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Interaction between the carbon tax and renewable energy support schemes in Colombia

Complementary or overlapping?

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Abstract

Colombia is advancing its mitigation and renewable energy policy instruments implementation. Especifically, the country has introduced support schemes for electricity generation from renewable energy sources (RES-E) and a national carbon tax. Therefore, these two instruments interact within the climate-energy policy mix. However, the interaction between them could be complementary or overlapping depending on the policy design of each instrument. The main objective of this thesis is to analyze if the policy design elements of the carbon tax and the RES-E support schemes make them complementary or overlapping instruments. This especifically through the comparison of the instruments' policy objectives. Furthermore, the thesis elaborates on why the coexistence of both instruments is justified. The methodology was mainly qualitative and encompassed descriptive as well as interpretive stages. Additionally, it comprised a comprehensive literature review on the interaction between mitigation, as well as, renewable energy policy instruments and a content analysis based on interviews with related stakeholders. Results show that the policy objective design element from the instruments was crucial to classify them as complementary and to conclude that their coexistence is justified. This is, the mitigation objective of the carbon tax and the energy security aim of the RES-E support schemes suggest both instruments are complementary. Moreover, an essential policy design element like the nature of the instrument is fundamental on the way it will interact with other instruments. For instance, a quantity-based instrument such as an emission trading scheme will interact differently than a price-based instrument, e.g. a carbon tax, with a RES-E support scheme. In an ETS the carbon price might change with the introduction of a RES-E support scheme, whereas the carbon rate in the tax will be always the same. Consequently, the thesis also found further research areas which include to analyze the effect of the existent RES-E support schemes on the carbon price within an ETS. This considering that currently there is a price floor provided by the carbon tax.

Keywords: Colombia; carbon tax; renewable energy support schemes (RES-E); interaction

Executive Summary

The increasing level of greenhouse gases (GHG) in the atmosphere has changed the climate system's temperature and so has the intensity and frequency of climate extreme events such as droughts, floods, cyclones, hurricanes and wildfires (IPCC, 2014a). As a result, governmental efforts to encourage the reduction of GHG are an increasing trend (IPCC, 2014b). Mitigation endeavours take form of legislation, policies, plans, strategies and instruments. Low-carbon policy instrument portfolios are composed mainly by regulatory approaches, economic instruments, information schemes and voluntary agreements (Mundaca & Markandya, 2016). At a global level, the ones that are more widely used are the economic instruments. For instance, 73 percent of the low-carbon policy instruments implemented in Latin America and the Caribbean (LAC) correspond to subsidies, loans, tax credits as well as research and development schemes (Mundaca & Markandya, 2016). While Colombia is in its initial phase of climate policy implementation (Calderón et al., 2016) is not the exception when it comes to applying mitigation or renewable energy economic instruments. These are the national carbon tax and the support schemes for electricity generated from renewable energy sources (RES-E). Since these two instruments coexist in Colombia's climate-energy policy mix, interactions among them take place (Oikonomou & Jepma, 2008). While these interactions can be mutually reinforcing, they can also work against each other or can be redundant depending on how both instruments are designed and implemented (Hood, 2011). Therefore, the reasonable coexistence of these instruments depends greatly in their design elements interaction.

The interaction evaluation between the carbon tax and the RES-E support schemes in Colombia requires a deeper analysis. Thus, this thesis aims to analyze how these policy instruments complement or overlap with each other through their design elements to understand if their coexistence in the policy package is justified. In addition, it also seeks to explain the perception of different stakeholders regarding the instruments' interaction in Colombia. Subsequently, three research questions guide this thesis to achieve its main objective:

Research question 1: What national and international factors have influenced the design and implementation of the carbon tax and the RES-E support schemes in Colombia?

Research question 2: How do the policy instrument design elements of the Colombian carbon tax and the RES-E support schemes interact?

> *Research sub-question 2.1:* How does the interaction between the design elements of the carbon tax and the RES-E support schemes justify or not their coexistence in Colombia's climate-energy policy mix?

Research question 3: How do different stakeholders perceive the interaction between the RES-E support schemes and the carbon tax?

Providing inferences about the interaction of these instruments in Colombia as well as on their coexistence in the climate-energy policy mix is possible through the implementation of a qualitative methodology, compound by a descriptive and an interpretive stage. The descriptive stage entails firstly to provide a background of the political economy of both instruments. Secondly, the descriptive stage consists on applying the first two steps of the Energy and Climate Policy Interactions (ECPI) decision tool. The first steps mean to describe the policy instruments to understand their nature. Then, next step is to compare both policy instruments in six main design elements: measure identification, objectives, target groups, market, financing and institutional setup (Oikonomou et al., 2014). Design elements are parameters within a policy instrument or key characteristics of policy instruments that are suited to interact. The interpretive stage is performed to understand if the coexistence of both instruments is justified.

This predominantly relies on the results from standpoints of the literature review and the descriptive stage. From the literature review, guiding assumptions for the interpretation follow insights from Twomey (2012), Lehmann and Gawel (2013) as well as del Río (2017). These related to the justification of policy instruments combination when policy objectives are different as well as when different market failures are being solved by each instrument. Furthermore, stakeholders' perceptions also contribute in the interpretation of the coexistence of the carbon tax and the RES-E support schemes in Colombia.

This thesis finds that national and international factors influence and enable the introduction of mitigation and renewable energy policy instruments in Colombia. At international level related to climate change mitigation, the Paris Agreement enables the National Determined Contribution of Colombia, which considers market-based instruments as important tools to achieve the country's mitigation target, clearly paving a pathway for a carbon tax. Furthermore, the accession of Colombia to the Organization of Economic Cooperation and Development, requires a national environmental management system guaranteeing stringent environmental tax levels that internalize pollution costs, including GHG emissions. Similarly, at international level but related to renewable energy, the Statute of the International Renewable Energy Agency shapes the commitment of the country to the adoption and use of renewable energy sources.

At national level, governmental agencies lead and provide efforts related to including climate change in the political agenda outside the environmental sector. This results in a strengthened cross-sectoral climate change system and a national low-carbon development strategy. Furthermore, these efforts are acknowledged by the Ministry of Finance by including the carbon tax as an instrument to raise revenues within the national structural tax reform. Concatenated to this, Colombia in Peace Fund as a trust created for the post-war period is financing its environmental operations and projects partially with the revenues from the carbon tax. Analogously, but related to renewable energy, Colombia's commitment to the abovementioned IRENA Statute ensues a national law on the promotion of renewable energy sources and their connection to the electricity grid. Consequently, support schemes for electricity generation from renewable sources in the form of financial and fiscal incentives stem from the law.

Low-carbon development usually entails to reduce an economy's GHG intensity while increasing economic development. However, in the context of Colombia's vulnerability to climate extreme events, it also means to secure energy supply, mainly given by the country's dependence on hydropower for electricity. The vulnerability to extreme climate events like droughts, has been further exacerbated by climate phenomena such as El Niño. Nonetheless, this provides an opportunity to subsidize electricity from renewable energy sources differently than hydropower in the form of fiscal and financial incentives. Thus, the main policy objective for renewable energy policy instruments is not GHG reduction but securing energy supply. This specific policy design element of the RES-E support schemes in Colombia suggest its interaction with the carbon tax to be complementary. While both instruments coincide on reducing GHG, each of them aim to solve multiple types of policy objectives. On the one hand, the carbon tax is internalizing the cost of GHG emission, thus contributing to the country's climate change mitigation pledge, promoting industrial efficiency and improving air quality. On the other hand, the RES-E support schemes aim to promote the electricity connection from other renewable sources than hydropower and thus increasing the country's energy security. In addition, the complementarity of both instruments is recognized by stakeholders in Colombia for different reasons. Firstly, while both instruments coincide to reduce GHG in the energy sector, each of them work in different sub-sectors. Secondly, a carbon tax gives a signal to transit from fossil fuel technologies to renewable energy ones. This, at the same time possibly generates a higher use of renewable energy incentives.

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Abbreviations

AFOLU	Agriculture, forestry and land use
BAU	Business-as-Usual
CAC	Command-and-Control
CEECT	Expert Comission on Equity and Tax Competitiveness (Comisión de Expertos para la Equidad y la Competitividad Tributaria)
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent
CONPES	Economic and Social Policy National Council (Consejo Nacional de Política Económica y Social)
DIAN	National Tax and Customs Directorate (Dirección de Impuestos y Aduanas Nacionales)
DNP	National Planning Department (Departamento Nacional de Planeación)
ECDBC	Colombian low carbon development strategy (Estrategia Colombiana de Desarrollo Bajo en Carbono)
ECLAC	Economic Commission for Latin America and the Caribbean
ECPI	Energy and Climate Policy Interactions
ETS	Emission Trading Scheme
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LAC	Latin America and the Caribbean
MADS	Ministry of Environment and Sustainable Development (Ministerio de Ambiente y Desarrollo Sostenible)
MBI	Market-Based instruments
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organization
NIS	National Interconnected System
OECD	Organization for Economic Cooperation and Development
PROURE	Rational and Efficient Energy Use and Non-Conventional energy sources program (Programa de Uso Eficiente y Racional de la Energía y de Fuentes No Convencionales)
R&D	Research and Development
RES	Renewable Energy Sources
RES-E	Electricity generation from renewable energy sources
SISCLIMA	National Climate Change System (Sistema Nacional de Cambio Climático)
TGC	Tradable Green Certificate
UNFCCC	United Nations Framework Convention on Climate Change
UPME	Energy and Mining Planning Unit (Unidad de Planeación Minero Energética)
VAT	Value Added Tax
WTO	World Trade Organization

1 Introduction

The Intergovernmental Panel on Climate Change (IPCC) has announced that warming of the climate system is unequivocal (IPCC, 2014a). The increasing level of greenhouse gases (GHG) in the atmosphere has changed the climate system's temperature and so has the intensity and frequency of climate extreme events such as droughts, floods, cyclones and wildfires (IPCC, 2014a). The main cause of the GHG level increase is economic and population growth. This has attributed climate change responsibility to human society. Therefore, governments along with private sector, civil society and academia have designed and implemented cooperative efforts to pursue a low-carbon development pathway to limit the global temperature increase. For instance, the Paris Agreement signed in 2015, gathered the international community and achieved a multilateral environmental agreement. This strengthened the global response to the threat of climate change by keeping the global temperature from rising well below 2ºC above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5ºC (UNFCCC, 2017).

Governmental efforts to promote the reduction of GHG are an increasing trend (IPCC, 2014b) and are supported by international cooperation (IPCC, 2014a). Mitigation efforts which in 2012 covered 67 percent of global GHG emissions (IPCC, 2014a), take form of legislation, policies, plans, strategies and instruments. Low-carbon policy instrument portfolios are composed mainly by regulatory approaches, economic instruments, information schemes and voluntary agreements (Mundaca & Markandya, 2016). At a global level, the ones that are more widely used are the economic instruments. For instance, 73 percent of the low-carbon policy instruments implemented in Latinamerica and the Caribbean (LAC) correspond to subsidies, loans, tax credits as well as research and development (R&D) (Mundaca & Markandya, 2016).

Colombia is not the exception when it comes to implementing mitigation or renewable energy economic instruments. These, which are also called market-based instruments (MBI), are the national carbon tax which was introduced in 2017 (Congreso de la República, 2016) and the support schemes for electricity generated from renewable energy sources (RES-E) which commenced in 2014 (Congreso de Colombia, 2014). The former belonging to the carbon pricing category and the latter from the renewable energy realm.

There have been several drivers at national and international level that have enabled the design and implementation of these instruments in Colombia. At national level, motivating the carbon tax introduction, several national policy tools have been implemented. These include the Low-Carbon Development Strategy in 2011, National Climate Change System in 2016 and the Climate Change National Policy in 2017. Furthermore, peace process and structural tax reform conjectures, both in 2016, also influenced the enactment of the carbon tax in Colombia. When it comes to the RES-E support schemes, one of the tools that influenced the most its implementation was the Rational and Efficient Use of Energy and Non-Conventional program in 2010 and the Renewable Energy Law in 2014.

At international level, Paris Agreement required Parties to submit their mitigation pledges. Therefore, Colombia presented its Nationally Determined Contribution in 2015. This including economic instruments as means to achieve the country's mitigation target. In addition, Colombia's OECD accession process, entailed a review of the country's environmental policy instruments. This which has held between 2013 and 2014, resulted in the need of implementing environmental taxes with stringent targets. Furthermore, the Statute of the International Renewable Energy Agency signed in 2009 influenced the commitment of Colombia to the adoption and use of renewable energy sources.

Additionally, another factor influences national, sub-national as well as sectoral climate change policies with their correspondent policy instruments, e.g. carbon tax and renewable energy support schemes. This has been the effect that climate extreme events have had in Colombia's population and economy. For instance, La Niña phenomena in 2010-2011 with its high intensity rain allowed harmful flooding which damaged crops and washed out roads. This resulted in 3.2 million people injured and over 7.8 billion USD in damages (Vieira, 2017). On the other extreme, El Niño increased temperatures to a level when food and energy security became affected (Vieira, 2017).

As these two mentioned instruments coexist in Colombia's climate-energy policy package, interactions among them take place (Oikonomou & Jepma, 2008). While these interactions can be mutually reinforcing, they can also work against each other or can be redundant depending on how both instruments are designed and implemented (Hood, 2011). Thus, the justified coexistence of these instruments depends greatly in their design elements interaction. Instrument combinations can be complementary when they address different market imperfections or different targets groups. Instead, overlapping instruments imply flexibility loss and higher administrative costs (Duval, 2008).

1.1 Problem definition

The Organization for Economic Cooperation and Development (OECD) states that carbon pricing should be central in reducing GHG emissions at the least-cost. However, it alone is not sufficient to address other market failures and achieve other environmental, social and economic objectives (OECD, 2013a). Similarly, although renewable energy technologies play an important role in reducing GHG emissions; they alone would not suffice to keep climate change manageable (Philibert, 2011). Therefore, a climate-energy policy mix is justified. Essentially, a carbon price instrument, whether a carbon tax or an ETS, or both, should be combined with an energy efficiency policy, technology development and deployment support (usually renewable energy) (Hood, 2013).

The existence of a broad climate and energy policy instrument portfolio in the European Union (EU) allows an increase in the number of analyses of individual policies. However, it is not the same trend for the interaction evaluation of these policies with each other (Hood, 2013). Interaction evaluations between carbon pricing, RES support schemes and energy efficiency policies are still areas that require further investigation. This relates especially to the mitigation policy instruments and the renewable energy technology deployment (Philibert, 2011). For instance, the interaction between the RES-E support schemes and the EU ETS has been studied and resulted in opposite standpoints. On the one hand, Böhringer & Rosendahl (2011) argue that the interaction of these policy instruments increase the social cost of GHG reduction. On the other hand, Sonnenschein (2016) refutes that mitigation provided by an ETS stand-alone through low-cost abatement measures is not enough to achieve a deep decarbonization.

Climate policy implementations are not common in Latinamerica and the Caribbean (LAC), especially regarding carbon pricing, mainly because climate policy in the region is in its initial stage (Calderón et al., 2016). To illustrate, as of 2017, only three countries in LAC have implemented a carbon tax, i.e. Chile, Colombia and Mexico. While ETS are under consideration in some countries, but have not yet been implemented (World Bank, 2017a). Economic models have been implemented in LAC by Álvarez, Burgos and Sierra (2017). Furthermore, studies in Colombia developed by Álvarez et al. (2017) and Calderón et al. (2016) have sought to analyze the effect of mitigation policy instruments, such as carbon taxes on selected economic sectors e.g. energy. Nevertheless, the interaction evaluation between the carbon tax and the RES-E support schemes in Colombia requires a deeper analysis.

1.2 Aim and research questions

The climate and energy package in Colombia includes the RES-E support schemes and the carbon tax. The thesis essentially aims to understand how these policy instruments complement or overlap with each other through their design elements to understand if their coexistence in the policy mix is justified. It also seeks to explain the perception of different stakeholders regarding the instruments' interaction in Colombia. Ideally, the mix of policies will avoid unnecessary overlap and remove any counteracting incentives which will facilitate effective policy design (World Bank, 2017c). Policy mixes that result in an overlap of instruments should be avoided, however, to identify if they do is not always clear (de Serres, Murtin, & Nicoletti, 2010). To consider how these instruments relate and interact is important in order to create smart climate policy and fiscal policy mixes (World Bank, 2017c) as well as to ensure the cost-effectiveness of such policy package as a whole (OECD, 2013a). Incoherent policy packages that lead to duplication or negative interactions will raise costs and face resistance (Vivid Economics, 2016). Identifying areas of overlap and duplication as well as understanding how to manage policy interactions can improve a country's climate and energy policy mix (Hood, 2013). For instance, by advancing synergies and complementarities between energy and climate objectives. Three research questions guide this thesis to achieve its main objective. These are presented subsequently:

Research question 1: What national and international factors have influenced the design and implementation of the carbon tax and the RES-E support schemes in Colombia?

