Ontology Network for the Standardization of the EU CBAM report data

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Abstract

The Carbon Adjustment Mechanism is a key element of the EU's 'Fit for 55 Package'. This mechanism augments the EU Emissions Trading System by ensuring that the carbon pricing of imports reflects the internal costs, thus preventing carbon leakage and fostering global decarbonization, and it mandates detailed emissions reporting for energy-intensive imports, supporting fair competition and compliance with World Trade Organization regulations. Such reporting constitutes a challenge to companies, since it requires the integration of data from heterogeneous data sources, that combine information retrieved directly from the suppliers and information generated internally by the company. In this work we describe how this problem is being addressed by Siemens Energy. Data integration is approached from a knowledge graph perspective, which is driven a common data model derived from the requirements established by the European Union of the Carbon Adjustment Mechanism reporting. We describe the development of the common data model as a network of ontologies.

Keywords

Carbon emissions, CBAM, Ontology, Knowledge graph, Data interoperability

1. Introduction

The global climate crisis demands collaborative international efforts to maintain global temperature increases below the 2°C threshold as mandated by the Paris Agreement. to address this objective, the European Union has set rigorous targets aiming to reduce its greenhouse gas emissions by 55% by 2030 and achieve carbon neutrality by 2050. Integral to this strategy is the Carbon Border Adjustment Mechanism (CBAM)[1], a key element of the EU's 'Fit for 55 Package' [1]. The CBAM augments the EU Emissions Trading System[2] (ETS) by ensuring that the carbon pricing of imports reflects the internal costs, thus preventing carbon leakage and fostering global decarbonization. This mechanism mandates detailed emissions reporting for energy-intensive imports, supporting fair competition and compliance with World Trade

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[1]https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55/
[2]https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en

Organization regulations. This reporting is carried out in the EU Carbon Adjustment Mechanism Report (CBAM Report).

The generation of the CBAM report requires gathering information related with installations, customs, suppliers, Goods Emissions, etc, from several stakeholders involved in the production process and from different internal and external data sources. Additionally, the CBAM specification defines some rules and constraints to be met by the content of the report. Siemens Energy is a company that must submit the CBAM Report. Generating the report requires them to compile data from disparate sources. Moreover, the process is highly manual, which means that it requires a lot of effort to curate and homogenize the data that needs to be compiled and organized in a structural way and is prone to human errors. This is therefore a industry data standardization and interoperability problem, and knowledge graphs have been proposed as an ideal technological platform for such a purpose [2]. The industrial relevance of knowledge graphs is supported by the existence of an OMG knowledge graph forum [3].

Knowledge Graphs [3] generally combine data from different sources of varying structure and granularity. The meaning of knowledge graph data are usually described by ontologies and the description of different datasets with the same ontologies enables data interoperability. Our hypothesis is that ontologies and knowledge graph technologies can support the standardization of CBAM report data, ensure data quality and save time and cost in the process of completing the CBAM Report. In this work, we describe the first steps for the development of a standardized, ontology-based CBAM data model for the development of organizational CBAM knowledge graphs.

2. The CBAM Report

The CBAM report (see Figure 1) requires detailed documentation of imported goods, and it is structured in three main sections; report's Header, CBAM goods and CBAM Goods Emissions. The size of the CBAM Goods and CBAM Goods Emissions sections depend on the number of goods imported and the emissions per production and per installation, respectively. Next, we describe the content of each section of the CBAM report.

- Report's Header: basic information for the CBAM Reporting Declarant and the reporting period. Declarants are required to submit a CBAM report each quarter, detailing imports to the competent authority of the importing Member State or a chosen state if multiple are involved, within one month after the quarter concludes.
- CBAM goods: Goods imported during the reporting period, along with information regarding their quantities, countries of origin and areas of import per CN code including total quantities per installation, electricity or other goods.
- CBAM Goods Emissions: the CO2 emissions and the emissions qualifying parameters to produce each CBAM good and any supporting documents per installation and per production method. This section also includes data such as the direct CO2e emissions per unit or the indirect CO2e emissions for non-electrical goods.

