CO_2 emissions the elephant in the room: a pathway of reduction using digitalization and unstructured data

Introduction

In this paper, we are exploring the challenges associated to climate change in the energy industry with the paradigm of extracting oil and gas in a low CO_2 environment to limit the effect of climate change and provide the world with affordable source of energy for mobility and heat generation.

We will be discussing how carbon accounting allows to track direct and indirect source of emissions, its origins and the challenges associated to them.

Finally, we will investigate how modern technology such as data mining can help mitigate direct and indirect emissions by increasing operations efficiency, identifying operation flaws, and implementing scalable Carbon Capture and Storage (CCS) implementation.

CO_2 emission and world energy consumption

Recently, the Intergovernmental Panel on Climate Change (IPCC) issued the sixth Assessment Report (AR6) related to **Climate Change 2022: Impacts, Adaptation and Vulnerability** which highlights the urgency of limiting the increase of temperature to 1.5°C to reduce the impact of climate change: "*Global warming, reaching 1.5°C in the near-term, would cause unavoidable increases in multiple climate hazards and present multiple risks to ecosystems and humans (very high confidence). […] Near-term actions that limit global warming to close to 1.5°C would substantially reduce projected losses and damages related to climate change in human systems and ecosystems, compared to higher warming levels, but cannot eliminate them all (very high confidence).*" (IPCC, 2022).

In addition, the AR6 report linked to **Climate Change 2022: Mitigation of Climate Change** suggests that *"All global modelled pathways that limit warming to 1.5°C […] involve rapid and deep and in most cases immediate GHG emission reductions in all sectors. Modelled mitigation strategies to achieve these reductions include transitioning from fossil fuels without CCS to very low- or zero-carbon energy sources, such as renewables or fossil fuels with CCS, demand side measures and improving efficiency, reducing non-CO_2 emissions"* (IPCC, 2022).

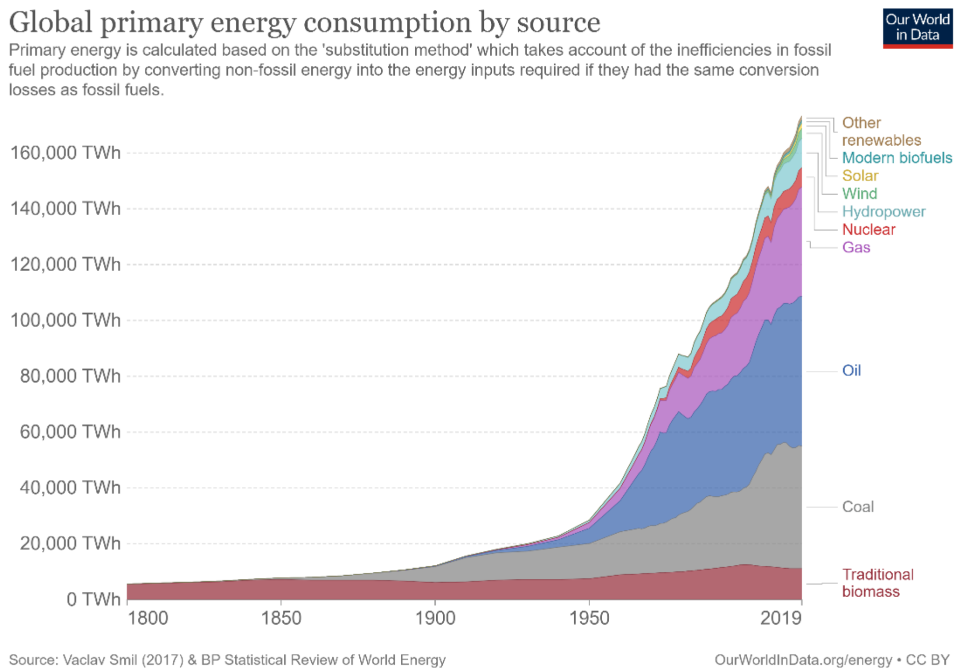

Figure 1: *Global primary energy consumption by source. Fossil energies account for 80% respectively Coal (25%), Oil (32%) and Gas (23%) (Source: Our World in Data - Energy)*
While limiting the reduction of CO_2 to reduce the impact of climate change, the world is still highly dependent on fossil fuels, with fossil energies accounting in 2019 for more than 80% in total and Oil/Gas for 60% alone (Figure 1). Combined with the need of powering the world and the challenges of climate change, the energy sector has a central play to significantly monitor and reduce its CO_2 footprint.

Carbon accounting

Carbon accounting is the process which allows organization to quantify and monitor Greenhouse Gas (GHG) emissions. By construction, carbon accounting counts the direct and indirect emissions linked to the activity of the organization through the full value chain.