Research question 2: How do the policy instrument design elements of the Colombian carbon tax and the RES-E support schemes interact?

> *Research sub-question 2.1:* How does the interaction between the design elements of the carbon tax and the RES-E support schemes justify or not their coexistence in Colombia's climate-energy policy mix?

Research question 3: How do different stakeholders perceive the interaction between the RES-E support schemes and the carbon tax?

1.3 Scope and limitations

This thesis firstly, analyzed the case of Colombia. Secondly, while the climate-energy policy mix in the country is broader than the carbon tax and the RES-E support schemes, this thesis only analyzed the interaction of these two instruments. Thirdly, the analysis was performed after both policies had already been implemented. However, as it will be pointed out in further research an interaction analysis is highly encouraged to be developed ex-ante. For instance, when a policy instrument is under design and will be added to the climate policy mix. Finally, while there are quantitative, qualitative and hybrid approaches for the evaluation of energy and climate policy interactions (Spyridaki & Flamos, 2014), this thesis mainly used a qualitative method. In addition, this thesis lacks an environmental effectiveness and economic efficiency evaluation. This limitation is related to the recent introduction of the carbon tax (January 2017) which suggests that yearly data (even for only one year) is not available yet. While the coexistence justification of both instruments can be analyzed through the analysis of all their design elements, this thesis focused on the design element related to policy instruments' objectives.

1.4 Ethical considerations

Primary data relied on semi-structured interviews from representatives of different institutions. These included governmental, international, consultancies and non-governmental organizations. Most views were expressed from a personal point of view and did not necessarily

represent the position of a given institution. As a result, insights while included mainly in the findings sections, remain anonymous without a direct quote. In addition, it was shared with the interviewees that the gathered information had academic purposes only. Recording consent was asked before every interview and transcriptions were merely used for the thesis' author coding procedure. If the reader would like to obtain the source of a specific idea within the thesis that is not explicitly referenced, please contact the author (mis15dgu@student.lu.se).

1.5 Audience

The main audience for this thesis are policy-makers working in the design, formulation, implementation and evaluation of climate change and renewable energy areas in Colombia as well as in Latin America and the Caribbean. With the analysis of the interaction between two of the instruments related to carbon pricing and renewable energy, the thesis aims to highlight the importance of knowing the instruments' design areas as well as their interactions to avoid overlaps and promote their complementarity. In addition, further research is presented to advance from a qualitative analysis to a policy interaction evaluation not only to an ex-post stage but also in an ex-ante evaluation for instruments currently under design such as the ETS in Colombia.

1.6 Outline

This thesis presents an analysis of the interaction between the carbon tax and the RES-E support schemes in Colombia. It discusses how complementary or overlapping they are among each other through their design elements. In addition, it reviews if the coexistence of both instruments is justified in Colombia's climate-energy policy mix. Furthermore, it provides information on the political economy of both instruments as well as the perception of stakeholders. The thesis is structured as follows:

Chapter 2 introduces the literature review performed to comprehensively and analytically review the interaction between carbon pricing and renewable energy instruments, specifically the carbon tax with the RES-E support schemes.

Chapter 3 presents the research design of the thesis. This includes setting the thesis as a within-case study, its methodology and methods used.

Chapter 4 presents the findings of the thesis, ranging from the political economy of both instruments, their nature and description, comparison of their design areas as well as the perceptions of several stakeholders.

Chapter 5 provides the analysis aiming to categorize the instruments as complementary or overlapping. In addition, it reviews if the coexistence of the carbon tax and the RES-E support schemes is justified in Colombia's climate-energy policy mix.

Chapter 6 presents the conclusions.

Chapter 7 provides the reader with further research inspired by the thesis development.

2 Literature review

The notion that a robust climate-energy package is needed has increased the global trend of combining policy instruments of this type (Oikonomou et al., 2010). For instance, del Río (2010) presents that a complex policy portfolio including ETS, carbon taxes, RES-E support schemes, energy-efficiency standards and voluntary agreements, has been introduced in the EU to reduce GHG emissions and secure energy supply. Likewise, in Colombia, RES-E support schemes have been in place since 2014 (Congreso de Colombia, 2014), a carbon tax has been recently introduced in 2017 (Congreso de la República, 2016) and an ETS is currently being designed (Minambiente, 2017).

The analysis of instruments stand-alone is important to understand if they are being effective and efficient. However, del Río (2010) states that policy instruments' combination raises concerns about potential overlaps, conflicts or synergies in their interaction. Likewise, Oikonomou and Jepma (2008) as well as Sorrel et al. (2003) indicate that policy instruments' interaction can be complementary and mutually reinforcing, but there is also a risk that different policy instruments will interfere with one another and weaken the objectives and credibility of each other. Similarly, Duval (2008) exposes that there are risks of poorly-designed policy mixes resulting in cost-effectiveness and environmental integrity decrease. Fais et al. (2015) state that this has increased the attention to policy interaction and coordination. Thus, evaluations and analyses of policy instruments combinations have been developed.

One of the most studied pair-wise policy interaction has been the one between the ETS and the RES-E support schemes. Shahnazari et al. (2017) defend that social cost of reducing GHG increases when a renewable energy support scheme is combined with a carbon pricing instrument. This is, the social cost could be lower when a carbon price is used as a stand-alone instrument. Twomey (2012) explains that this argument is often demonstrated through a carbon abatement curve where additional policies (renewable energy subsidies) may only result in resources being pushed towards more expensive abatement options and displacing lower-cost ones.

Similarly, Böhringer & Rosendahl (2011) argue that supplementing an ETS with a RES-E support scheme would likely increase the overall cost of the emissions cap. A green quota would influence the technology mix by inducing excessive abatement from renewables and too little abatement from additional mitigation options, for instance, fuel-switching or energy efficiency improvements. However, as pointed out by Sonnenschein (2016), mitigation provided by an ETS through low-cost abatement measures is not enough to achieve a deep decarbonization. Thus, the reduction cost of RES technologies which are generally more expensive is essential to accelerate GHG reduction. Further, Sonnenschein (2016) emphasizes that delaying the deployment of RES-E technology will increase the cost of reaching long-term GHG reduction targets. Similarly, Philibert (2011) states that immediate CO_2 reductions driven by the early deployment of renewable energy may cost more than other options in the short-term, but will reduce the costs of mitigating climate change in the future. Furthermore, del Río (2017) claims that additional costs of CO_2 mitigation resulting from the combination of targets and instruments could be interpreted as the costs of achieving non-CO_2 goals added to the dynamic efficiency benefits of RES-E deployment. Therefore, he argues not to focus on the costs of achieving one goals in the presence of one market failure. Instead, to contemplate the costs of attaining different goals simultaneously, considering that there are several market failures (del Río, 2017). This also means that the interaction may result in higher compliance costs related to the mitigation target but not necessarily to higher costs to reach all goals jointly.

Böhringer and Rosendahl (2010, 2011) argue that if an emission cap was binding, the green quota would not affect GHG. Instead, the CO_2 allowances price would fall and benefit CO_2

emission intensive power plants harming low and zero carbon sources. Differing from this view, del Río (2014) argues that if RES-E and CO_2 targets are coordinated, CO_2 prices do not necessarily have to be lower. In addition, he states that with a carbon tax, the RES-E support schemes deployment does not affect the carbon price or tax rate.

Moreover, del Río (2014) as well as Lehmann and Gawel (2013) stress that attention to the environmental benefits aside from CO_2 reduction objective by RES-E support needs to be held. Lehmann and Gawel (2013) emphasize that along a CO_2 reduction aim, additional objectives like energy supply security and industrial policy support provide a rationale for implementing RES-E support schemes in addition to a carbon pricing instrument. First, non-renewable energy sources as oil or coal cause ecological impacts, thus, introducing RES generate environmental benefits aside from GHG emission reduction. Second, energy supply security supplemented by RES increases the variety of domestic energy sources decreasing dependency on energy imports. Third, small and medium enterprises as well as independent electricity producers might be benefited by RES-E support schemes.

Furthermore, Hood (2013) states that there is not one single solution, as there are many individual barriers to a transition to clean energy systems. Similarly, Sonnenschein (2016) adds that an ETS stand-alone does not address the entry barriers to energy markets. For instance, oligopolies in power generation and distribution, absence of experience in RES-E technology financing, missing standards or lack of information. This last barrier is also mentioned by Twomey (2012), however, in this case, he advocates for the need of an additional information instrument in combination with a carbon price.

Tinbergen (1952) presents that multiple market failures require multiple policy instruments. Also, that the number of targets must equal the number of instruments (del Río, 2017).In addition, OECD (2013a) exposes that no single policy instrument can achieve a mitigation target at a reasonable cost. Delbeke and Vis (2016) attest this adding that mitigation occur across a multitude of sectors and activities. Therefore, the implementation of a robust climate-energy instrument mix[1] potentially including carbon pricing instruments, renewable energy subsidies, energy efficiency standards, to mention a few, is justified (World Bank, 2017c). In this same line, Hood (2011, 2013) considers that an appropriate cost-effective policy package, while country and region-specific, will be compound by energy efficiency policies, RES support schemes (including R&D) and a carbon price policy instrument, as shown in Annex 5.

Besides, Duval (2008) as well as Fischer and Newell (2008) advocate that the multiplicity of market failures to be addressed, including environmental externalities generated by GHG emissions, imperfect information and innovation and diffusion failures, makes it unlikely that cost-effective climate mitigation can be achieved through a single policy instrument. Similarly, Fankhauser et al. (2010) as well as Fischer and Newell (2008) review that a variety of models suggest that in presence of multiple market failures, a portfolio of policies to reduce emissions is more optimal than a single policy. In addition, it will achieve results at a significantly lower social cost.

In this same stream, Lehmann and Gawel (2013) state that the existence of two market failures justifies adding an RES-E support scheme to an ETS. These are the externalities caused from GHG emissions and knowledge generation. The second, also known as knowledge spillover, refers to the new knowledge produced through innovation by one firm that spills to other firms.

[1] Annex 6 presents a mitigation and RES-E policy instrument portfolio including both regulations and MBIs (quantity and price-based).

Lehmann and Gawel (2013) imply that the EU ETS which is designed to correct externalities from CO_2 emissions, stand-alone won't be enough to induce technological change. Along with Twomey (2012) they support that in the existence of knowledge spillovers, a policy combination which includes a RES-E support schemes is justified. Likewise, Sonnenschein (2016) emphasizes that an ETS alone is not cost-effective because it does not capture positive externalities resulting from knowledge spill-overs.

Besides, Lehmann & Gawel (2013) stress that adding RES-E support schemes, as second-best policy, is justifiable because the external costs of non-renewable energy sources are not internalized completely. Aside from GHG emissions, non-renewable energy sources generate additional external costs. For instance, ecological impacts produced oil spills in offshore platforms or open cast mining for coal. In addition, nuclear energy can cause possible future accidents and the final storage of its waste generates externalities. Moreover, energy supply security can be affected when natural gas or oil are imported from politically unstable countries.

Moving on to an additional policy instrument combination, Oikonomou et al. (2014) suggest that feed-in tariffs combined with subsidies for energy efficiency and labelling in building generate an added value than the performance of each instrument stand-alone. Also, a carbon tax with subsidies for energy efficiency and labelling in buildings present a positive added value creation. Furthermore, another interaction that was found to be positive is given by the tradable green certificates (TGC) and subsidies for energy efficiency and labelling in buildings. This indicates that RES-E support schemes (feed-in tariffs and TGC) and energy efficiency instruments combination generate an important added value. This compared to the cases were these instruments are implemented as stand-alone instruments in the market. However, Oikonomou et al. (2010) suggest that added value creation is provided by energy efficiency subsidies instead of other policy instruments. Oikonomou et al. (2010) presents that most interactions of the five policy instruments studied seem to generate small or no added value than the case of applying these instruments stand-alone in the market. Positive interactions were only found in the case of energy efficiency subsidies with the remaining instruments. Specifically, these can be better combined with labelling for energy efficiency in buildings and carbon taxes.

In addition, Oikonomou et al. (2012) analyze the interaction of two RES-E support schemes, i.e. the TGC and feed-in tariffs. When comparing these instruments among their design elements they are overall complementary in terms of their targets and obligated entities. This is, the TGC targets primary energy whereas the feed-in tariff targets final energy. Also, the obligated entity in the TGC is industry unlike the feed-in tariff in which the energy supplier is the obligated entity. However, they present overlaps in terms of costs, technologies and market applicability. Further, when evaluating their interaction, Oikonomou et al. (2012) suggest that integrating a TGC with a quota obligation to producers with feed-in tariffs for energy suppliers might not be the optimal solution. This in comparison to the implementation of both instruments stand-alone. Nonetheless, this study focused in the Netherlands and the authors pledge that the results must not be considered blueprint for all countries.

Fais et al. (2015), Görlach (2013), Mickwitz (2003) as well as Oikonomou and Jepma (2008) pledge that evaluation of policy interaction often comprise criteria such as effectiveness, efficiency and political feasibility. However, del Río (2014) argues that analysis of the interaction between a pair of policy instruments should be often developed through their design elements. Essentially, design elements are characteristics of policy instruments that are suitable to interact. These have been defined by Leal Filho (2011) as parameters within a policy instrument. Furthermore, del Río (2017) argues that discussion related to the climate and energy package often takes place at a very abstract level, leaving out specific instruments and design elements.

For instance, the interaction between ETS and RES-E support schemes, according to del Río (2017) is mediated by the choice of instruments and by different design elements within specific instruments. Leal Filho (2011) as well as Oikonomou et al. (2010, 2014) classify design elements into measure identification, objectives, target groups, market, financing and institutional setup. These will be defined in Chapter 3.

There are several ways to classify design elements interaction. According to Konidari and Mavrakis (2007) as well as OECD (2007), interaction between policies can be classified into positive or negative. OECD classifies as positive the interactions that occur between instruments when one of them provides information, stimulates innovation, addresses split incentives, limits monitoring and enforcement costs and reduces compliance-cost uncertainty. On the other hand, negative interactions among instruments take place when there are different approaches at different administrative levels and redundancies (OECD, 2007). Moreover, del Río (2014) proposes to analyze interactions ranging from strong and weak conflict, full complementarity to synergy. Furthermore, Sorrel et al. (2003), distinguishes five types of interaction: direct, indirect, operational, sequencing and trading.

An additional classification is presented by Oikonomou et al. (2010, 2014, 2012). They propose to classify interactions between policy instrument design elements as overlapping, complementary or indifferent. In these studies, if the interactions carry over positive impacts on the policy mix, they are considered complementary; on the contrary if they reduce the overall effects that each instrument stand-alone could generate in the market in achieving their objectives, they are considered overlapping and if a design element is not influencing the same design element of the second policy instrument, they are considered indifferent.

The report on State and Trends of Carbon Pricing 2016 by World Bank et al. (2016), changes indifferent for countervailing but considers as well complementarity and overlapping on their classification. Complementary, in this report, is given when policy instruments work together to produce desired outcomes. On the other hand, overlapping policy instruments are those that share objectives but may be redundant. However, the focus in this report is mainly devoted to the interaction of other policy instruments with carbon pricing instruments. This means if the carbon price signal is reinforced by another policy instrument. Thus, interaction is merely being analyzed upon the influence of an additional policy instrument to the carbon signal provided by a tax or an ETS.

3 Research design

This chapter aims to contextualize the reader with the research design by explaining the methodology as well as the methods developed in the thesis. Section 3.1 presents the thesis as a within-case study. Then, Section 3.2 explains the methodology that was used to answer the research questions mentioned above. Finally, Section 3.3 includes data creation, collection and analysis methods developed during the research process.

3.1 Within-case study about climate and energy policy instruments interaction in Colombia

The approach selected to analyze the interaction between the carbon tax and the RES-E support schemes in Colombia was the case study, specifically the within-case study. Accordingly, defined boundaries were set in order to develop an in-depth, intensive, comprehensive and detailed exploration of the case study (6 & Bellamy, 2012; Bryman, 2016; Willig, 2013). From the climate-energy policy instruments portfolio, two were selected to analyze their interaction, specifically upon the design of these type of instruments in Colombia. This is one of the main characteristics of case study research, that it allows to study interactions between factors (6 & Bellamy, 2012), in this case the policy instrument's design elements.

Design elements of carbon taxes and RES-E support schemes vary from one country to another. Hence, the results from the case study developed for Colombia can only be generalized if the policy instruments analyzed in another country comply with the same characteristics in their design elements, resembling the typicality of this thesis. This is the main limitation of case studies, their results are very particular and their relevance to other contexts may be unclear (6 & Bellamy, 2012). However, the possibility of developing theory from case studies should not be disregarded.

