LEGAL AND REGULATORY BARRIERS TO CO2 GEOLOGICAL STORAGE IN BRAZIL

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Overview

Global energy demand is still growing based on fossil fuel consumption, and its consequences, such as greenhouse gas emissions (e.g. CO2 emissions), are a concern for humanity due to global warming. Faced with this problem and challenged by the increase in fossil fuels supply from the Brazilian Presalt, Brazil committed to reduce greenhouse gases emissions (NDC Brazil). Therefore, it became relevant to adopt specific measures for the CO2 intensively emitting sectors, such as the Brazilian energy sector and the petroleum industry, aiming towards its decarbonization. Thus, proposals based on sustainable development should promote the deployment of 'zero emission' technologies, such as carbon capture, utilization and storage (CCUS). These can contribute to the immediate and effective reduction of CO2 emissions from large stationary sources of certain industrial sectors and from the energy sector, ensuring CO2 storage in a durable and safe way.

Though the use of a descriptive-analytical methodology, we identified and analysed the main legal and regulatory barriers to implantation this technology in Brazil. Since CCUS activity implies in risks, such as CO2 leakage, we point out the need to elaborate a legal and regulatory framework, in order to minimize the associated uncertainties. In this scenario, more efforts are needed to ensure that carbon abatement technologies are well understood among public policy makers in Brazil, as well as to create an ideal environment for the national development of CCUS projects.

Methods

This study presents the main legal and regulatory barriers to CCUS technology been implemented in Brazil, through a descriptive-analytical methodology. The analysis focused on the aspects of the CO2 geological storage, considering the geological risks, such as CO2 leakage and potential environmental impacts. Therefore, we analysed the Brazilian Civil Code and the Brazilian Laws that can relate to this research topic, such as 6453/1977 and 6938/81, which discourse regarding objective responsibility and environmental risk, respectively. In addition, we performed a comparative analysis between Environmental Licensing and Environmental Impact Assessment (EIA) requirements in Brazil with the CCS Directive 2009/31/EC, which regulates CCS projects with regard to CO_2 storage, in quantities above 10^5 ton of CO2, within the European Union.

CO_2 Geological Storage

Carbon capture and utilization technologies have been used since the early twentieth century. In the 1920´s carbon dioxide separation processes were used in the natural gas stream in several fields in order to separate the CO_2 for industry aplications (IEAGHG, 2017). By the 1970´s, carbon dioxide was already being used for enhanced oil recovery in Texas, with permanent storage. Since the 1990´s, several CCUS projects were deployed with the expanded scope of mitigating greenhouse gas emissions. The definition of a carbon storage project and the differentiation from a enhanced oil recovery based on the quantity of gas injected is necessary so that enhanced recovery projects are not subjected to the same regulatory restrictions as the CCUS projects. In this context, the European Union Directive 2009/31/EC establishes a cut-off point of 100,000 tons (European Parlament, 2009).

Geological storage, as in subject focus of this article, is considered an abiotic capture process. In this category, physical and chemical processes act on the CO_2 in order to separate the gas and fix it to the structure of the storage (Freund; Ormerod, 1997). The physical or chemical mechanism that control the fixation process in the geological storage depend on depth, local stratigraphy, fluid saturation, permeability and porosity (Aminu et al., 2017). The geological structures more appropriate for CO_2 storage are depleted oil and natural gas reservoirs, underground salt caves, deep underground aquifers and deep unmiable coal seams (Aminu et al., 2017). The underground salt caves are considered the best CO_2 reservoirs in terms of relative capacity, cost and integrity, followed by depleted oil and gas reservoirs (Aydin, 2010; Aminu et al., 2017). Depending on the country, each of these structures may have a different regulatory framework for it's exploration, wich becomes extremely important when defining responsibility over the CO_2 storaged, as well as demands for geological integrity, seal integrity and monitoring. Table 1.0 presents pathways for CO_2 storage based on literature review.

Table 1-Main pathways for CO2 storage

Permanent Geological Storage	Depleted Oil and Natural Gas Reservoirs
	Underground Salt Caves
	Coal Deposits
Industrial Aplications	Food Industry (beverages)
	Steel and Chemical Industry (as inert)
	Chemical Industry (reforming)
	Biological Application (microalgae cultures)

Other forms of CO_2 storage comprise biological fixation, such as reforestation or microalgae cultures, and utilization in the chemical and food industries. Some of these options do not characterize permanent storage, although capture and transport processes are usually similar as the ones applied for permanent geological storage (Oliveira, 2016).