Direct emission are the emissions directly related to the own activity of the company such as oil/gas extraction and production and are often referred to scope 1 emissions. Indirect emission are the emissions emitted considering the full value chain. In the case of the energy industry, this would consider all the necessary services contracted to perform the extraction of oil and gas from the subsurface and all the emissions related to the usage of the oil and gas as a molecule for the human usage in mobility, industry usage and heat generation. These emissions are falling into the scope 2 associated to the supply of energy (input) and the scope 3 linked to the oil and gas products sold (output).

Figure 2 illustrates the breakdowns and evolution of four (4) representative Oil major operators' emissions until 2018. In average, 10% of the emissions are associated to direct emission and 90% of them are linked to indirect emissions connected to hydrocarbon products sold. Considering oil and gas commitment in reducing carbon emission, this means that both direct and indirect emissions would need to be tackled simultaneously.

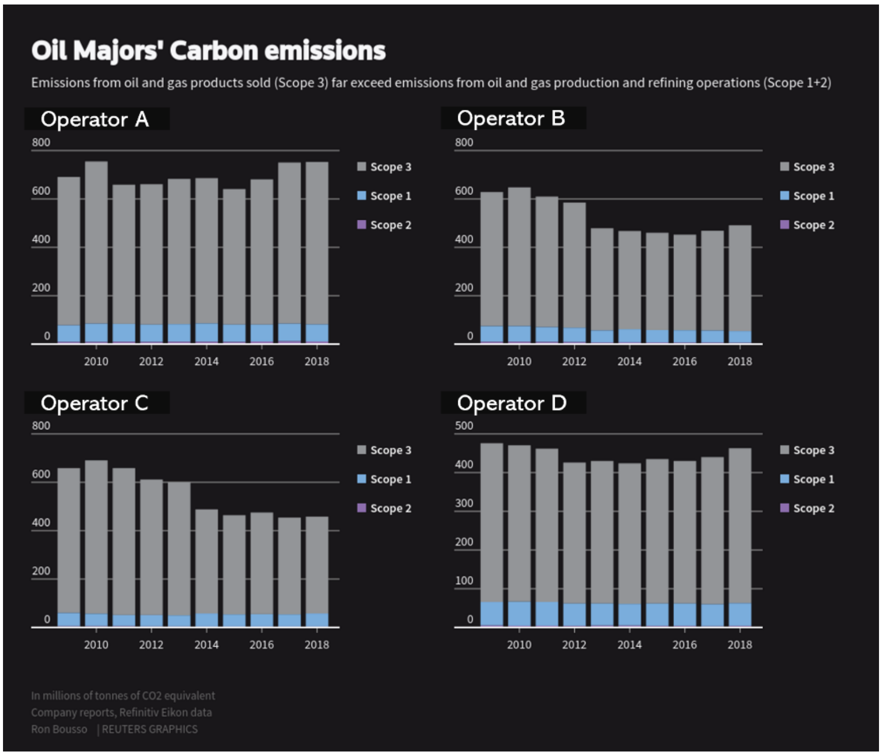

Figure 2: *Evolution of direct and indirect emissions for four (4) Oil Majors. scope 1: Own operations (direct emissions), scope 2: Power supply (indirect emissions), scope 3: Indirect from oil and gas products sold (indirect emissions) (Source: Modified from Reuters 2019)*

Data mining technology

Decades of oil and gas operations associated to the exploration, development and production of oil fields have generated vast amount of data which provides a deep insight of constant optimization of costs and resources. The data are interpreted and compiled into unstructured data such as reports, presentations and studies providing a carbon copy of the history of the operations. The unstructured data provides an immense potential of CO_2 emissions reduction for both direct and indirect emissions. New technology such as Data Mining and Machine Learning technology helps to process and retrieve information at scale contained in the unstructured data in a pipeline called ingestion of unstructured data (Hernandez, 2019). The process involves automated pipeline of text identification, image classification, Name Entity Recognition (NER), Knowledge Graph and Heat Map analysis.

For the direct emissions, the ingestion of unstructured data gives the G&G experts a discovery experience allowing him to interrogate the full corpus of data instantly. Such ingestion platform reduces the time of information retrieval and provides a holistic view of the lateral extent for the parameters of interest. An example of such application is seen in Figure 3, where reservoir intervals with high CO_2 content is highlighted for more than 500 wells associated to the ingestion of over 45,000 unstructured documents.