From the possible features of case study research described by Willig (2013), this thesis used the triangulation as the main one. Therefore, as highlighted by Brannen et al. (2008), the case study integrates information from a variety of sources. Governmental entities and international organizations were interviewed to obtain an in-depth understanding of the interaction between the carbon tax and the RES-E support schemes in Colombia in addition to the literature review. Triangulation sources are explained in Sections 3.3.1 and 3.3.2. These enriched the case study as they provided information from different perspectives (6 & Bellamy, 2012; Willig, 2013).

3.2 Methodology

Providing inferences about the coexistence of the carbon tax and the RES-E support schemes in Colombia was possible through the implementation of the methodology, which is compound by a descriptive and an interpretive stage. These are explained in Sections 3.2.1 and 3.2.2, respectively. Overall, the qualitative methodology aimed to conduct a policy instrument mapping to better understand the pressure points between both instruments (Vivid Economics, 2016). This allowed to identify their overlapping or complementary nature in their design elements, which lead to the generation of inferences of their justified coexistence in the policy mix of Colombia.

3.2.1 Descriptive stage

This stage of the thesis entailed firstly on providing a background of the political economy of both instruments, which answered research question 1. Secondly, the descriptive stage consisted on applying the first two steps of the Energy and Climate Policy Interactions (ECPI) decision tool. This solved research question 2. ECPI applies a qualitative framework for analyzing the interaction among policy instruments (Oikonomou et al., 2012). It is mainly for policy mixes

instead of pairwise combinations, however, the author has partially applied the methodology to the interaction between two policy instruments in Colombia, i.e. the carbon tax and the RES-E support schemes.

The steps belonging to the ECPI framework were to elaborate a database of the policy instruments and compare their design elements. The first steps meant to describe the policy instruments to understand their nature. After this, next step was to compare both policy instruments in six main design elements: measure identification, objectives, target groups, market, financing and institutional setup (Oikonomou et al., 2010, 2014). Table 1 presents them with their components and definitions.

Table 1. Design elements, its main components and definitions. Source: Own elaboration from Oikonomou et al. (2010, 2012,2014) and Leal Filho (2011)

Design element	***Key components***	**Definition**
Measure identification	Measure type	Refers to the category of policy instrument e.g. carbon tax, ETS, RES-E support scheme
	Application in the market	The option for a policy target group to participate or not in the instrument's objective accomplishment (mandatory or voluntary)
	Scope	Classifies the instrument into national or international
Objectives	Nature of targets	General objective of a policy translated into targets in different ambient levels e.g. promote renewable energy, GHG reduction or increase energy efficiency
	Level of targets	Classify the instrument's target into low or high stringency
	Energy/environmental goals	Very much related to the nature of targets, this element catalogues the instrument into energy or environmental oriented.
	Type of energy	Describes which category of energy the instrument is addressing: primary or final energy. Targeting sources of energy leads to a substitution effect and hence to cleaner production, while targeting final energy stimulates energy efficiency and reduction of energy use.
Target groups	Obligated entities	Refers to the market agent that participates in the fulfilment of the target, distinguished into energy producers, energy suppliers, industry or consumers
Market	Trading commodity	Type of commodity generated, exchanged and traded e.g. emissions allowances, WhC, TGC.
Financing	Cost recovery	The way the target group recovers induced policy costs. There is partial, full or no cost recovery and it is determined by the market's structure and market's liberalization degree.
Institutional setup	Body for setting up the scheme	Entities that design, set the rules for the implementation, monitor, verify the eligibility for

	Body for administering the scheme	target fulfilment, register all actions of a policy instrument.
	Body for verification	
	Body for registration	
	Body for accounting	

The comparison of design elements resulted in complementary or overlapping depending on the design element analyzed. For instance, instrument combinations were complementary when they addressed different market imperfections or different targets groups (Duval, 2008). In other words, policies overlap if they address similar market failures and affect directly or indirectly the same target groups (Duval, 2008). Furthermore, instruments overlapped when the same emissions source (individuals, firms, public administrations) where covered by both instruments (de Serres et al., 2010) or when the combination of both instruments implied higher administrative costs (Duval, 2008).

Design elements are parameters within a policy instrument as presented in the literature review. Essentially, design elements are key characteristics of policy instruments that are suited to interact. As mentioned in the literature review, often discussions about energy and climate policy mix have taken place at a very abstract level, without considering specific instruments and design elements (del Río, 2017). However, the interaction between instruments is facilitated by different design elements within them. Therefore, it was relevant to understand how the design elements of the carbon tax and the RES-E support schemes in Colombia interact with each other to analyze if the coexistence of both instruments is justified. Thus, the descriptive stage of the thesis provided the main body for Chapter 4.

3.2.1 Interpretive stage

With the purpose of answering research sub-question 2.1, an interpretive analysis was performed to understand if the coexistence of both instruments is justified. This predominantly relied on the arguments from the literature review in Chapter 2 and the descriptive stage in Chapter 4. From the literature review, guiding assumptions for the interpretation followed insights from Twomey (2012), Lehmann and Gawel (2013) as well as del Río (2017).

First, Twomey (2012) argued that low-carbon activities or technologies may be promoted for social objective different than emissions reduction. For instance, supporting renewable energy is justified since it contributes to the creation of green jobs and exporting benefits from international leadership in emerging technologies. Furthermore, investing in domestic renewable energy provides greater energy security. He also states that is important to acknowledge that an instrument combination entailing a carbon pricing and renewable energy instrument belong to a climate-industrial-energy-security realm instead of a pure climate policy (Twomey, 2012).

Second, Lehmann and Gawel (2013), claimed that the existence of multiple policy objectives might provide a further, political rationale for implementing RES-E support schemes next to a carbon pricing instrument e.g. EU ETS. For instance, they mention that an autonomous RES-E deployment target politically set justifies its existence in the policy mix along with an emission policy instrument. Moreover, they stated that using RES-E may also provide environmental benefits apart from GHG reduction like air pollution reduction from fossil fuel combustion and conservation of non-renewable resources. Additionally, in some countries RES-E promotion suggest substituting oil and natural gas imports from unstable countries. Thus, RES-E support increases the variety of available domestic energy sources (Lehmann & Gawel, 2013). Furthermore, Lehmann and Gawel (2013) claimed that RES-E support schemes have been

identified to benefit small and medium-sized independent electricity producers. Thus, they have been considered as an effective tool of industry policy.

Third, del Río (2017) stated that policy mixes can be justified to account for the coexistence of different market failures to achieve certain policy goals. He recalls what was claimed by Tinbergen (1952): "more targets than instruments make targets incompatible. More instruments than targets make instruments alternative". Furthermore, del Río (2017) emphasized that often, policy-makers have other goals apart from CO_2 mitigation. For instance, in the climate and energy realm, other goals involve security of energy supply (diversification of energy sources), energy affordability, job and industry creation as well as regional development. While carbon pricing instruments such as an ETS and RES-E support schemes share one common goal, i.e. CO_2 emissions reductions, RES-E support schemes contribute to other goals in addition to CO2 mitigation. However, these are not usually included in marginal abatement curves. Moreover, del Río (2017) concluded that combinations of instruments may be justified if they address different goals. This is, if the existence of several goals cannot be achieved by only one instrument.

Furthermore, stakeholders' perceptions in Section 4.5 also contributed in the interpretation of the coexistence of the carbon tax and the RES-E support schemes in Colombia. Results from the interpretive stage can be found in Chapter 5.

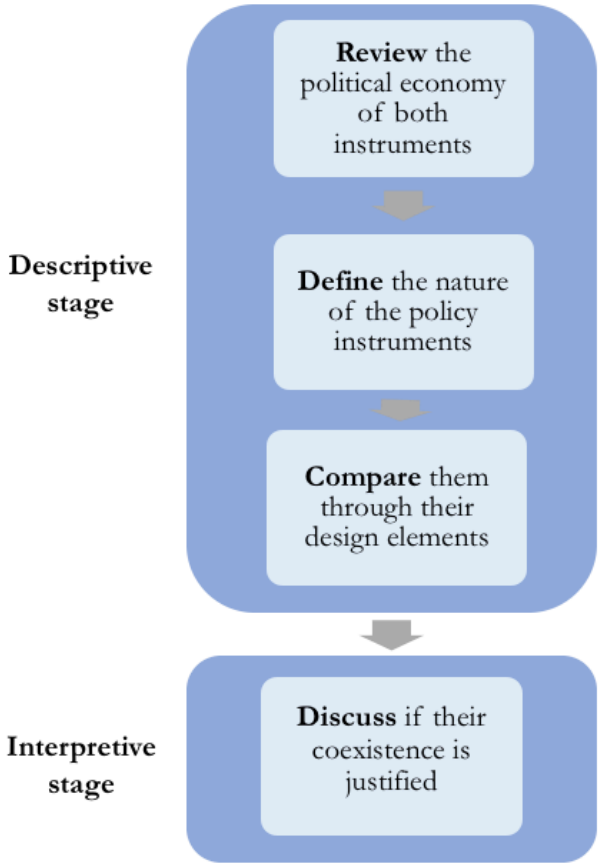


Figure 1. Main steps of the methodology. Source: Own elaboration

3.3 Methods

This section aims to explain to the reader which set of techniques, specific strategies or procedures were implemented to create, collect and analyze data in this thesis. Section 3.3.1 explains data creation methods, Section 3.3.2 data collection methods and Section 3.3.3 data analysis method.

3.3.1 Data creation method

Data creation methods include ethnographic or participant observation, focus groups, individual interviews and questionnaire surveys (6 & Bellamy, 2012). In this thesis, the method of individual semi-structured interviews was performed. Semi-structured interviews are used to produce the raw material of research, namely well-structured data or sets of information that can be used to perform further investigations or the content analysis. They consist in asking questions and prompting conversation to obtain unique information and understanding of a social phenomenon (Stake, 2010; Walliman, 2006). They contain structured and unstructured sections with standardized and open-format questions (Walliman, 2006). Interviews were audio-recorded (when the interviewees agreed to) aiming to retain a full, uninterpreted record of what was mentioned in the interview and then were transcribed. This allowed further on to perform the content analysis through the coding method which will be explained in Section 3.3.3.

Semi-structured interviews were conducted to Colombian policy-makers, International Organizations and Non-Governmental Organizations (NGOs) to better understand the interactions between climate and energy policies in Colombia, specifically the carbon tax and the RES-E support schemes. Representatives from the following institutions were interviewed: Ministry of Environment and Sustainable Development, Ministry of Energy and Mining, National Planning Department, Mining and Energy Planning Unit, Interamerican Development Bank, World Bank, Enterprise Environmental Corporation and World Wildlife Fund. The complete list of interviewees with their roles and date of interview can be found in Annex 1. The list of questions asked during the interviews while not the same for each interviewee can be found in Annex 2.

3.3.2 Data collection method

Literature review is a procedure for capturing what is important for answering the research question from the data that have been created (6 & Bellamy, 2012). In this thesis, a comprehensive literature review was conducted through the collection of data related to climate mitigation and renewable energy policy instruments interaction. As recommended by Stake (2010) the literature review included scientific and peer-reviewed journals, governmental and institutional reports as well as conference presentations. The main search engine utilized to accede journal articles and institutional reports was LUBsearch powered by EBSCO *host*. The main search words were: "Combination"; "Interaction"; "Carbon tax", "Carbon pricing", "Renewable energy", "Climate policy instruments"; "Policy alignment". In contrast, information about Colombia was mainly acceded through governmental websites. This search included the following words "Carbon tax in Colombia"; "Renewable energy incentives"; "Low-Carbon Development Strategy".

3.3.3 Data analysis method

Content analysis

With the purpose of identifying key analysis elements generated in the semi-structured interviews a content analysis was performed. This is a procedure for manipulating data so that the research question can be answered, usually by identifying important codes and patterns. Qualitative analysis techniques involve open-ended content analysis (6 & Bellamy, 2012). This

is a method that allows the organization, identification and detailed analysis of the information. Which also generates a cautious interpretation of collected information and allowing result inferences according to the studied phenomenon (Braun & Clarke, 2006).

Content analysis requires a method of pulling together the coded information in more compact and meaningful groupings (Walliman, 2006). Codes are labels or tags used to allocate units of meaning to collected data. Coding helps to organize piles of data in the form of notes, observations, transcripts and documents and provides a first step to conceptualization (Walliman, 2006). The coding procedure reduces the data into smaller and analytical units functioning as themes, causes or explanations (Walliman, 2006).

After transcribing the interviews, an open-coding process was developed per each interview. After the emergent codes were listed, the common ones were merged into sub-themes. After this, the procedure was repeated with sub-themes and final themes were identified. Figure 2 presents the themes identified as well as the sub-themes. Emergent codes related to the sub-themes can be found in Annex 3.

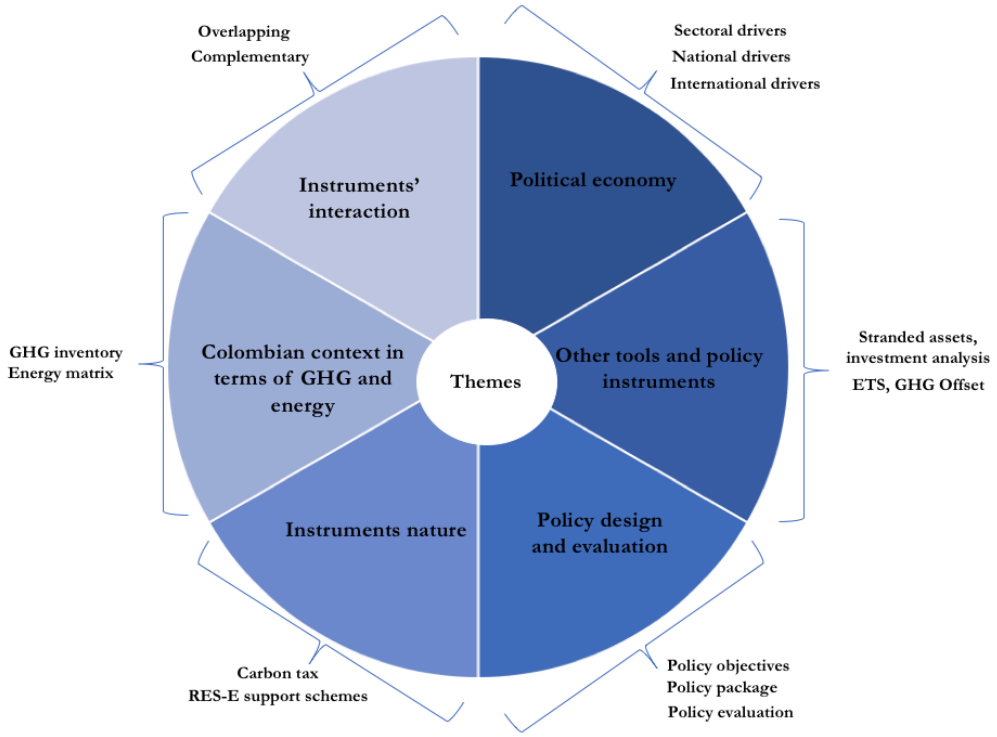


Figure 2. Themes and sub-themes identified in the coding process. Source: Own elaboration

4 Findings

This chapter presents the findings of the thesis as follows: Section 4.1 introduces the political economy of both instruments at national and international level, Section 4.2 presents the carbon tax, Section 4.3 introduces the RES-E support schemes, Section 4.4 presents the comparison of both instruments design elements. Finally, Section 4.5 presents the perceptions of the stakeholders involved in the interviews process in relation to the themes that were presented in Figure 2.

4.1 Political economy of the carbon tax and RES-E support schemes in Colombia

There had been several drivers at international as well as national level which have supported the mitigation and renewable energy policy instruments introduction in Colombia. Specifically, the carbon tax and RES-E support schemes. The following section aims to provide information on the enablers of these two main MBI at international (Section 4.1.1) and national level (Section 4.1.2).

4.1.1 International context

OECD accession process

Colombia started its accession process to the OECD in 2013 as the reflection of the country's commitment to enhance its public policies and economic performance (OECD, 2013b). For instance, this process has entailed several reviews by the OECD expert committees which had recommended best practices as well as identified areas for further reforms. Usually, OECD member countries have used the accession process to improve regulations, address emerging policy challenges and promote reforms (OECD, 2013b). Several OECD committees have engaged with Colombian governmental officials in areas such as international business transactions, corporate governance, financial markets. Also, insurance and private pensions, taxes, environment, chemicals, public governance, regulatory policy, education, employment, labor and social affairs, health, fisheries, science, technology and consumer policy (OECD, 2013b).