[3] https://www.ekgf.org/

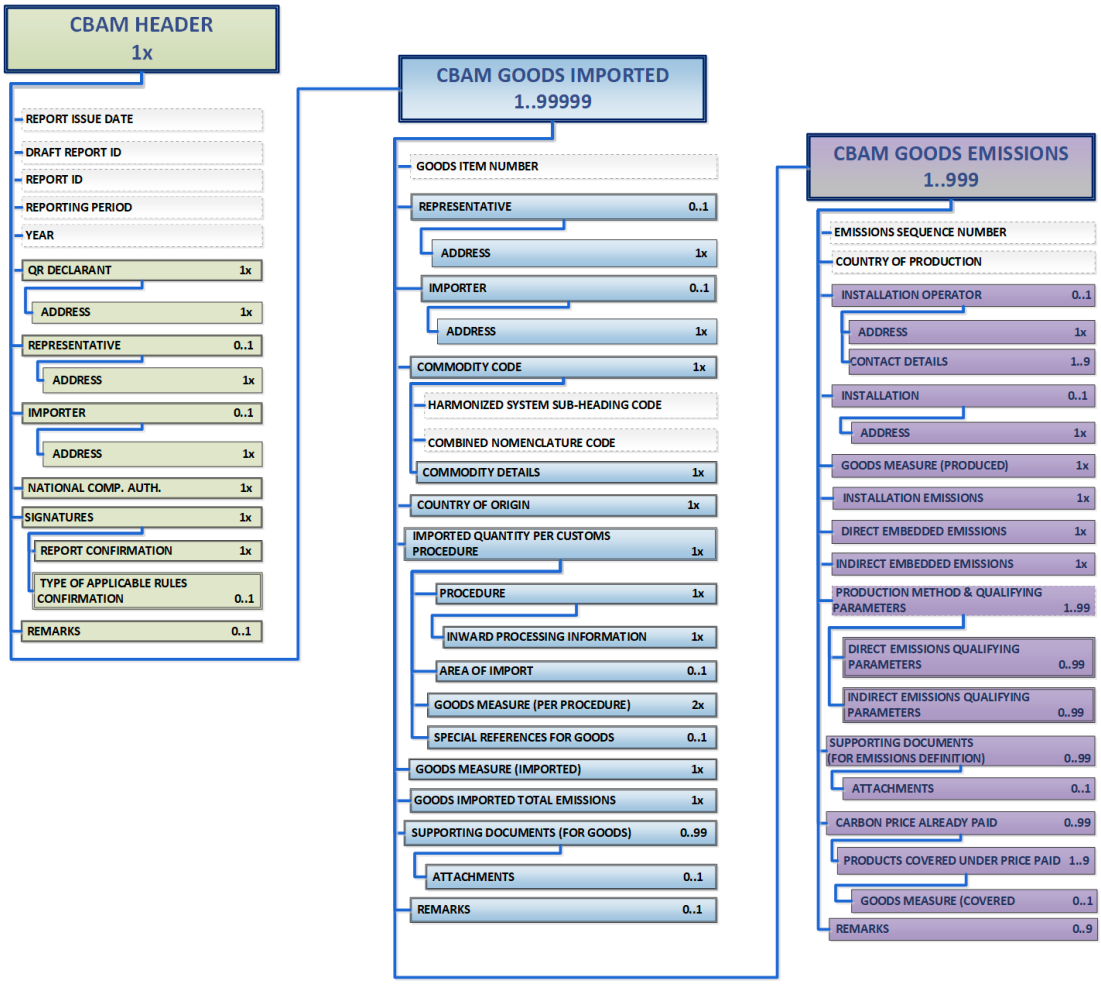

Figure 1: CBAM Report Structure. The three sections of the report are shown in different colors: the header in Green, the Goods imported in blue, and the Goods Emissions in purple. Figure taken from the Figure Application User Manual [4]

3. The CBAM Ontology Network

We are currently designing and implementing the CBAM common data model as a network of ontologies to ensure the formal, precise definition of the meaning of the content of the CBAM report. This network, called the CBAM Ontology Network, consists of a set of OWL[4] ontologies and controlled vocabularies that support the description and interoperability of CBAM related data. For some parts of the domain we have developed new ontologies, which have been implemented using the Protegé ontology editor [5]. In addition to this, given that the CBAM report has 20 controlled vocabularies (coded value lists) associated, we have automatically

[4]https://www.w3.org/TR/owl2-overview/

generated OWL files for their representation. For this purpose, a custom Python script has been used.

Figure 2 depicts a high-level overview of the network and its key relationships. A core ontology, CBAM Core Ontology (shown in gray with yellow elements), defines the main concepts within a CBAM report. The figure shows how the core ontology is linked with the other resources in the network: (1) ontologies created from the Code List (green); (2) controlled vocabularies created automatically from the code List (orange); (3) ontologies reused (blue). The structure describes that a Commodity is identified by a Commodity Code (CN and HS), the Commodity is transformed into a Good, which is measured by using a specific Unit of Measurement. An Imported Good is acquired in an Importation process, which is Registered in a Customs procedure, and that the importation comes from a Country identified by a Country Code.