Difficulties regarding the regulatory framework

As of the writing of this article, there is no specific regulatory framework regarding CCUS activities in Brazil. There was a proposal for regulation in 2011, wich was not approved (Costa, 2014). There are, however, specific state laws created to promote these initiatives in a broader context, such as Law 3.020/2005 from Mato Grosso do Sul state, wich mainly regards carbon credit monetization (Júnior, Xavier and Alves, 2014). Since the majority of ongoing projects are related to enhanced oil recovery, the regulatory framework for the oil and gas industry is usually applied, in wich norms and resolutions from the National Oil, Natural Gas and Biofuels Regulatory Agency (ANP) regulate the applied technical procedures, such as cement integrity and/or capacity estimation demands, and the state and national laws regulate the broader aspect of the activity, such as permission and gas property.

As the 5th largest country on Earth, Brazil has a very heterogeneous territory. This contributes to different regulatory demands from each state, due to the divergent nature of its natural resources and even the lack of, wich also is relevant for interstate tax regulation for activities related to CO_2 transport, for example. These sometimes divergent interests are one of the first barriers for the development of a regulatory framework for CCUS in Brazil. Júnior, Xavier and Alves (2014) defend a broad regulation in all level, including, municipalities, with fiscalization for civil, penal and administrative responsibility imposition for public and private companies, especially when carbon credits are involved.

Geological risks are one of the main barriers not only for the development of a regulation but also for encourage the investors considering the long term liability. Industrial activities that generate risks to the environment or property are described in the Brazilian Civil Code (Law 10.406/2002), that establishes the risk-generating theory wich attributes to the activity itself the harmful potential of this activity. The main geological risk is CO_2 leakage, wich leads to consequences such as contamination of other geological layers, causing environmental and property losses (Oliveira, 2016). This fact pressures the development of a ownership transfer regulation able to endure long term responsibility. Is also worth to note that the existence of storaged CO_2 should be included in property ownership documents.

Romeiro-Conturbia (2014) and Costa (2014) agree that makes more sense for ANP to regulate and fiscalize most CCUS activities, since most of it is connected to the oil and gas industry. Romeiro-Conturbia (2014) proposed a integrated approach for several government agencies in each step of the CCUS chain. In this scenario, capture would be regulated by ANP and the National Electric Energy Agency (ANEEL); transport would fall under ANP, the National Land Transportation Agency (ANTT) and the National Waterway Transportation Agency (ANTAQ); and storage would be regulated by ANP, the National Mining Agency (ANM) and National Water Agency (ANA).

Câmara (2012) presented a multiple scenario approach in wich the base case presents the responsibility of the state to regulate CO_2 emissions and concede exploration rights to third parties in the capture, transport, injection and monitoring stages. In this scenario, the company would be responsible for the execution of the project and the CO_2

would be state property. In this case, the capture stage would be regulated by the state authority and all the processes going forward would be regulated by the national authority. Although most authors agree that there should be some level of state regulation (Costa, 2014; Câmara, 2012; Romeiro-Conturbia, 2014), this imposes a challenge for investors, since each state might have different laws and some might even lack the regulation by the time the opportunity arises.

Other barriers include definition of the process of restitution for land owners, in case of transport and injection activities. Câmara (2012) suggests utilization of the same system the oil and gas industry applies, in the absence of any regulation. Another barrier is the cost of applying and abiding with the regulation, wich shouldn't be relevant to project design, since, in this stage of CCUS development, there are fringe gains, particularly when not associated with enhanced oil recovery. Also, the definition of the transported and injected gas composition should be regulated, with strict limits to other substances. Lastly, the presence of natural monopolies in the CCUS chain generates information asymmetry, as well as necessity to controlled taxation (Costa, 2014), wich demands state intervention through regulation.

Results

The large-scale deployment of CCUS is still subject to political, economic, environmental and social challenges. In Brazil, with regard to CCUS activities, it is necessary to increase regulatory capacity and build support for government authorities in order to develop a deeper understanding of how this technology and liabilities should be applied (IEAGHG, 2013; Romeiro-Conturbia, 2014).

In this context, the sole paragraph of article 927 of the Brazilian Civil Code (Law 10.406/2002) establishes the risk-generating theory, that attributes to the activity itself the harmful potential of this activity, as it says: "There will be an obligation to repair the damage, regardless of culpability, in cases specified by law, or when the activity, often carried out by the offender, implies, by its nature, risk to the rights of others." Considering the total risk theory, which regards to the non-perquisition of any aspect of extra damage, i.e. if there was damage, if the author of it is identified; he/she is responsible for its repairs, regardless of causality.