In the environmental realm, the OECD presented in 2014, recommendations which included making green growth a central pillar of the 2014-2018 National Development Plan, promoting greater use of environmentally related taxes and phasing out environmentally harmful subsidies and tax exemptions. It also recommended to strengthen the environmental management system, better managing the environmental impacts of mining and strengthening the environmental information system (OECD/ECLAC, 2014). In addition, the OECD Environment Policy Committee presented as a core principle for the technical accession, the promotion of the use of economic instruments to improve allocation and efficient use of natural resources and better reflect the social costs of resource use, waste and pollution (OECD/ECLAC, 2014). There was presented a specific one which aimed to assess the extension of environmentally related taxes such as restructuring fuel and vehicle taxes to take account of their contribution to GHG emissions and local air pollutants. In addition, removing tax exemptions on transport fuel and on mining and oil exploration, introducing excise duties on energy products used for stationary purposes and taxing agrochemicals (OECD/ECLAC, 2014).

Paris Agreement and the Nationally Determined Contribution

Colombia, as a Party to the UNFCCC, approved the Paris Agreement on July 2017 through the Law 1844 of 2017 (Congreso de la República, 2017). This global Agreement signed in 2015, gathered the international community and achieved a multilateral environmental agreement.

This strengthened the global response to the threat of climate change by keeping the global temperature rise well below 2ºC above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5ºC (UNFCCC, 2017). Law 1844 of 2017 mentions the Nationally Determined Contribution (NDC) presented by Government of Colombia in 2015 to the international community. Colombia's NDC, as required by the Agreement communicates the country's mitigation target. Through its NDC, as shown in Figure 3, the country set a unilateral mitigation target which aims to reduce its GHG 20 percent by 2030 with respect to the Business-as-Usual (BAU) scenario (Gobierno de Colombia, 2015).

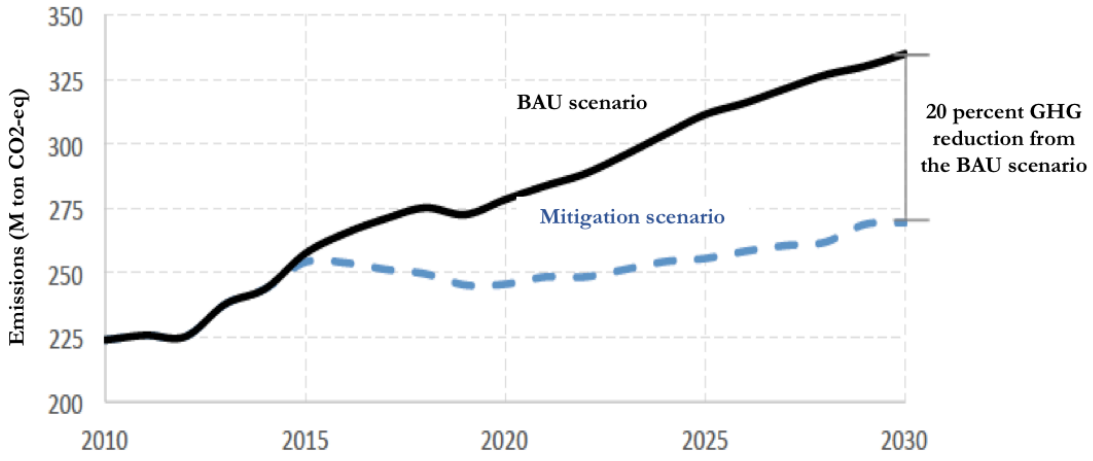


Figure 3.Mitigation scenario as of Colombia's NDC commitment. Source: Gobierno de Colombia (2015)

This target has been set even when Colombia contributes with 0.46 percent to the global GHG for 2010. While this percentage can be considered relatively low, projections suggest that if emissions continue with the current trend, in 2030 the emissions in Colombia would increase by 50 percent and would continue to grow in following years (Congreso de la República, 2017).

Colombia has pledged, through its NDC, that the country will reduce its GHG emissions by 20 percent by 2030 and that to do so the country will explore the use of economic instruments (Gobierno de Colombia, 2015). In addition, the NDC makes explicit that to achieve the 2014-2018 National Development Plan's (NDP) main pillars: Peace, equity and education, the country must identify and take advantage of the national economy's diverse sectors, its opportunities to increase its competitiveness and productivity. This at the same time, reducing its GHG emissions (Gobierno de Colombia, 2015). The NDC submission signified the government's commitment to its low-carbon and green growth agenda, but also represented a steady responsibility with the international community, as the Paris Agreement required Parties to submit their best mitigation efforts.

Furthermore, Colombia is an active member of the NDC global partnership. The NDC partnership was launched in 2016, during the Conference of the Parties held in Marrakesh. Its main aim is to enhance cooperation in the sense that countries (members) have access to technical knowledge and financial support. This, to achieve long-term and large-scale climate targets in an effective manner. The partnership works by building in-country capacity and increases knowledge sharing (NDC, 2017). Therefore, the in-country engagement provides Colombia with technical assistance to develop and implement robust climate and development

plans (NDC, 2017). Moreover, this support ranges from NDC strategy formulation and implementation to leveraging and mobilizing resources (NDC, 2017)

Statute of the International Renewable Energy Agency (IRENA)

Colombia became a Party to the Statute of the International Renewable Energy Agency (IRENA) by approving Law 1665 in 2013 (Congreso de la República, 2013). This entailed the acknowledgement and commitment of the country in relation to the adoption and use of renewable energy. It indicated its assurance of the opportunities offered by renewable energy for addressing and alleviating issues like energy security and volatile energy prices (IRENA, 2009). Furthermore, by approving the Statute, Colombia recognized the important role of renewable energy in the transition to a low carbon economy by reducing GHG emissions to the atmosphere (IRENA, 2009).

One of the reasons advocated to ratify IRENA Statute in Colombia was mainly the vulnerability of electricity generation sector to climate change impacts. This considering that 71 percent of electricity in Colombia is generated by hydropower. Consequently, the country's energy security is threatened when extreme climate events as droughts occur (Congreso de la República, 2013). Furthermore, the Congress pledged that renewable energy use would contribute to plenty of environmental benefits. First, GHG reductions would occur, contributing to climate change mitigation. Second, the pressure on water resources would decrease. Third, they would represent an alternative to avoid ecosystem destruction caused by large-scale hydropower (Congreso de la República, 2013).

Ratifying IRENA's Statute influenced Colombia's pathway on setting a renewable energy target as well as enacting a renewable energy law. Establishing a renewable energy target gives a trajectory for the future evolution of the energy mix and points out the level of renewable energy development and timeline envisioned by governments (IRENA, 2015). By definition a renewable energy target is "a numerical goal established by governments to achieve a specific amount of renewable energy production or consumption" (IRENA, 2015). In the case of Colombia, this means to produce 6.5 percent of electricity by 2020, excluding large hydropower. Similarly, enacting a renewable energy policy or law provides a legitimate framework with the enabling conditions for the development of renewable energy sources (IRENA, 2015). Moreover, as it will be explained further on, renewable energy incentives stem from the national law on renewable energy. These, which belong to the fiscal incentive category are often used in the electricity sector of Latin American countries, along with auctions (IRENA, 2015).

4.1.2 National context

National Climate Change Policy

The National Climate Change Policy was launched in mid-June 2017. Its main objective is to embed climate change management into public and private decisions. This to progress in a low-carbon and resilient pathway that decreases climate change related risks and take advantage of opportunities created by climate change (Murillo et al., 2017). Furthermore, the policy intention is to turn Colombia into a carbon-neutral country in the long-term. To achieve this, the policy has established four specific objectives. First, to guide climate change management into the realm of priority development areas. Second, direct climate change management towards the conservation of ecosystems and its services. This would ultimately decrease population and economic activities vulnerability. Third, create enabling conditions related to science, technology, information and innovation to increase resilient and low-carbon pathways. Finally, to generate institutional changes with the aim of increasing climate change management effectiveness (Murillo et al., 2017).

Considering the policy's main aim and specific objectives, the government has proposed a set of five territorial and sectoral strategies along with instrumental guidelines. The territorial and sectoral strategies are: low-carbon and climate resilient urban and rural development, ecosystems management, low-carbon energy development and low-carbon strategic infrastructure. On the other hand, the four instrumental guidelines are: information, science and technology; education and sensitization, climate change planning and climate change finance and economic instruments (Murillo et al., 2017). Regarding economic instruments aiming to achieve low-carbon targets the policy establishes that the typology of instruments prioritized shall be coherent with economic, social, environmental and institutional dynamics proper of Colombia. Moreover, these instruments will have as pivotal principles the efficiency, equity, justice and legitimacy (Murillo et al., 2017).

The policy considers that public entities at national, regional and local level as well as economic sector and society will be responsible of climate change management in Colombia. Thus, coordination and articulation bodies will be created in which governmental entities will participate. This is clearly described by the National Climate Change System enacted in 2016 and which will be explained henceforth.

National Climate Change System (SISCLIMA)

Although climate change has been present in the political arena in Colombia since 1994, after the country ratified the UNFCCC, the National Climate Change System (SISCLIMA, for its acronym in Spanish) was not established until 2016 (Ministerio de Ambiente y Desarrollo Sostenible, 2016). However, it is important to note that SISCLIMA's institutional structure was envisioned since 2011 by the Economic and Social Policy National Council (CONPES, for its acronym in Spanish) through the document "Institutional Strategy for climate change policies and actions articulation" (DNP, 2011). Here it is important to highlight that the climate change CONPES, established as a guideline that national and local policies, plans, programs and regulations will have economic incentives and instruments that enable low-carbon development in the country (DNP, 2011).

SISCLIMA aims to solve to the mitigation and adaptation coordination needs at jurisdictional (national, regional, departmental) as well as sectoral level of the country. It aims to articulate, design, follow up and assess adaptation and mitigation policies, laws, strategies, plans, programs and projects through a cross-sectoral and jurisdictional level. Therefore, two main bodies have been created to achieve the system's objectives. First, the Climate Change Cross-sectoral Commission (CICC) that acts as the National Climate Change Policy implementation coordination and guiding body, which will be supported by the Finance Management Committee and the International Affairs Committee. Second, the Climate Change Regional Nodes, which are the regional bodies in charge of climate change policies, strategies, plans, programs and projects promotion and support in the regions. Figure 4, presents the climate change management articulation and coordination levels in Colombia.

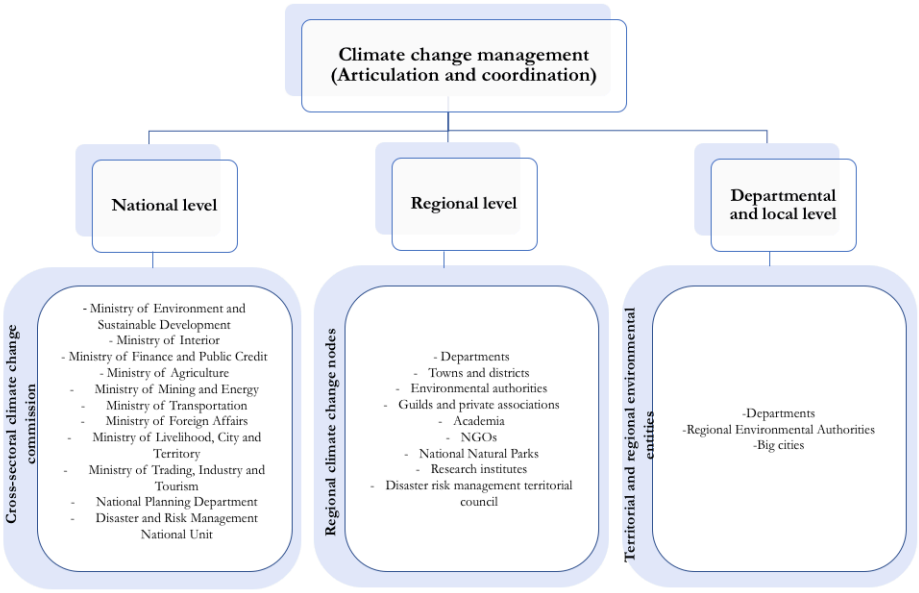


Figure 4. Climate change management articulation and coordination levels. Source: Murillo et al.(2017)

At this point it is important to mention the current national policies that act as a framework for SISCLIMA's proceedings. These are the National Climate Change Adaptation Plan (PNACC), Low-Carbon Development Strategy (ECDBC), Deforestation and Forest Degradation Emission's Reduction Strategy (ENREDD+) and Disaster Finance Protection Strategy.

Low Carbon Development Strategy (ECDBC)

The Low-Carbon Development Strategy (ECDBC for its acronym in Spanish) is a strategy that aims to identify and assess actions with purposes related to avoid accelerated growth of GHG emissions due to sectoral growth. These actions will comprise measures, interventions, policies or programs that promote GHG mitigation or that avoid its long-term growth. These measures will be appropriate for national conditions and will contribute to sustainable development by contributing, for instance, to the country's economic growth (DNP, 2011). The Low Carbon Development Strategy comprises 3 key components: alternative and opportunities appraisal in low-carbon development, plans, policies and measurements design and implementation related to low-carbon development and Monitoring, Reporting and Verification (MRV) system design (Sustainable Development Knowledge Platform, 2011).

For instance, from the second component, there have been implemented Sectoral Action Plans (PAS for its acronym in Spanish), which identify mitigation priorities as well as implementation means considering co-benefits. This last, includes productivity, cost reduction, technology transfer, employment generation, non-duty barrier risks, air quality improvement, *inter alia* (Ministerio de Ambiente y Desarrollo Sostenible, n.d.). Figure 5 presents PAS that have been produced in the framework of the ECDBC. The introduction of PAS in Colombia is consistent with the trend presented by the IPCC which states that sector-specific policies have been more widely used than economy-wide, market-based policies (IPCC, 2014b). While MBIs are considered in general most cost-effective than sector-specific policies, political economy considerations increase the difficulty of the design and implementation of MBIs (IPCC, 2014b).

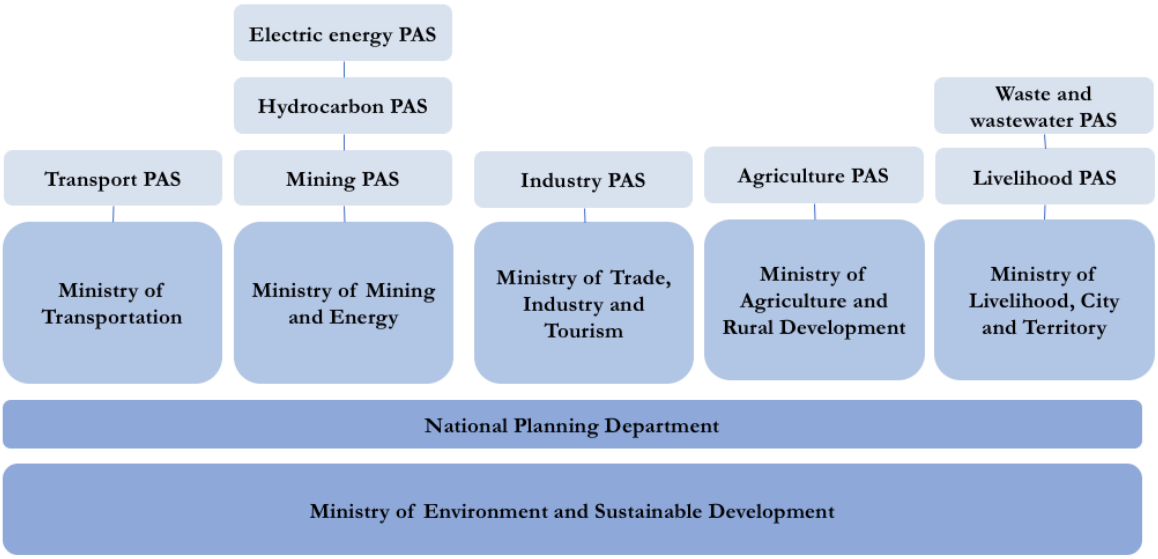


Figure 5. PAS elaborated from the Low-Carbon Development Strategy Source: Ministerio de Ambiente y Desarrollo Sostenible (2014)

Structural tax reform

There is a close relation between the carbon tax and the structural tax reform enacted by Law 1818 of 2016. This national tax reform was led by the Expert Commission on Equity and Tax Competitiveness (Comisión de Expertos para la Equidad y la Competitividad Tributaria-CEECT) which provided recommendations to the Ministry of Finance. The arguments upon which the national tax reform was claimed were related to external and fiscal misbalances and the re-design of the tax system as a key piece to advance in economic and social development. Further, the CEECT stated that mining and oil funds would be in the future insufficient to support social programs to tackle poverty as well as for the provision of public goods. In addition, the low tax collection level compared to the potential was also a reason to develop a tax reform. Furthermore, the OECD accession process (mentioned in Section 4.1.1) also entailed a recommendation considering need of a fundamental reform to raise additional revenue, promote economic growth and reduce inequality. OECD stated that opportunities exist to simplify the system, reduce distortion and raise additional revenue, including from environmental, property and mining taxes (OECD/ECLAC, 2014).