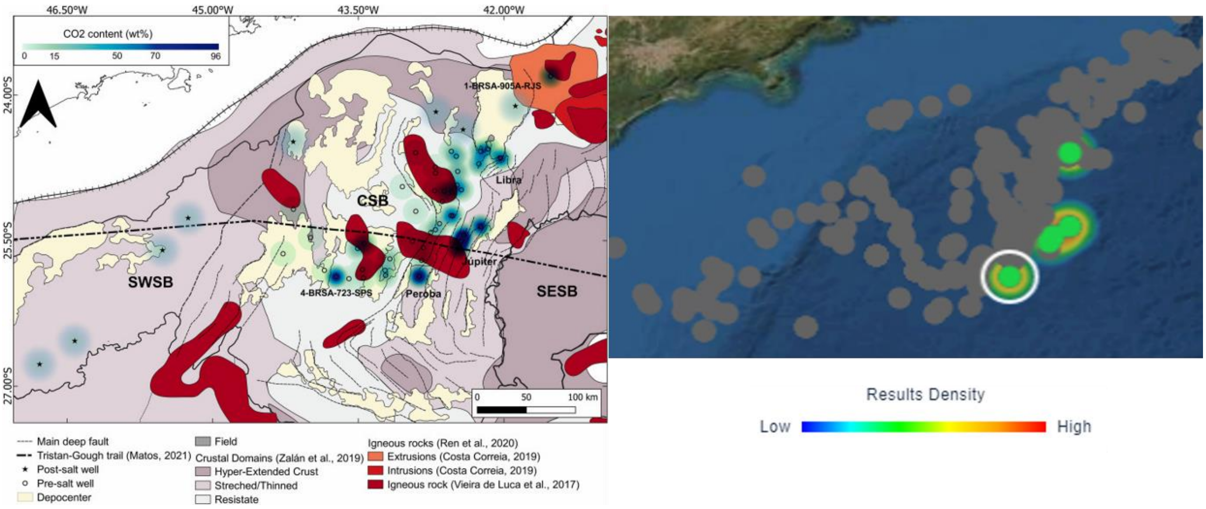

Figure 3: *Regional maps covering 500 wells showing the presence of high CO_2 content in the reservoir interval (Source: https://doi.org/10.1016/j.jsames.2022.103760)*

Reducing the time of information retrieval provides a unique opportunity of fast-tracking studies, hence reduce the CO_2 emissions. An extended scope of the data ingestion workflow is the identifying and tracking the origin of operations flaws and best practices for potential improvement and reduction of CO_2 emissions (Hernandez, 2021).

The reduction of indirect emissions involves large scale adoption and deployment of CCS capabilities worldwide. Such a pathway is possible by leveraging on current existing oil and gas assets which are the mature depleting fields. Extensive work and studies over decades generated a vast amount of data subsurface studies and production that are mined to rank the best opportunities for CCS based on the field maturation, intervention history and geological settings. Once the target reservoir identified CO_2 injection can then be monitored wit novel environmentally friendly methods such as using nondisruptive 4D seismic (Figure 4) to prove the potential. Such Data to Sink funnel provides the technical scalability and the cost effectiveness to assess CCS potential in a large area of interest.

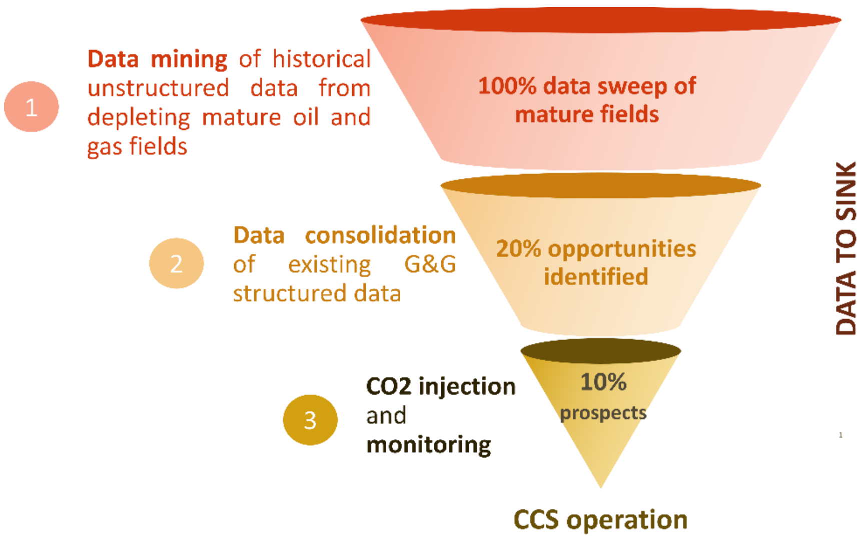

Figure 4: *Data to Sink funnel workflow powered by data mining, machine learning and lean 4D seismic monitoring.*

Conclusions

The reduction of carbon emission at scale in the energy industry remains a challenge. In this paper we have demonstrated how digitalization applied on unstructured data can help reduce both direct and indirect emissions.

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