and the interactions with users. The first stage of the business process is entry of information stage in which Stakeholder Executing Entities would enter their reports and reference documents according the MRV templates within the KMS. When the data is initially entered into the KMS, it would need validation, and therefore, is not yet incorporated into the organizational, sectoral or national levels.

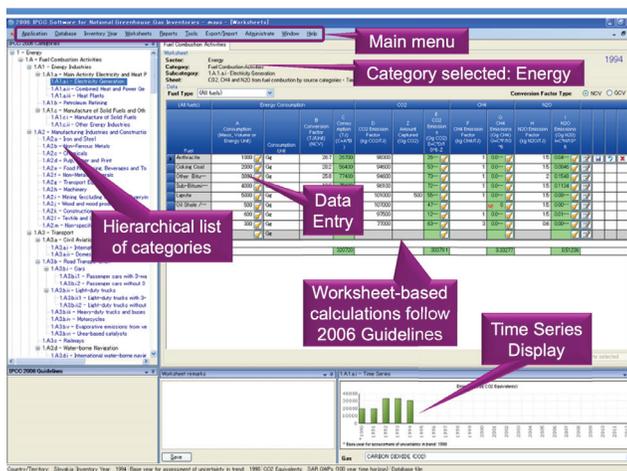


Figure 4: IPCC Software Source

Upon submission of the data, the Quality body/KMS custodian would review the information and perform the necessary checks on the information. The EMA (Environmental Management Authority) through its Air Unit would perform these checks and either return the entry for rechecking or approve the information. Once the information is approved, the KMS data would be stored in a validated state to be incorporated into the yearly organizational, sectoral and national levels.

Ministerial Executing Entities would be allowed to enter information on supporting information, mitigation, and improvement reports for the overall system as part of the KMS. The publishing of official national reports would be completed by the Central Statistical Office (CSO) with the assistance of the EMA and any additional Ministries or entities.

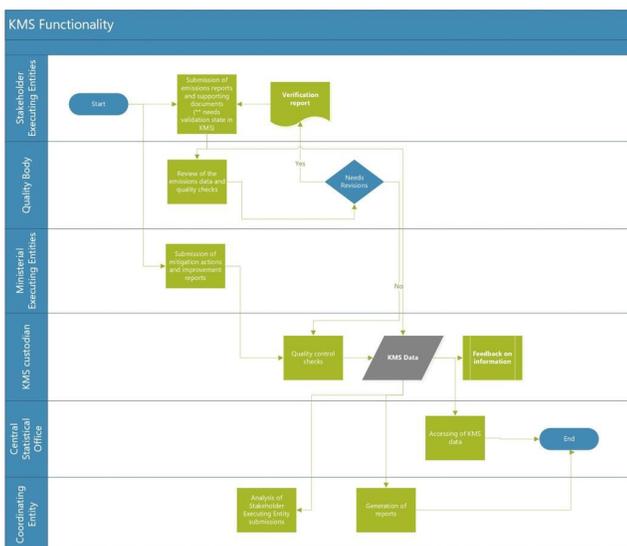


Figure 5: Process Flow

2.3 REPORTING

One of the key areas of the KMS is reporting of the information. The data model was structured into Country, Categories (Energy, Industrial Process and Product Use, Agriculture and Waste) and Stakeholder or company submitting the information. Figure 6A below shows a sample of fictitious data set showing the level of reporting. As part of the reporting business, intelligence reporting was activated using Microsoft PowerBI to allow for analysis of the data. Therefore, figure 6B shows the analysis reporting of the system to determine the reason for the increase or decrease in emissions.



Figure 6A: Sample Reporting

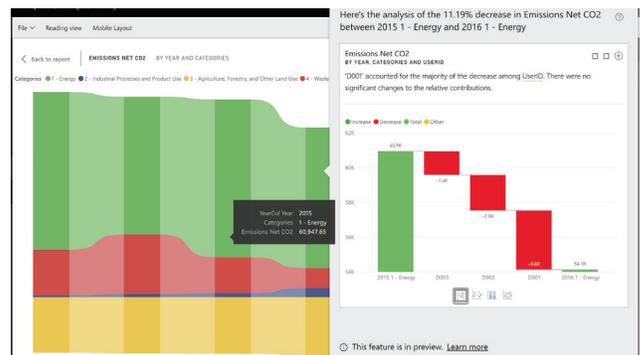


Figure 6B: Sample Reporting

3.0 KEY BENEFITS AND CHALLENGES

The first major benefit of the KMS is the ability of the data to be housed in a centralized space. This will allow users of the system to access historical data and documents associated with the MRV system. This system will also aid in the implementation of the Paris Agreement [2] as a core, and also to potentially support other transparency/data needs for domestic policy and other overlapping needed (e.g., air quality data). The reporting will provide insightful data into the GHG emissions and the increases and decreases over the inventory years.



The standardization of reporting of information using the IPCC software is also a gain for the country. Previously, entities would report information using various methods and units, however, with the IPCC software, all entities are required to make submissions using this tool. The system supports confidentiality of information and compliance with international and domestic rules and laws. It will ensure that entities submit GHG inventory data within the timeframes specified. There are also challenges associated with the KMS such as lack of legislation associated with the GHG emissions related data. Additionally, within the country, there is a lack of capacity or experts in this area to provide quality checks and quality assurance on the information submitted.

4.0 CONCLUSION AND FUTURE WORK

This paper describes the KMS implemented for Trinidad and Tobago to track its GHG emissions. The KMS components includes a data and information layer which is used to capture and store GHG emissions from the submissions by Stakeholders. The KMS also has a workflow or processing area for the approval of data through the system and an advanced reporting and business insight layer. The key benefit of the system is ability to act as a central repository of data, aid in the implementation of the Paris Agreement, standardize reporting and improved confidentiality for stakeholders. Some of the challenges of the KMS is the lack national experts and legal framework for compliance. Overall the goal of the system for the tracking of GHG was achieved and this data will be used to determine the reduction strategy and other interventions needed.

Adaptation is the process of adjusting to the impacts of the changing climate, seeking to moderate or avoid harm or exploit beneficial opportunities [9]. The future work of the KMS will involve the implementation of adaptative modules for tracking of NDCs. In addition,

the creation of an optimization algorithm for the carbon reduction strategy is therefore based on particular constraints the optimization algorithm will select for the best possible group of strategies to be implemented. It is also envisioned that other countries across the Caribbean may begin using a similar KMS. At the writing stage of this paper, the MRV Hub project [10] is engaged in developing a data management system similar to the KMS in twelve Caribbean countries.



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