The report containing the Expert Commission's recommendation also argues that the current tax regime incurred in tax administrative weakness which lacked human resources, technology and institutional organization and which presented few achievements in tackling evasion and contraband (CEECT, 2015). Under these arguments, the CEECT provided a recommendation chapter on indirect taxes which include the VAT (Value Added Tax), consumption tax and the national fuel tax. The latter one mentions that fuel taxes in Colombia are low compared to international standards and that a high space of opportunity exist in order to increase a tax in the area (CEECT, 2015). This would have positive effects on the environment and would allow the collection of resources to infrastructure needs. Is at this stage when the national carbon tax is defined and introduced in the national tax reform as Chapter IX of Law 1819 of 2016 (Congreso de la República, 2016). Furthermore, OECD also recommended that opportunities existed to strengthen environmentally related taxes as part of a broader fiscal reform (OECD and ECLAC, 2014). Additional green taxes introduced in the tax reform, include the plastic bag tax, incentives for electric and hybrid vehicles and exclusion of Value Added Tax (VAT) for the

purchase and sale of equipment for projects that certify greenhouse emissions reduction (DNP, 2017).

Colombia in Peace Fund

Armed conflict in Colombia between the Armed Revolutionary Forces of Colombia (FARC) and the national government ended in November 2016. This, through a final agreement which proclaimed the end of the conflict as well as a stable and enduring peace in Colombia (Alto Comisionado para la Paz, 2016). Six notable topics were highlighted in this agreement: a comprehensive rural reform, political participation, integral solution to illicit drugs, conflict's victims accord and finally, implementation, verification and endorsement (Presidencia de la República, 2017). Regarding the last topic, the agreement establishes that the government will be responsible for the due implementation of achieved agreements in the peace process' conversations. Therefore, the government commits to guarantee its financing through different sources (Presidencia de la República, 2017).

Under this framework, the Colombia in Peace Fund (Fondo Colombia en Paz, for its name in Spanish) was envisioned in a CONPES document at the end of 2015 (DNP, 2015). This Fund was proposed to be the main body to coordinate efforts both institutional and financial to guide investments in Colombia's transition towards an enduring and sustainable peace. It also had in its objectives to strengthen State's capacity and democracy in most conflict-affected territories. This Fund was first created in 2015 as the Environmental Sustainability and Sustainable Rural Development at Conflict-affected Zones Fund. This Fund was then modified in 2016 including as its purposes to articulate post-war financing and improve peace-building financing initiatives, *inter alia*. Then, it was formally substituted as Colombia in Peace Fund in April 2017 (Presidencia de la República, 2017).

Colombia in Peace Fund currently leverages financial resources from several sources and holds an account in the Colombian Budget Law (BID, 2015). These sources include resources from the Budget Law, territorial entities contributions, General Royalties Systems, Participation General System, Peace and Post-War Multidonor Fund from the World Bank. Also, Sustainable Colombia Trust Fund from the Interamerican Development Bank, European Union Post-War Fund, NGO and donations from international organizations or States (Presidencia de la República, 2017).

In parallel, to the Environmental Sustainability and Sustainable Rural Development at Conflict-affected Zones Fund creation the country was under a structural tax reform as presented in the previous section. This allowed that the revenue collected by the carbon tax, contributed directly to the Fund's account in Colombia's Budget Law. Following a double dividend approach, the carbon tax has been earmarked to the main areas of the Environmental Sustainability and Sustainable Rural Development at Conflict-affected Zones Fund (Congreso de la República, 2016), now Colombia in Peace Fund. This, as a mechanism to ensure that revenues would be allocated to sustainable and enduring peace in Colombia. The areas include mitigation and adaptation to climate change, coastal erosion management, water resources conservation and ecosystem protection (BID, 2015; Congreso de la República, 2016). In addition the areas also include alternative development to replace illegal crops, comprehensive care for vulnerable populations, and promoting silvopastoral and agroforestry systems (BID, 2015). However, the sustainable sub-account regulation of Colombia in Peace hasn't been enacted as of August 2017.

Efficient and rational energy use and non-conventional energy sources program (PROURE)

PROURE 2010-2015 program presented strategies, subprograms and action guidelines oriented to the energy intensity decrease, energy efficiency improvement and non- conventional energy sources promotion (Ministerio de Minas y Energía, 2010). It is established until 2015 with a vision towards 2020, providing specific roles to public and private stakeholders to achieve expected objectives. These are, first, to establish a sustainable and efficient culture around natural resources along the energy value chain. Second, to build economic, technical, regulatory and information conditions to urge a goods and services energy market. Third, to strengthen institutions and urge private or mixed initiatives to develop programs and projects (Ministerio de Minas y Energía, 2010).

PROURE 2010- 2015 had targets for non-conventional energy sources participation in the energy mix. These are energy sources that are not used or marginally used in Colombia. Non-conventional energy sources include solar, wind, geothermal, biomass, small hydropower or tidal energy. PROURE proposed that in 2015 non-conventional energy sources should participate with 5 percent in the energy mix. From this percentage, the electricity share from non-conventional energy sources would correspond to a 3.5 percent participation target in the Interconnected National System (INS). Therefore, the target for electricity from non-conventional energy sources (RES-E) for 2015 was 2 percent in the INS. The PROURE established action guidelines related to establishing non-conventional energy sources in Colombia. These oriented the development of technical studies to evaluate the feasibility of implementing renewable projects. *Inter alia* to characterize solar, tidal and geothermal energy potential (Ministerio de Minas y Energía, 2010).

PROURE in 2010 claimed that Ministry of Mining and Energy would create a committee to define policies that would introduce non-conventional energy sources in the energy matrix. In addition, the program stated that Energy and Gas Regulation Commission (CREG, for its acronym in Spanish) would be the responsible in creating a regulatory framework with incentives and tariffs that would promote the use of RES-E. Thus, this program enabled since 2010 the discussion around the need to incentivize the use of renewables. Consequently, the government ruled the integration of non-conventional renewable energy sources to the SIN by Law 1715 of 2014 (Congreso de Colombia, 2014).

4.2 Carbon tax in Colombia

The carbon tax in Colombia was part of the "green tax" package introduced by the Colombian government in the tax structural reform as mentioned in Section 4.1.2. It is described in Chapter IX of the structural tax reform enacted by Law 1819 of 2016 (Congreso de la República, 2016). Along with Mexico and Chile, Colombia is one of the pioneer countries in LAC that has adopted a carbon tax. Annex 9 presents the list of countries worldwide that have adopted a carbon tax along with their year of adoption.

Environmental taxes were presented by Pigou (1932) and they aim to internalize negative externalities in a competitive market by introducing a tax equal to the social marginal damage caused by the environmental degradation (Baiardi & Menegatti, 2011). However, the amount of emissions reductions that will be achieved by the tax remains uncertain (Görlach, 2013). Carbon taxes function as presented in Figure 3. Each emitter weighs the cost of emissions control against the cost of emitting and paying the tax; the final result is that polluters undertake to implement those emission reductions that are cheaper than paying the tax, but they do not implement those that are more expensive (Gupta et al., 2007).

In Figure 3, this means that if the market agent does not abate its pollution units, then it should pay the tax rate for *a* units. However, if the agent abates one unit of pollution (*a-1*) then the cost of abating that unit added with the tax rate for *a-1* units is lower than if the market agent doesn't abate. This rationale continues to happen until *a**, where the marginal abatement costs are equal to the tax rate at *a**, this is known as the equilibrium abatement quantity, beyond those units of pollution (between 0 and *a**) the abatement costs will be higher, therefore its more profitable for the agent to emit those GHG units and pay the tax.

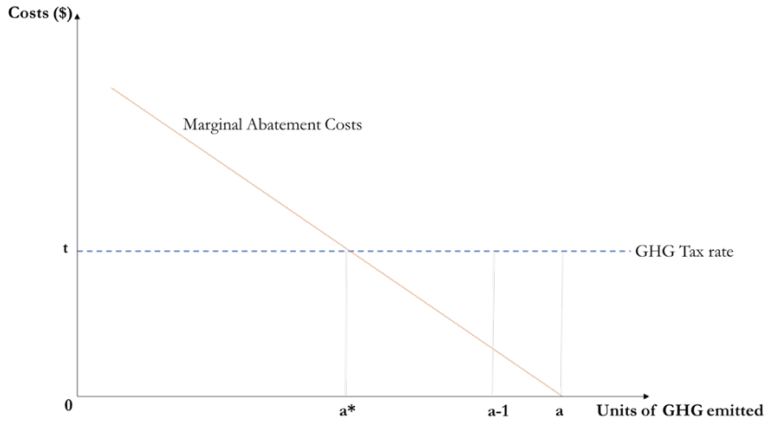


Figure 6. Abatement with GHG tax. Own elaboration, adapted from: Endres and Radke (2012)

A carbon price instrument, in this case a tax, provides an economic signal to emitters and allows them to decide to either transform their activities and lower their emissions or continue emitting and paying for their emissions. The overall environmental goal is to achieve this in the most flexible and least-cost way to society (World Bank, 2017b). Carbon pricing is often presented as a cross-sectoral cornerstone of a package of policy measures designed to achieve GHG emissions reductions at lowest cost (World Bank & OECD, 2015). It helps to minimize the market failure caused by firms and individuals not taking into account the costs, in terms of climate damages, that result from activities that lead to further emissions (World Bank et al., 2016).

There are two main types of taxes which in some cases are used indistinctly. Taxes can set a price per unit of pollutant emitted and can be directly applied to the pollution source or in contrast to the inputs or outputs of a production process (Görlach, 2013). In this sense, the first tax type is an emission tax on GHG emissions which requires individual emitters to pay a fee, charge or a tax for every ton of GHG released into the atmosphere (Gupta et al., 2007). The tax is directly applied to the pollution source and is imposed on the actual GHG emissions. In addition for this type of tax, taxpayers need to monitor and report their actual emissions (Görlach, 2013). The second case is a carbon tax which directly sets a price on carbon by defining an explicit tax rate on the carbon content of fossil fuel (World Bank, 2017b).

The carbon tax in Colombia belongs to the second category of carbon taxes presented before. It essentially is a tax on the carbon content of fossil fuels instead of a tax on the GHG emissions for direct sources. It entails all petroleum derivatives as well as all gaseous fuels used with energy purposes, but excludes coal. In Colombia, the share of fossil fuels in the transportation sector is as follows: 48 percent uses diesel, 24 percent gasoline, 8 percent jet fuel, 8 percent natural gas, 6 percent petroleum, 3 percent biodiesel and 2 percent ethanol, as shown in Annex 4 (UPME, 2015). At the same time, this sector emits 38 percent of the GHG emitted by energy sector. This, contributes with 44 percent of total GHG in Colombia, vis-à-vis AFOLU sector with 43

percent (IDEAM et al. (2015). Figure 7 presents the GHG inventory with an emphasis on energy sector.

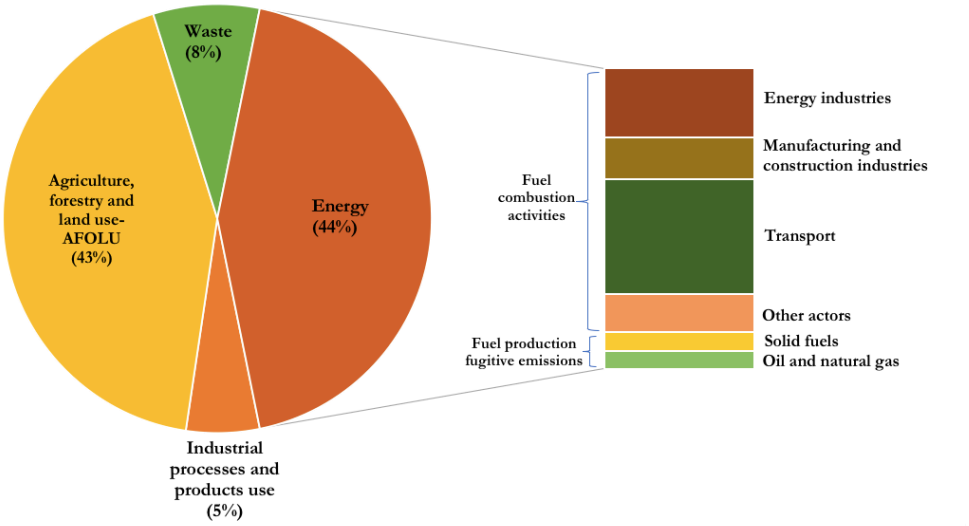


Figure 7. GHG inventory with an emphasis on the energy sector. Own elaboration from IDEAM et al. (2015)

The tax sets a specific fee considering the CO_2 emission factor per fossil fuel. From the fuels mentioned above (excluding biodiesel and ethanol), the fossil fuel which has the lowest fee per unit (cubic meter or gallon) is the natural gas while fuel oil has the highest fee. This is, because the carbon content in the natural gas is lower and therefore the tax to be paid for its use is lower. In any case, the fee corresponds to 15.000 COP (approximately 5 USD) per ton of CO_2eq burnt. Annex 7 presents the fees per fuel unit as well as the fuel conversion factor to CO_2.

However, as mentioned before, coal is exempt from the carbon tax. Coal's lack of regulation in the carbon tax might increase the possible leakage[2] in the future considering two main reasons. First, coal import's trend is decreasing in countries that have been well known for acquiring this type of fuel such as China and India (IEA, 2016). For exporting countries like Colombia this implies that local availability of the commodity will increase, hence, influencing the GHG emitted from coal use. In addition, extreme climate events such as droughts may affect the electricity supply provided by hydropower, which might influence the re-start of coal-based thermal plants (Álvarez et al., 2017). Thus, intensifying the use of coal for electricity generation.

The carbon tax in Colombia belongs to the category of an upstream regulation in contrast to downstream regulation where the tax is applied to direct sources of GHG which may include motor vehicles, farms, power plants and other stationary sources (Mansur, 2010). As in any "up streamed" regulated climate policy instrument, the carbon tax responsible in Colombia (meaning the ones that collect and pay to the government) are the producers or importers of all fossil fuels. These include the oil derivatives and all types of fossil gas that are used with energy purposes, when their purpose is the combustion (Congreso de la República, 2016). The generator fact is the fossil fuel's sale or import within the Colombian territory. The passive subject or the "direct carbon tax payer" in Figure 8 will be who acquires fossil fuels, from the

[2] Leakage occurs when partial regulation results in an increase in emissions in unregulated parts of the economy (Bushnell & Mansur, 2011).

producer or the importer. In addition, the producer when it withdraws fossil fuel for its own consumption e.g. fossil fuel to transport goods from the same production company and the importer when withdrawals are made for its own consumption are also passive subjects.

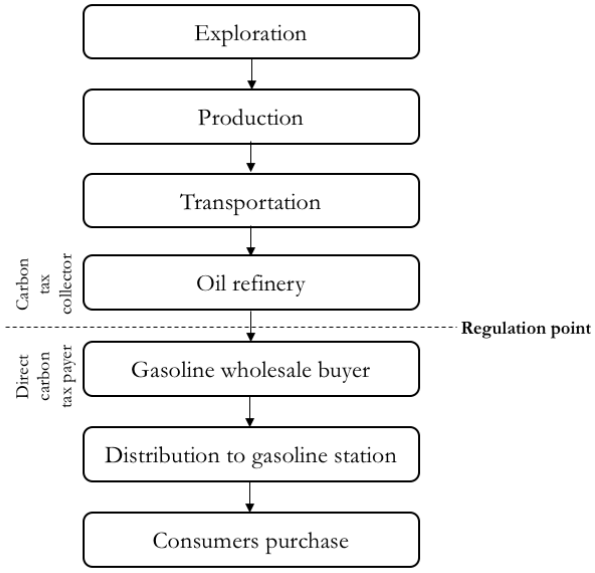


Figure 8. Carbon tax regulation point in the gasoline value chain in Colombia. Source: Own elaboration based on interviews, Agencia Nacional de Hidrocarburos (2017) as well as Tordo and Wolf (2009)

At this point it is important to talk about the gasoline transmission price which increases as it approaches the final consumer. As the gasoline wholesale buyer is the one that directly pays the tax to the collector, it is this agent in the market who increases the price downstream. Which means that vehicle owners who purchase a gasoline gallon will indirectly pay the tax. However, these last market agents won't be notified of the tax they are being levied for as the receipts they are given when they purchase the gasoline won't include explicitly the carbon tax.