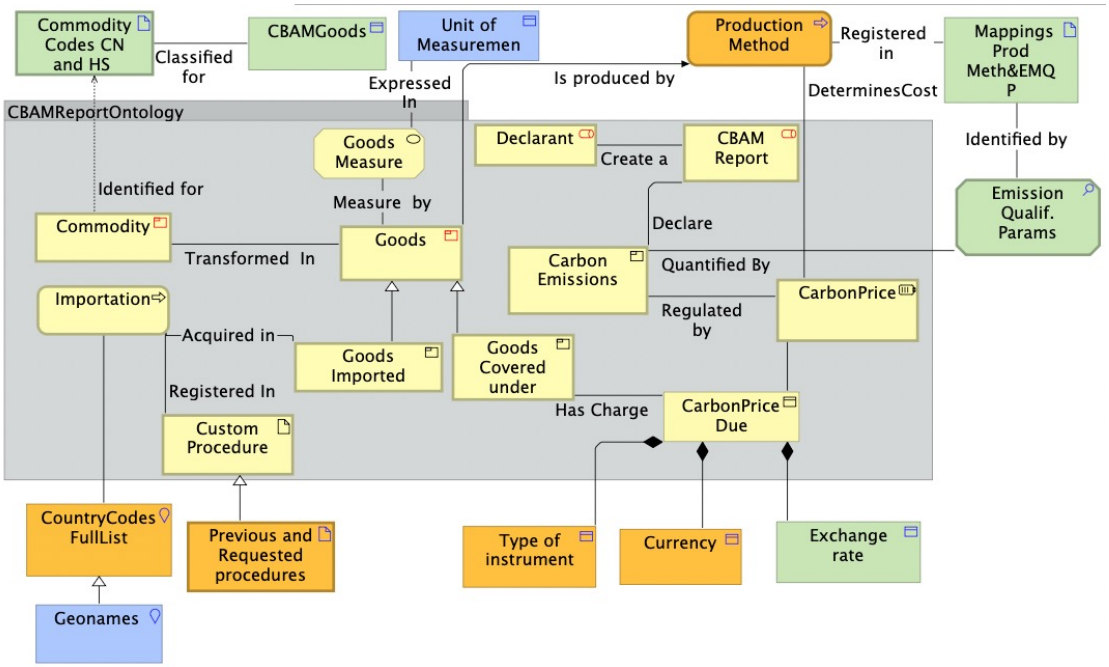

Figure 2: High level representation of the CBAM ontology network. The Figure includes the CBAM Core Ontology which contains the main concepts of the CBAM report (Gray Group with yellow elements); Ontologies created from Code Lists (green elements) and Controlled Vocabularies (orange elements) and reused ontologies from the community (blue elements)

Figure 3 is a snapshot of the CBAM ontology network in Protégé. There we can identify the main concepts provided by the different ontologies that constitute the network, and we can see a partial expansion of the hierarchy of customs procedures, which is a hierarchy automatically constructed from the EU CBAM specification.

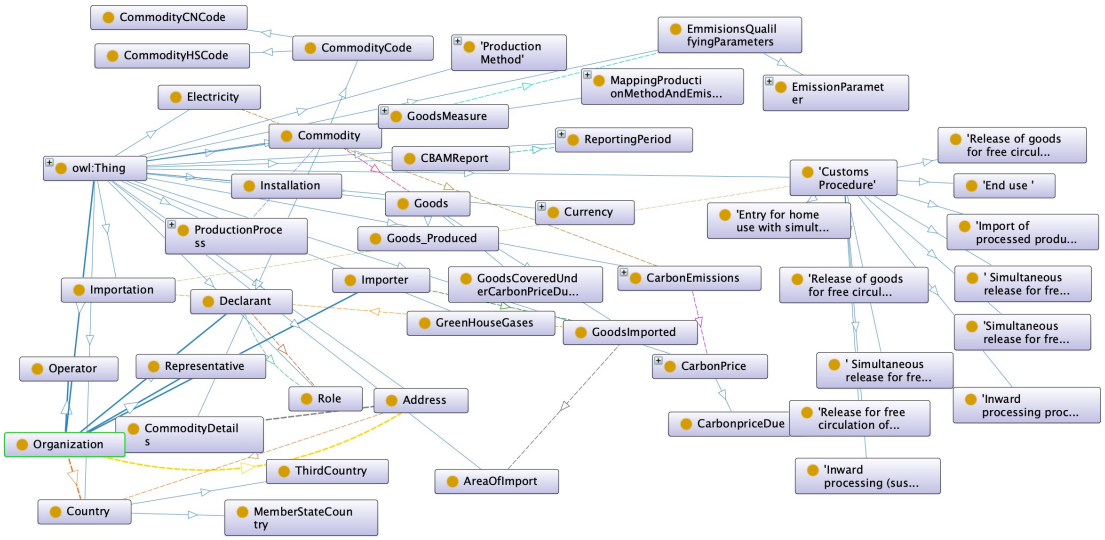

Figure 3: Snapshot of the main CBAM ontology in Protégé. In this ontology the elements Production Method and Customs Procedure are imported ontologies, created from the Code List

4. Conclusions

In this work we have presented the initial steps towards the development of a common data model driven by an network of ontologies for the standardization of CBAM reporting data. This ontology will be used to describe CBAM related data stored in disparate data source, thus enabling effective integration in a knowledge graph, promoting data interoperability, and reducing the cost of generating the reports required by the European Union.

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