Considering the 'permanent' storage of CO2, which relates to thousands of years of CO2 been trapped in storage complex, many authors compare this geological storage to radioactive waste burial disposal. This compasarion can be based on the required permanent storage in underground rock formations, and on the long-term liability (Oliveira, 2016).

In regards to this long-term liability and to objective liability, Law 6453/1977, which discusses civil liability for nuclear damage, as well as criminal liability for acts related to nuclear activities, can be applied to CCUS context. Regarding the environmental scope, article 14, first paragraph, of Law 6938/1981 has already described the objective of environmental damage: "Paragraph 1 - without prejudice to the application of the penalties described in this article, the polluter, regardless of the existence of culpability, is responsible to repair or restore the damage caused to the environment and to third parties affected by its activity. The Federal and State Public Prosecutions will be legitimate to suggest actions of civil and criminal responsibility for damages caused to the environment.

Furthermore, altough the Brazilian Civil Code does not have a specific mention of liabilities related to CCUS activitie, we can apply Law 6453/1977 and Law 6938/81 which prescribes the theories of civil liability related to nuclear activities, total risk and objective liability, as legal instruments to enforce strict sense responsibility, in order to ensure that victims are compensated for damages.

Accoring to the CCS Directive 2009/31/EC, in order to be selected as a storage site, the geological formation should be under the safe storage criteria, defined by Bachu (2008), These criteria are mainly based on the reservoir capacity, containement, and injectivity, as well as not presenting significant risk of CO_2 leakage, and no significant environmental or health risks. To identify and evaluate the risks associated to a potential storage site, a complete characterisation and assessment of the potential storage complex and surrounding area must be carried out, as well as an Environmental Impact Assessment, which should include risk assessment. In addition to a complex reservoir monitoring, since the operation to the post-closure phase of the CCUS project.

Long-term responsibility over the injected CO_2 is one of the main contested points between regulators and agencies (Oliveira, 2016). According to the Directive 2009/31/EC, the operator transfer the responsibility over to the local government after 20 years from the installation licencing date. During this period, monitoring is required. This period is shorter is Australia (15 years) and Canada (10 years in Alberta) (Romeiro-Conturbia, 2014).

Conclusions

Although the Brazilian Civil Code does not have a mention specific to the responsibility related to CCUS activities, we can apply Law 6453/1977, in regards to eventual similarities between CO_2 storage and nuclear residue storage due to long-term liability; and Law 6938/81 which prescribes the theory of total risk and strict responsibility, in order to avoid possible leakage of CO_2 from the geological storage.

According to Bachu (2008), the main barrier CCUS technology deployment is the lack of a legal and regulatory framework on this activity. "There are jurisdictions that present regulatory elements, however, these are incomplete and insufficient," says the author. CO2 capture and transport processes are generally regulated activities, with precedents and similarities other industrial processes. Correspondingly, the injection of fluids into subsurface, such as the enhanced hydrocarbon recovery technology, is generally a mature technology, been majorly regulated in developed countries, or at least extensively used and known. The regulation for these activities can be adopted and/or adapted to other countries. However, it is the post-operational phase to the injection of fluids, that is, the process of geological storage that requires regulation and public policies worldwide.

This lack of a regulatory framework, as well as heterogeneity in international, national, a local regulation and environmental legislation on geological storage represents the main barrier to the deployment of CCUS on a large scale, since it represents a financial risk to the operating company.

In this scenario, the main regulatory barrier lies in the relationship between international, national and subnational (local) jurisdictions. This relationship between federal, state and municipal jurisdiction must be clear and, in certain cases, harmonized. In this sense, the transport and storage of trans-border CO_2 must be considered, both in surface (e.g. gas pipelines) and subsurface (CO_2 plume and its possible migration).

In addition, there is the jurisdiction regarding the classification of CO_2, which also presents in a varied way: CO_2 can be classified as polluting or as a commodity, depending on its origin and end use.

Another point to consider is the property on the subsoil as well as the direct ownership over the storage fluid and other mineral resources. Finally, regulatory agents and licensing and environmental impact assessment procedures should be considered.

Although CCUS can significantly contribute to the total reductions in CO_2 emissions by 2050, and therefore will require an ambitious growth path for this technology globally, risks of potential carbon leakage need to be considered and prevented by law, as well as ensuring the permanence and safety of CO_2 storage.

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