On other topic, it is apparent that regulators in Colombia have considered the transaction costs of regulating upstream vs downstream in the carbon tax design. Transaction costs are all indirect costs incurred by public or private parties when creating and implementing a policy. These include costs for research, information gathering, policy design, enactment, establishment, contracting, administration, monitoring and enforcement (Coggan et al. 2010). From literature, it is clear that transaction costs increase or decrease along a vertical chain depending on the number of producers and consumers involved in each segment of the fossil fuel vertical chain (Mansur, 2010). This is, the transaction costs of monitoring and enforcing regulation for millions of buildings and cars could decrease the incremental benefits from direct regulation (Bushnell and Mansur, 2011).

In Colombia, the number of fossil fuel producers is lower than the number of fossil fuel consumers which means that implementing the carbon tax upstream decreases the transaction costs. To illustrate this, the transaction costs related to the administrative burden of the appointed governmental authority, in this case, National Tax and Customs Directorate (DIAN) would increase as we move downstream on the vertical chain of fossil fuels, decreasing the efficiency of the instrument. In addition, in developing countries, institutions may be insufficiently developed for the collection of emission fees from a wide variety of dispersed sources (Gupta et al., 2007).

For governments, carbon pricing is also a source of revenue, which is particularly important in an economic environment of budgetary constraints (World Bank, 2017c). The carbon tax in Colombia is complying with the double dividend approach as mentioned in Section 4.1.2. First, it aims to protect the environment by internalizing the cost of GHG emissions. This, through the taxation of the content of carbon in the fossil fuels. Second, it involves collecting revenues for environmental management. In this case for "Colombia in Peace Fund", which allows the resources to be allocated to coastal erosion, water sources protection and ecosystem protection. This Fund was an integral part of Colombia's International Cooperation Post-Conflict Strategy, Colombia in Peace (BID, 2015), which had its own account within the national budget managed by the Ministry of Finance and Public Credit (Congreso de la República, 2016). This figure, allowed the tax to be allocated to Colombia in Peace Fund. This, considering that taxes in Colombia can only be specifically destined when they are for education or public services.

As the carbon tax is being levied upstream (see figure 8), the wholesale buyers are the main actors receiving the signal to reduce their fossil fuel consumption or to be offset-certified, if this latter option results to be more affordable. This means that if for the wholesale buyer the cost of offsetting a ton of CO_2eq is lower than the cost it should pay for emitting that same ton of CO_2eq, then the wholesale buyer will choose to be offset-certified. Offset legislation was introduced 6 months after the tax, through Decree 926 of 2017 (Ministerio de Hacienda y Crédito Público, 2017).

4.3 Electricity from renewable energy sources support schemes (RES-E) in Colombia

Subsidies or financial incentives are payments to encourage a particular economic action (Moarif & Patodia, 2012). They are provided from public sector to private sector to stimulate the diffusion of new, less GHG-emitting technologies (Gupta et al., 2007). The World Trade Organization (WTO) defines subsidy as "any financial contribution by a government that confers a benefit on its recipients in comparison to other market participants" (WTO, 1994). Governments use subsidies as part of wider processes of economic policy to support businesses, markets, sectors or regions (Whitley & Van der Burg, 2015). Subsidies are one of the most common public policy instruments with political interests often determining who receives subsidies and at what scale (Whitley & Van der Burg, 2015). Usually subsidies decrease the production costs and increase the output. As shown in Figure 9, the production price of a given good or in this case the renewable energy production price decreases when the subsidy is introduced and the equilibrium price post-subsidy decreases to a point where it is possible to buy more of a given x at a reduced price.

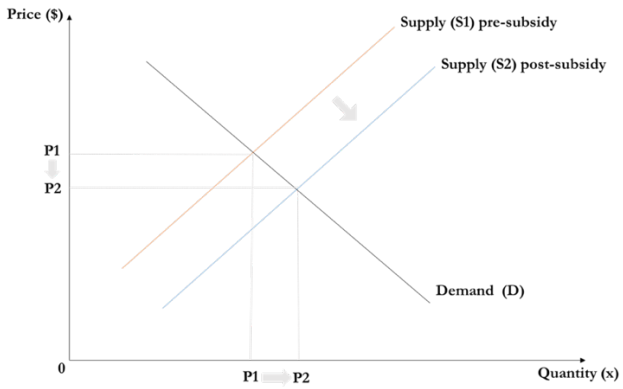


Figure 9. Economic rationale of an environmental subsidy. Source: Mundaca (2016)

Energy sector represents a major area for governmental subsidies. For instance, governments widely subsidize various types of energy such as fossil fuels, nuclear power, renewable energies and biofuels. Subsidies that increase emissions are mainly related to fossil fuel production and consumption (Gupta et al., 2007) and are often known as perverse subsidies.

Energy subsidies can be classified into consumption or production subsidies. The former refers to the situation in which the government lowers the price paid by the consumers whereas the latter refers to when the government lowers the cost of energy production or raises the price received by energy producers (Espa & Rolland, 2015). In the second case, there is a broad range of market based-instruments that governments can use to subsidize electricity from renewable energy sources (RES-E).

A wide array of support schemes are currently being applied in the EU to promote RES-E (del Río & Gual, 2004). This promotion has been based in primary mechanisms supplemented by complementary instruments. While the first group contains feed-in-tariffs, tradable green certificates and bidding/tendering systems, the second group comprise investment subsidies, fiscal and financial incentives and green pricing (del Río & Gual, 2004). Usually, countries apply one, maximum two instruments from the first group and complement them with a combination of measures pertaining to the second group. In Colombia, RES-E support schemes belong to complementary instruments. Furthermore, RES-E can be divided into investment or operating support. The former refers to capital grants, tax exemptions or reductions on the purchase of goods while the latter refers to price subsidies, tender schemes and tax exemptions or reduction on the production of electricity from RES-E (European Commission, 2008).

RES-E support schemes aim to significantly change the world's electricity shares. This implies a dominance of electricity generated from renewable sources instead of fossil fuels. However, this is not the case in the global reality. World electricity is highly dominated by fossil fuels. As shown in figure 10, coal has a share of 39.3 percent, natural gas a share of 22.9 percent and nuclear 10.6 percent. Less than a fourth of total electricity is generated from renewable sources (22.8 percent). From these, hydropower prevails with 16 percent.

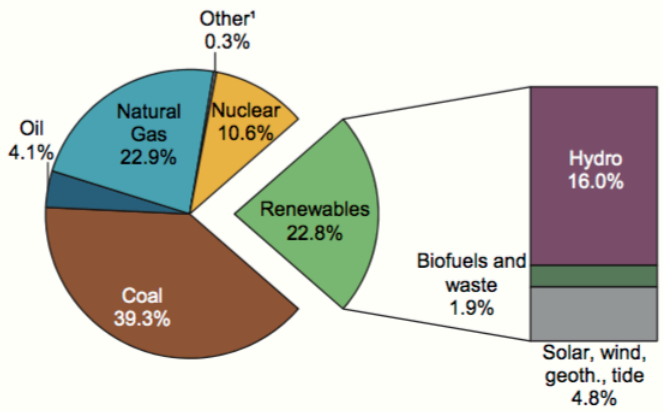


Figure 10 . Shares in world electricity production 2015. Source: IEA (2017) Others include electricity from non-renewable wastes and other sources not included elsewhere such as fuel cells and chemical heat.

Promisingly, in Colombia, as presented in figure 11, electricity sources are mainly renewable in contrast to the global trend where coal dominates. Around 73 percent of the electricity is generated by hydropower and the next most common source is natural gas with approximately 15 percent. The relative abundance of hydro and conventional fossil resources has limited the development of other renewable energy such as wind or solar. However, renewable energy

interventions such as wind and solar PV are now considered attractive due to the decrease in technology and development costs (World Bank & DNP, 2014).

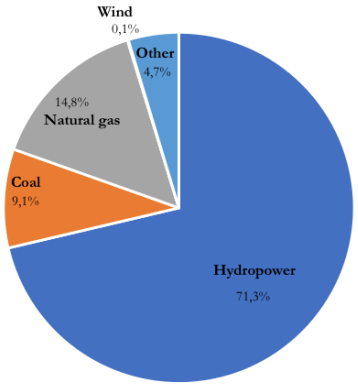


Figure 11. Shares in electricity production in Colombia. Adapted from: IDEAM et al. (2015)

In Colombia, it has been difficult to find competitive non-hydro, renewable energy alternatives. While there are many competitive options for renewables in off-grid areas (including small hydro, solar, wind and biomass), the challenge is to develop grid-connected renewables such as wind and geothermal that can compete with hydro and natural gas (World Bank & DNP, 2014). This, even when domestic availability of renewable resources such as wind, geothermal and solar allows the country to diversify its electric power sector.

Colombia's energy market is composed by public and private economic agents. Wholesale agents and large-scale consumers purchase energy and power in large blocks by signing contracts with generators to the market. Generators that participated are connected to the National Interconnected System (NIS). The price of energy is established according to transactions made through the spot market and contractual agreements among agents (World Bank & DNP, 2014). The country's electric power sector was once highly regulated but then it changed into a market-regulated one. This happened for electricity generation, transmission and distribution.

To increase stability, the government introduced the concept of "firm" energy in its energy auctions. Thus, energy producers which counted with technical capacity and ability to provide on-demand energy when it is needed most were paid a premium through firm energy payment (World Bank & DNP, 2014). The firm energy market pays generators a reliability fee for their firm energy obligations in exchange for a commitment to provide energy at a fixed price whenever spot prices exceed a pre-defined scarcity price. Firm energy auctions deliver incentives to invest in new generation projects, and producers are legally obligated to provide firm energy. In the long-term, this makes the energy system more reliable while promoting competitive price (World Bank & DNP, 2014).

In response to short-term problem such as unexpected droughts, the government has had to directly intervene in energy markets, which can undermine the firm energy market. Also, because the sector is dominated by few agents, the "scarcity price" can be manipulated, making it more expensive for consumers and potentially disadvantaging smaller producers (World Bank & DNP, 2014). However, in Colombia, although wind and other renewables qualify for "firm" energy payments, current rules offer significantly less payments to wind than in other countries. While the CREG regulations base their firm energy payments for wind on historical data, the program's aim is to provide energy at times when hydro is insufficient and during time of the day when power is needed (World Bank & DNP, 2014).

While the country's electricity relies on renewables (hydropower), Colombia enacted through Law 1715 of 2014 the integration of the non-conventional renewable energy sources to the national energy system through their integration to the electricity market (Congreso de Colombia, 2014). This law included a chapter on support schemes for non-conventional renewable energy sources and was then regulated by Decree 2143 of 2015 (Ministerio de Minas y Energía, 2015).

Climate change effects in hydropower threaten electricity supply in the country. Thus, it is important to diversify the electricity matrix to other RES aside from hydropower or geothermal. As a matter of fact, the "Generation and transmission expansion plan 2014-2028" in its scenarios, presents that RES could provide from 6 percent to 15 percent of electricity, ranging from a conservative to an optimist scenario, respectively (UPME, 2015). These scenarios would likely happen in relation to the efficient implementation of the RES-E support schemes that the government is providing to decrease investment costs of RES, mainly wind, solar and biomass.

While electricity generation from RES (RES-E) support schemes normally include feed-in tariffs, quotas with green certificates (TGC), tender systems and tax incentives, not all of them are being used in Colombia. However, it has been noted that given Colombia's large and high-quality wind resources and the potential for diversifying energy, the government could consider fostering wind power through various mechanisms. These including financial incentives through fiscal mechanisms, including tax credits for investment.

The RES-E support schemes in Colombia belong to both, investment and operating support categories. These are import duty exemption for pre-investment and investment, income tax exemption, VAT exemption and accelerated depreciation regime (Congreso de Colombia, 2014; Ministerio de Minas y Energía, 2015). First, the person or company owner of a new investment in RES new projects (in the stage of pre-investment and investment) with its related machinery, equipment, material and inputs, which has been approved by the UPME, National Environmental Licensing Authority (ANLA) and the DIAN will be import duty exempted.

The second incentive refers to when the person who spends in research, development or investments in the production or use of energy from RES or efficient energy management, can deduct 50 percent of the value of investments in the income declaration. In the third case, equipment, elements and machinery (national or imported) purchase as well as acquisition of services within or outside Colombia destined to pre-investment and new investments in RES, will be exempt of Value Added Tax (VAT). Also, the equipment destined to the measurement and evaluation of potential resources.

Finally, those energy producers from RES that develop new machinery, equipment and civil works investments, exclusively for the stages in pre-investment, investment and operation of RES generation projects, can apply to the incentive of accelerated fiscal depreciation, until an annual global rate of 20 percent. The beneficiary of this incentive will define an equal depreciation rate for each year, which can be modified in any year, after notifying the Tax Directorate of its section, before presenting the income declaration. The United States, also has a depreciation rate incentive to solar photovoltaic and solar thermal, fuel cells, micro turbines, geothermal electric, small wind and combined heat and power (Batlle, Perez-Arriaga, & Zambrano-Barragán, 2011). The number of RES-E scheme support granted in Colombia as well as the RES-E projects approved by the UPME can be found in Annex 12 and Annex 13, respectively.

Table 2.RES-E schemes in Colombia classified into operating and investment schemes. Source: Own elaboration

RES-E investment schemes	RES-E operating schemes
Import duty exemption VAT exemption	Income tax exemption Accelerated depreciation regime*

*The accelerated depreciate regime can also be applied for pre-investment and investment stages.

4.4 Comparison of the design elements of the carbon tax and the RES-E support schemes in Colombia

Interactions among the instruments are country specific and depend on the design elements of each instrument. As Hood (2013) states, national circumstances and energy systems are unique, as are the design details of policies that are implemented to reduce emissions in each jurisdiction. Section 4.4.1 to 4.4.6 aim to compare the design elements[3] of the carbon tax and RES-E support schemes in Colombia to provide a basis for the analysis presented in Chapter 5. In addition, Table 3 presents the comparison of the design elements.

4.4.1 Measure identification

As the carbon tax, the RES-E support schemes in Colombia are price-based instruments which have a national jurisdiction, however, the carbon tax is a mandatory instrument while the RES-E support schemes are voluntary. A narrow explanation of both instruments' nature can be found in Sections 4.2 and 4.3.

4.4.2 Objectives

The carbon tax and the RES-E schemes aim to internalize the costs of GHG emissions. However, they are also directing to solve other policy objectives. As this specific instrument (RES-E support schemes) have other objectives than GHG reduction, it can be complementary to a carbon price. This is, when an RES-E policy has as a primary goal to reduce emissions it will be less cost-effective than an ETS or a carbon tax (Fischer & Preonas, 2010). While renewable energy technologies are more expensive than other abatement possibilities, they can be considered worthwhile for all the additional objectives they tackle, e.g. energy security, provide local economic benefits or technology learning*, inter alia* (Hood, 2013). In addition, while a short-term viewpoint supposes that emissions reductions from RES or technology raise costs, these "side" objectives lower the costs over the long term.

Coming back to Colombia's case, by applying the double dividend approach, the carbon tax reduces GHG emissions while collecting financial resources for Colombia in Peace Fund (as mentioned in Section 4.1.2). In parallel, the RES-E schemes aim to secure the energy supply if extreme climate events such as El Niño continue to threaten the electricity supplied by hydropower, along with mitigating climate change. Therefore, the carbon tax main goal can be classified as environmental while the RES-E support schemes have an energy goal as their primary objective. Figure 12 shows the main policy objectives of each of the instruments under analysis.

[3] The instrument policy design elements were described in Chapter 2

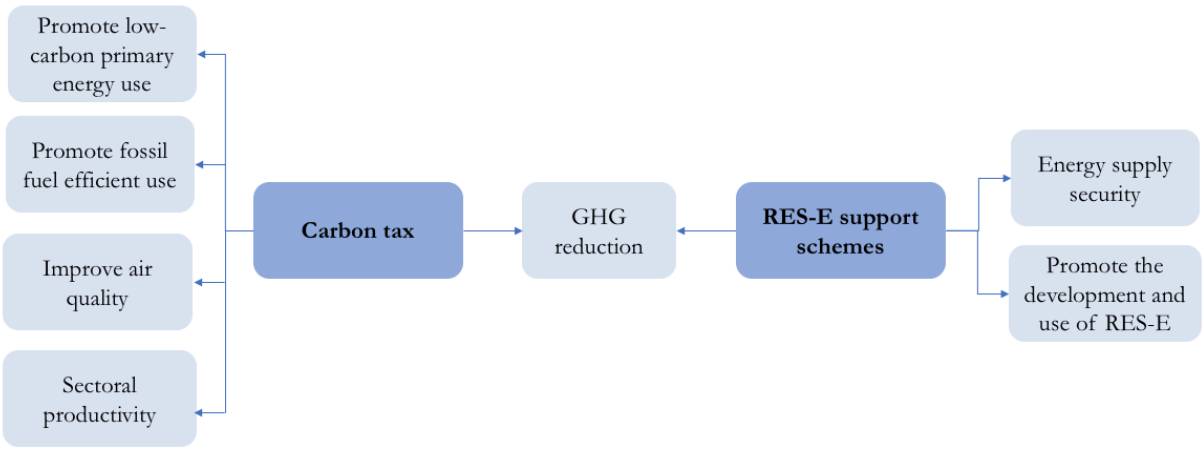


Figure 12. Policy objectives of the carbon tax and the RES-E support schemes in Colombia. Source: Own elaboration based on Congreso de Colombia (2014) and Congreso de la República (2016)

Unlike an ETS, the carbon tax while certain on the carbon price, remains uncertain on the CO_2 tons it will mitigate in the real scenario. Placing an adequate price on GHG emissions is of fundamental relevance to internalize the external cost of climate change in the broadest possible range of economic decision-making and in setting economic incentives for clean development (World Bank, 2017b). Economic models have been developed to understand the effect of a carbon tax of 50 USD per CO_2eq on CO_2 emissions (Calderón et al., 2016). The High-Level Commission on Carbon Prices considers that in order to achieve Paris Agreement's target at global level the carbon price level should be at least between 40 and 80 USD per CO_2 ton by 2020 and between 50 and 100 USD by 2030 (Carbon Pricing Leadership Coalition, 2017). Colombia's NDC aims to reduce 20 percent of the country's emissions by 2030 as explained in Section 4.1.1. The country has established a carbon tax of 5 USD per ton. This tax level is similar to the ones of the country's counterparts in LAC region, i.e. Chile and Mexico (See Annex 10). While this level of target might seem low[4] in comparison with for instance, Nordic countries it is important to consider these countries' socioeconomical and cultural contexts.

For instance, the distributive effect of a carbon tax of either 10 USD or 50 USD in Colombia has been categorized as regressive, because it supposes a negative change in welfare of mainly high-income and low-income livelihoods (Romero, Álvarez, Calderón, & Ordoñez, 2015). Taking into account that fiscal policy in Colombia aims to provide public services and redistributing and stabilizing the economy, a carbon tax of either this level (10 or 50 USD) would not support the objective of distributing income in the country, thus, it would not be contributing to the eradication of inequality (Romero et al., 2015). A certain tax level as a mitigation policy instrument should consider its effects on livelihoods' welfare, moreover, in developing countries such as Colombia. While the double dividend approach allows the tax to allocate its collection to improve conditions of low-income population and this would affect indirectly income distribution, internationally, this practice is highly discussed as for instance, studies have found that the worst distributive effect occurs when the collection is allocated to environmental entities' financing (Romero et al., 2015). Furthermore, as mentioned by Gupta

[4] Oikonomou et al. (2014) considers a low tax an average of 20-25 euro per CO_2 ton while Oikonomou et al. (2010) considers 40 euro per CO_2 ton a low tax. Taxes are considered by both authors as high when they range between 80 and 100 euro per CO_2 ton.

et al (2007) emissions or energy taxes often fall disproportionately on lower income classes, therefore, creating negative distributional consequences.

On the other side, unlike the EU, where targets for RES-E along with GHG reduction and energy efficiency have been set by 2020 (del Río, 2010), Colombia does not have a solid statement with respect to the share of RES-E in its energy matrix (Álvarez et al., 2017). While fiscal incentives for RES-E are in place, quotas for quantity-based MBIs such as tradable green certificates or feed-in tariffs are still inexistent in the country.

Moving on to the element of type of energy tackled, both instruments aim to steer the primary energy sources instead of final energy sources. First, the carbon tax by levying fossil fuels based on their carbon content, steers the behavior towards fuels with less carbon content, what is commonly known as fuel-switching, e.g. from gasoline to natural gas or from fuel oil to gasoline. Here is important to mention again that coal is exempt from the tax, which might cause leakage in the future as mentioned in Section 4.2. Second, the RES-E support schemes aim to increase the electricity generation from solar, wind and biomass sources.

4.4.3 Target groups

The obligated entity in the carbon tax are the fossil fuel producers and importers. However, as the RES-E support schemes are voluntary, these incentives are mainly directed to enterprises which have an interest on generating electricity from RES or using electricity from RES. While the carbon tax in Colombia is not legally earmarked for a specific economic sector, the energy and electricity matrix in the country causes the transportation sector to be the market agent that will assume most of the carbon tax costs. As explained in Section 4.2, the responsible for the tax is the producer or importer of the fossil fuel, but the "direct tax payer" or passive agent are the companies that buy different types of fossil fuels to support land, air or in-water transportation. The shares of fuel used in transportation sector are presented in Annex 4. As a whole, transportation sector emits around 16 percent of total GHG emissions in Colombia, as shown in figure 7 (IDEAM et al., 2015). This is around 29.558 Gg of CO_2-eq from a total of 178.258 Gg of CO_2-eq for 2012 (IDEAM et al., 2015). As a result, if this sector offsets all its emissions this would only contribute to a decrease of 16 percent of Colombia's GHG. Thus, attention should be given to the AFOLU sector and specifically to the country's deforestation rate.

4.4.4 Market

While both instruments are price-based instruments, they do not promote the trading of any commodity. In contrast, quantity-based instruments, in most cases, provide the market with measurable targets which sets the scene for market agents to intervene by selling or buying a given commodity. In the case of an ETS, the allowances and in the case of a TGC, the certificates. Colombia is still in its initial phase with carbon pricing, especially regarding a quantity-based instrument like the ETS. In addition, the absence of a RES-E quota hinders the possibility of implementing instruments such as the TGC.

4.4.5 Financing

The definition by Leal Filho (2011) states that analyzing the financing design element requires to review if the target group recovers induced policy costs. Applying this definition to both instruments under analysis is not straightforward. However, after having reviewed their nature two statements can be made. First, the fossil fuel wholesale buyers described in Section 4.4.3 can't recover the cost imposed by the tax. However, they can reduce its cost by offsetting or by decreasing their emissions. Thus, it can be stated that the carbon tax comprises a partial-recovery nature. Second, the RES-E support schemes are mainly fiscal incentives targeting energy

suppliers. Therefore, as the RES-E support schemes work mainly as a subsidy they can be classified as partial-recovery. They decrease energy generation costs by, for instance, reducing duty import taxes and providing income tax exemptions. However, there are costs associated to buying the machinery that are still part of the projects. Furthermore, from the governmental side, as stated by Verde and Pazienzia (2013), RES support in the form of tax benefits and public funds weighs on the governmental budget.

4.4.6 Institutional setup

The carbon tax has been responsibility of several institutions since its project-law stage until its introduction into the structural tax reform. First, Ministry of Finance and Public Credit with support of the technical insights from the National Planning Department designed the tax. Further, this Ministry was the institution responsible of the stringency level negotiations in the Congress and with economic stakeholders. After, the instrument was introduced in Law 1819 of 2016, the responsibility of the Ministry of Environment is to pledge for the accurate allocation of funds collected by the tax double dividend. While the regulation has not been enacted as of September 2017, the Law mentions that revenues collected shall be allocated to environmental projects including water resources, climate change and coastal areas protection. Furthermore, the Ministry of Environment will receive the GHG offset information, which will also be uploaded to the National GHG Reduction Registry. In addition, the National Tax and Customs Directorate (DIAN) also participates in the scheme by receiving the tax by the producer or importer of fossil fuel as presented before. Moreover, stemming from the carbon tax, the GHG offset instrument was enacted as mentioned Section 4.2. This increases the institutional setup around the carbon tax by including verifying organisms (third-party) which confirm emissions reduction.

In the case of the RES-E support schemes, three institutions participate in their implementation. First, the Ministry of Environment will issue the environmental benefit certificate according to each RES project, which will be used by the project owner to be exempted from the income tax or applying to the accelerated regime incentive. Second, the Mining and Energy Planning Unit (UPME) will issue the RES goods and services list which will be exempted from VAT. This same institution, will oversee the issue of a certificate approving the RES-E project as well its machinery and inputs, to obtain duty import tax exemption. Finally, DIAN will participate in this case by receiving the certificate issued by UPME.

Table 3. Comparison between the policy design elements of the carbon tax and the RES-E support schemes in Colombia. Own elaboration based on Oikonomou et al. (2010)

Design element	***Key components***	**Carbon tax**	**RES-E support schemes**
Measure identification	Measure type	Tax	Subsidy: Financial and fiscal incentive
	Application in the market	Mandatory	Voluntary
	Scope	National	National
Objectives	Nature of targets	GHG reduction	Energy security
	Level of targets	*	**
	Energy/environmental goals	Environmental goal	Energy goal
	Type of energy	Primary energy	Primary energy
Target groups	Obligated entities	Energy producer	Energy producer and energy supplier

Market	Trading commodity	Does not apply	Does not apply
Financing	Cost recovery	Partial recovery	Partial recovery
Institutional setup	Body for setting up the scheme	Ministry of Environment and Sustainable Development, Ministry of Finance, Tax and Customs Directorate, National Planning Department and third-party verifier.	Ministry of Environment and Sustainable Development, Tax and Customs Directorate and National Energy and Mining Planning Unit.
	Body for administering the scheme		
	Body for verification		
	Body for registration		
	Body for accounting		

*The tax level is aligned with other carbon tax initiatives in LAC. However, if compared with European countries the tax might seem low.

**The renewable energy target is not set in the RES-E support scheme but in the PROURE.

4.5 Stakeholders' perception

This section summarizes the findings from the interviews and present them by themes as shown in Figure 2. These findings are interpretation from the author as a result of the transcription and coding process. The section is structured as follows: Section 4.5.1 presents the political economy in the design and implementation of an instrument, Section 4.5.2 reviews the GHG shares as well as the energy matrix in Colombia, Section 4.5.3 presents the carbon tax and RES-E support schemes nature, Section 4.5.4 summarizes the interviewees' view on the interaction between both instruments, Section 4.5.5 reviews important elements of policy design and evaluation and Section 4.5.6 brings into the discussion additional mitigation tools and policies.

4.5.1 Political economy

In general, interviewees recognize the political economy as important in a policy instrument's design and implementation. For instance, one respondent highlighted that "political economy is essential to understand the instruments" While some mention only national drivers, others point out international ones as important. These drivers provide legitimate basis for an instrument's introduction, as mentioned by another interviewee. Furthermore, sectoral drivers are also acknowledged. Below is a summary of these drivers. In addition, Section 4.1 elaborated in them more thoroughly.

National drivers: Main national policies and strategies that are currently influencing the development of economic instruments are the Low Carbon Development Strategy - along with its Sectoral Action Plans (ECDBC), National Climate Change System (SISCLIMA) with its Cross-sectoral commission on Climate Change and the National Climate Change Policy. In addition, the tax reform as well as the post-war period allowed the introduction of environmental economic instruments. The structural tax reform aims to transform the tax system into a more efficient and effective one, with less evasion and that contributed to competitiveness and productivity of the country. Further, one interviewee mentioned that "the Expert Committee for the Structural Tax Reform stated that there was not a tax tackling environmental impacts or pollution". Moreover, the peace process was also a topic that influenced the carbon tax because there are needs and costs that can be covered through the double dividend approach of this type of MBI. One interviewee stated that "the tax is

supporting Colombia in Peace Fund as a sub-account of the Ministry of Finance national budget".

International drivers: One respondent mentioned that "Green growth mission in this National Development Plan is highly influenced by the pressure of acceding to the OCED". Green growth agenda promoted by the OECD as well as the purpose of Colombia in acceding to this economic group, enhanced the development of green taxes and catalyzed the tax reform. The Paris agreement also pulled the development of the National Determined Contribution (NDC) which *inter alia* mentions the use of economic instruments to reach mitigation targets. For instance, one interviewee mentioned that "Paris negotiations effectively influenced that countries are searching for mitigation instruments".

Sectoral drivers: Sectoral and guilds pressure in the political bargain process influence the instrument's stringency. Technical results are important because in them the optimal price of a given instruments is calculated. However, after sectoral pressure the price usually changes because of opposition. In addition, political feasibility discussed with sectoral stakeholders is essential to avoid economy distortion, sectoral depression or a sector's competitiveness loss. For instance, fossil fuels types that can be left out of the tax. i.e. coal is exempted from the carbon tax in Colombia.

4.5.2 Colombian context in terms of GHG and energy matrix

Overall, the interviewees consider that national context is very important when designing an instrument. For instance, electricity generation is not the main source of GHG in Colombia, unlike other countries where, for instance, electricity from coal is a major issue. One interviewee stated, "international market-based instruments are focused on electricity generation because their generation is based on fossil fuels". Within the energy sector in Colombia, transportation is the one which emits the most. Below is a summary of related topics. In addition, these are also explained in Section 4.3.

AFOLU sector along with energy are the main sources of GHG in Colombia. However, within the energy sector transportation emits the most as mentioned before. Unlike electricity generation which comes mainly from hydropower which turns the energy matrix into a "clean" one. Additional mitigation should be achieved in transportation and land use change. In addition, deforestation rate in Colombia caused by land use change is critical e.g. the conversion of forest into crops or livestock rearing areas. However, it is also important to consider that "other emissions also come from industrial processes" as one interviewee mentioned.

There are challenges in energy issues, nonetheless they are not essentially related to electricity generation but to energy efficiency. One interviewee added "one big current issue in Colombia is energy efficiency". However, there are long-term challenges for hydropower such as extreme climate events like droughts, exacerbated by climate change.

4.5.3 Carbon tax and RES-E support schemes nature

Carbon tax

The double dividend of the tax was considered as relevant for the peace process. For instance, strategies aiming to reinforce sustainable rural development will be financed with the revenues collected by the tax. For instance, the carbon tax earmarking, now contributes to the Colombia in Peace Fund.

The vertical chain of the carbon tax involves fossil fuel producers to final users. It has an upstream regulation point which reduces the instrument's transaction costs and administrative

burden. The fact that the carbon tax levies carbon content instead of GHG emissions sources also decreases the instrument's transaction costs. All actors involved in the carbon tax pay the tax. This is the price transmission from wholesale buyers to final users. However, the fossil fuel producer is the stakeholder that directly collects and pays to the tax agency. As one interviewee stated, "only one stakeholder pays directly to the Tax and Customs Directorate (DIAN)".

While fuel-switching is highly encouraged "the carbon tax in Colombia is a very inelastic instrument" said one interviewee. It won't be common for users to substitute a certain fossil fuel for one with less carbon content i.e. to switch from gasoline to natural gas. This would require a high investment. However, the tax is promoting GHG abatement through efficient use of fossil fuels or technology change.

The GHG offset mechanism that has been established assures the mitigation of CO_2 tons. This will also involve the accountability by the National Emissions Reductions Registry (Registro Nacional de Reduccion de Emisiones- RENARE). However, it is important to identify if Colombia has enough local carbon credits to be sold as part of the GHG offset, this was pointed out in one interview. Thus, it also entails an analysis of how the country can be part of international carbon credits markets.

There are several economic, social and cultural conditions that influence a tax stringency level. It is important to analyze the distributional impact a tax will have in the population. For instance, to model if low-income groups will be affected in a higher manner than other societal groups. An interviewee stated this as to "analyze will be regressive for the economy". While a tax level should be ambitious enough, it is fair to compare it with similar counterparts. One respondent argued "I would not suggest comparing the tax level with the ones in developed countries but in Latin countries". For instance, in Latin America, aside from Colombia, only Mexico and Chile have implemented their carbon taxes. These are very similar in the level applied in Colombia, i.e. 5 USD per ton, as shown in Annex 10.

Furthermore, another issue to be considered is that coal was exempted from the carbon tax. This is also a result of the political economy and mainly involves coal use within-country and coal exported to other countries. Consequently, this suggests further analysis on the possible leakage effect that this situation will carry domestically as well as internationally.

RES-E support schemes' nature

RES-E support schemes are mainly fiscal incentives which involve duty import exemption, income tax exemption, lower depreciation rate and VAT tax exemption. This denotes that renewable energy is still very costly. One interviewee even argued "renewable energy is yet too elite for Colombia". Thus, RES incentives are mainly imposed in the initial phases of renewable energy projects. One interviewee stated, "the RES-E support schemes are directed to the initial investment so interested parties can entry the market in an easier way". Renewable energy costs are considered in general high. In addition, there is a need to support the connection of energy from cogeneration to the grid. Currently, to participate in the energy auction can be very costly.

Access to RES-E incentives can be considered a very lengthy process. The administrative burden entails that it might discourage possible investors in renewable energy for electricity generation or for own use. As one interviewee stated "RES-E support schemes are good instruments but it is a very long process to accede to them, it's a long procedure involving three entities".

In addition, one of the main characteristics from the RES-E support schemes is that they "spend fiscal revenue" instead of generating it as a carbon tax.

4.5.4 Interaction between the carbon tax and the RES-E support schemes

Most stakeholders have considered that both instruments are complementary for several reasons. Firstly, as one interviewee claimed, "both instruments have the same reduction objective but they work in relatively different subsectors" within the energy sector. The carbon tax is focused mainly for transportation while RES-E support schemes target electricity generation. Nonetheless, if coal was levied in the carbon tax, electricity generation share under the tax would be higher. Secondly, both instruments in theory are mutually reinforcing. A carbon tax gives a signal to transit from fossil fuel technologies to renewable energy ones. This, at the same time possibly generates a higher use of renewable energy promotion incentives, either explicit or implicit. Thirdly, both instruments were not mainly designed for GHG reduction. Only the carbon tax was designed with this objective. Instead, RES-E support schemes stem from the law that aims to promote and deploy renewable energy sources and increase energy security. However, to analyze if the RES-E support schemes reinforce the carbon price signal suggests another perspective for the analysis. Especially, when the carbon pricing instrument is an ETS, as the price depends on the market and can be affected by the GHG mitigation provided by renewable energy sources.

However, it is important to note that the definition of overlapping or complementary is essential. For instance, the definition defended in Trends and State of Carbon Pricing highlight that a policy is overlapping if it interferes with the carbon price. Thus, in this case, the definition of complementary revolves around the effect on any policy instrument in the carbon price, whether a tax or an ETS. Nonetheless, from this perspective to consider two instruments as overlapping does not necessarily mean that they are counterproductive. This is, in the case of a carbon tax, as there is not a fixed constraint on emissions, an overlapping policy can provide additional abatement, even in the short-term. However, in this thesis the definition used revolves around the policy objective of each instrument under analysis.

4.5.5 Policy design and evaluation

Interviewees agreed that it is of most importance to know which are the objectives to be achieved to elude them to be overlapping. Specifically, one argued "If you have clear the policy instrument's objectives, you will avoid that they will be overlapping". Furthermore, "understanding national priorities also influence the interaction nature among instruments" claimed one expert.

However, there has been individual assessment of the instruments and not by pairs or multiple instruments. The assessment of the interaction between several instruments would assure that they are complementary from the beginning. Nonetheless, one respondent stated, "Discussions have been isolated, only individual discussions on instruments have occurred".

Moreover, in relation to the effectiveness of mitigation instruments, it was of common agreement that one instrument-stand alone would not be enough to reach mitigation targets. For instance, one respondent argued "I would combine command-and-control instruments with economic ones and even from the information realm". In addition, regarding the sector that emits the most GHG in Colombia, one interviewee added that a command-and-control for AFOLU sector would be highly encouraged. Nonetheless, to levy tax on meat or on land might not be politically feasible as they affect food security and land ownership.

4.5.6 Other tools and policy instruments

Colombia is beginning its path regarding the introduction of an ETS in the climate policy mix. This will be based upon the National Climate Change System law. Its design shall consider how to decrease transaction costs as its implementation entails high administrative efforts. Its planning shall contemplate that a carbon tax is already setting a carbon price in the market. Furthermore, policy-makers participating in the instrument's design shall avoid double regulation as the carbon tax is levying certain market agents.

Besides, one of the important energy issues Colombia is currently facing is energy inefficiency. Therefore, energy efficiency instruments play an important role in correcting this externality. Essentially, these are also covered by the renewable energy law in Colombia.

While carbon pricing is starting to develop in LAC, other climate tools exist to track the type of investments a given country is supporting in relation to climate risks. For instance, when central banks identify what type of actions should be implemented to "remove market distortions caused by climate risks". This involves very closely the private sector and its full disclosure regarding its investments in the market. Consequently, the government would know where are the investments and their related climate risks.

5 Analysis

This chapter aims to provide the reader with insights on why the carbon tax and RES-E support schemes in Colombia are complementary. First, Twomey (2012) argues that low-carbon activities or technologies may be promoted for social objectives different than emissions reduction. For instance, supporting renewable energy is justified since it contributes to the creation of green jobs and exporting benefits from international leadership in emerging technologies. Furthermore, investing in domestic renewable energy provides greater energy security. This is the case in Colombia, where energy security is threatened by climate change. Thus, renewable energy sources different than hydropower like solar or wind increases energy security. Moreover, Lehmann and Gawel (2013) stated that using RES-E may also provide environmental benefits apart from GHG reduction like air pollution reduction from fossil fuel combustion and conservation of non-renewable resources. Additionally, in some countries RES-E promotion suggest substituting oil and natural gas imports from unstable countries (Lehmann & Gawel, 2013). While this is not the specific case for Colombia because the country does not rely on energy imports, RES-E support increases the variety of available domestic energy sources.

Lehmann and Gawel (2013), claim that the existence of multiple policy objectives might provide a further, political rationale for implementing RES-E support schemes next to a carbon pricing instrument e.g. EU ETS. For instance, they mention that an autonomous RES-E deployment target politically set justifies its existence in the policy mix along with an emission policy instrument. In Colombia's situation, this is visible by the renewable energy target exposed in PROURE which is autonomous from the mitigation target set in the NDC.

Similarly, del Río (2017) states that policy mixes can be justified to account for the coexistence of different market failures to achieve certain policy goals. This follows a general economic principle: governments should apply a given policy instrument most closely related to a particular market failure (Schneider & Goulder, 1997). Del Río (2017) recalls what was claimed by Tinbergen (1952): "more targets than instruments make targets incompatible. More instruments than targets make instruments alternative". Moreover, in the existence of different market failures, the most appropriate response will be in many cases to involve a combination of instruments (de Serres et al., 2010). This also means that a policy overlap arises when a carbon pricing instrument is supplemented with other instruments to address only the environmental externality generated by GHG emissions. This means that renewable energy support schemes, for instance, are justified when they address other externalities than GHG reduction such as adoption spillovers and/or energy security (Duval, 2008; Hood, 2013).

Furthermore, del Río (2017) emphasizes that often, policy-makers have other goals apart from CO_2 mitigation. For instance, in the climate and energy realm, other goals involve security of energy supply (diversification of energy sources), energy affordability, job and industry creation as well as regional development. While carbon pricing instruments, in this case a carbon tax and RES-E support schemes share one common goal, i.e. CO_2 emissions reductions, RES-E support schemes contribute to other goals in addition to CO2 mitigation. This is the case in Colombia as shown in Figure 12. In addition, carbon pricing works in synergy with complementary policies to support policy objectives different than emission reductions. This offers the opportunity for decision-makers to develop a carbon pricing as one element of a broader policy package that enhance the performance of each policy (World Bank et al., 2016). Moreover, as presented in the State and Trends of Carbon Pricing report, there is a case of complementarity when the interaction between carbon pricing and other policies in power market deliver greater reductions while also supporting energy access and reliability (World Bank et al., 2016). In addition, improving access to finance in order to support emerging GHG reduction technologies and

overall investments along with a carbon price is also considered complementary (World Bank et al., 2016).

Del Río (2017) concludes that combinations of instruments may be justified if they address different goals. Moreover, World Bank et al. (2016) claim that an integrated package of climate policies that reduce emissions while also supporting other policy objectives will be more likely to gain widespread stakeholder support and to be implemented more effectively.The case between the carbon tax and the RES-E support schemes in Colombia, in relation to the policy objectives they tackle, does not result in an overlapping case. This, consequence of considering national priorities in the instrument's design and avoiding double efforts. As presented in Figure 12, and mentioned before, while both instruments coincide in addressing GHG emissions externality, they also have other policy objectives to address. For instance, the carbon tax aims to collect revenues to support Colombia in Peace Fund and contribute to the national budget. This to fundraise resources with the objective of designing and implementing projects of this type. At the same time, the RES-E support schemes aim to promote the development of renewable energy sources to decrease the country's vulnerability to extreme events intensified by climate change such as droughts. Thus, RES-E support schemes are supporting the policy objective of increasing energy security in Colombia. The fact that both instruments under analysis tackle different market failures suggest that they are not overlapping. Moreover, in terms of target groups, while both instruments target primary energy producers their nature implies a different market behavior.

In addition, CO_2 reductions from renewable energy policies could possibly add to the CO_2 reductions driven by a carbon tax, depending on the strength of each (Philibert, 2011). In the presence of a carbon tax, energy policies that reduce emissions in the same sector and over the same timeframe can increase the total emissions reductions for a given fixed carbon tax level. On the contrary, but also in a enhancing manner, they can decrease the carbon tax level needed to achieve a given emissions outcome (Hood, 2013). In the former case, an energy policy either energy efficiency or renewable energy related, drives emission reductions and adds to the abatement provided by the carbon tax signal. In the latter case, the required tax level to achieve an emissions goal should be set considering the additional abatement from energy policies. Other criteria, in addition to the technological progress, that need to be considered when adjusting the tax level are the inflation and new emission sources (Gupta et al., 2007).

Here it is particularly important to note that, as mentioned before, the carbon pricing instrument in Colombia is a carbon tax instead of an ETS. If the case was the latter, other considerations would have to be considered. Efforts to increase the deployment of renewable energy have lowered the carbon price in the EU ETS, although at a higher short-term cost of avoided CO_2 given the additional administrative cost and the loss of flexibility. Policy overlaps should be considered by policymakers in Colombia as they set the CO_2 cap (OECD, 2013a). Further, RES-E support schemes' effectiveness should be considered in the design of the ETS.

Subsidizing environmental-friendly activities should generally be avoided given the potentially large budgetary costs and the uncertain impact on negative externality. Here it is important to recall that RES-E support schemes are revenue spending instead of revenue generating. However, they can be an effective option in case where pricing instruments would be difficult or very costly to enforce and when the subsidized activity is a strong substitute for the dirty activity that is targeted (de Serres et al., 2010). In the case of Colombia, the subsidized activity in this case the RES-E is not a strong substitute for the "dirty" activity mainly because the electricity in the country is vastly generated by hydropower. Nonetheless, as the coal is exempt from the carbon tax to some extent it could be considered that RES-E support schemes are a

substitute for this commodity, even when the electricity generated from coal in Colombia is minimal.

Furthermore, the combination of the carbon tax and the RES-E support schemes is cost-minimizing. This considering that the policy package is exploiting the complementarities between the instruments (IPCC, 2014b) which is given by the objectives that each of them is addressing. In addition, it also implies that mitigation cost as a result of their combination is lower than if these instruments would be implemented alone (IPCC, 2014b). The potential for cost-reducing interactions is greatest when different instruments address different market failure IPCC (2014b). If this is not the case, there will be a policy overlap and double regulation, which will raise mitigation costs (IPCC, 2014b). Similarly, incoherent policy mixes leading to duplication or negative interactions will increase costs and could be object of resistance (World Bank et al., 2016).

6 Conclusion

National and international factors have influenced and enabled the introduction of mitigation and renewable energy policy instruments in Colombia. This thesis has classified them as the political economy around each of the instruments. At international level related to climate change mitigation, the Paris Agreement has enabled the National Determined Contribution of Colombia. The NDC considered market-based instruments as important tools to achieve the country's mitigation target, clearly paving a pathway for a carbon tax. Furthermore, the accession of Colombia to the Organization of Economic Cooperation and Development, required a national environmental management system guaranteeing stringent environmental tax levels that internalize pollution costs, including GHG emissions. Similarly, at international level but related to renewable energy, the Statute of the International Renewable Energy Agency shaped the commitment of the country to the adoption and use of renewable energy sources.

At national level, the National Planning Department and the Ministry of Environment and Sustainable Development have lead and provided efforts related to including climate change in the political agenda outside the environmental sector. This has resulted in a strengthened cross-sectoral climate change system and a national low-carbon development strategy. Furthermore, these efforts have been also acknowledged by the Ministry of Finance by including the carbon tax as an instrument to raise revenues within the national structural tax reform. Concatenated to this, Colombia in Peace Fund as a trust created for the post-war period will finance its environmental operations and projects partially with the revenues from the carbon tax. Analogously, but related to renewable energy, Colombia's commitment to the abovementioned IRENA Statute ensued a national law on the promotion of renewable energy sources and their connection to the electricity grid. Consequently, support schemes for electricity generation from renewable sources in the form of financial and fiscal incentives stemmed from the law. In addition, the program on efficient use of energy and promotion of non-renewable energy sources set a target for the participation of renewable energy within the electricity generation sector.

Low-carbon development usually entails to reduce an economy's GHG intensity while increasing economic development. However, in the context of Colombia's vulnerability to climate extreme events, it also means to secure energy supply, mainly given by the country's dependence on hydropower for electricity. While in other countries, this might be related to fossil fuel imports from politically unstable countries. The vulnerability to extreme climate events like droughts, has been further exacerbated by climate phenomena such as El Niño. Nonetheless, this has provided an opportunity to subsidize electricity from renewable energy sources differently than hydropower in the form of fiscal and financial incentives. Thus, the main policy objective for renewable energy policy instruments is not GHG reduction but securing energy supply. This specific policy design element of the RES-E support schemes in Colombia suggest its interaction with the carbon tax to be complementary. Because while both instruments coincide on reducing GHG, each of them aim to solve multiple types of policy objectives. On the one hand, the carbon tax is internalizing the cost of GHG emission, thus contributing to the country's climate change mitigation pledge, promoting industrial efficiency and improving air quality. On the other hand, the RES-E support schemes aim to promote the electricity connection from other renewable sources than hydropower and thus increasing the country's energy security.

In addition, the complementarity of both instruments is recognized by stakeholders in Colombia for different reasons. Firstly, while both instruments coincide to reduce GHG in the energy sector, each of them work in different sub-sectors. This is, the carbon tax mainly applies to GHG emissions from transportation sub-sector while support schemes for renewable energy

are destined to electricity generation. Secondly, stakeholders acknowledge that both instruments in theory are mutually reinforcing. A carbon tax gives a signal to transit from fossil fuel technologies to renewable energy ones. This, at the same time possibly generates a higher use of renewable energy promotion incentives, either explicit or implicit. Thirdly, as mentioned before, both instruments were not mainly designed for GHG reduction. Only the carbon tax was designed with this objective. Instead, RES-E support schemes stem from the law that aims to promote and deploy renewable energy sources and increase energy security.

After having reviewed the political economy of both instruments, understood how these have been designed in terms of their objectives and described the perception of several expert stakeholders, it can be concluded that the coexistence of both instruments in Colombia's climate-energy policy mix is justified. Their main objectives differ which means that each of them is solving a different policy objective. They coincide in reducing GHG but this is a result of the nature of the RES-E instrument which at the same time of increasing energy security contribute to climate change mitigation. In a deep view, even if both instruments are reducing GHG, the carbon tax is mitigating in the transportation sector while the RES-E support schemes are promoting electricity generation from other renewable energy sources. On the other hand, if the RES-E support schemes were primarily designed as a policy instrument to reduce GHG, then their interaction would be overlapping. Furthermore, the nature of the carbon pricing instrument, i.e. the carbon tax, allows additional emissions reduction from the RES-E support schemes. The case would be different if the carbon pricing instrument would be an emission trading scheme where the emissions are limited by a cap and RES-E support scheme would affect the carbon price.

7 Further research

The climate-energy policy mix in Colombia is still at an initial stage. Carbon pricing has recently started with the carbon tax at national level and an ETS is under design. Moreover, energy policy still lacks quotas and obligations e.g. feed-in tariffs or tradeable green certificates for renewable energy different than hydropower. However, the incorporation of these instruments in the policy mix requires analysis on their interactions. This not only through qualitative methods but also through quantitative ones. Essentially, it is recommended that an analysis on the interactions of the instruments design elements is followed by an evaluation of criteria *inter alia* effectiveness, efficiency and feasibility. For instance, the effectiveness of reducing GHG under an ETS combined with RES-E support schemes in Colombia.

In addition, to understand how a carbon price in an ETS would change due to the RES-E support schemes in an ex-ante evaluation would influence the instrument's design. This would eventually lead to a cost-efficient policy package and the probability of the combination to be overlapping would decrease. Moreover, it is important to analyze the interaction between an ETS and RES-E as it has been argued that the juxtaposition of a CO_2 policy instrument of fixed quantity form (such as the EU ETS) and of policy instruments specifically promoting the early deployment of RE technologies, may lead to a CO_2 price that is lower than it would have been otherwise. It may also raise the overall costs of achieving short-term CO_2 reductions of the ETS, as this is achieved through some costlier emission reductions driven by RE technology deployment (Philibert, 2011). Moreover, it is considered important to analyze the combination of the GHG offset instrument with the RES-E support schemes. Concatenated to this, it also requires attention to understand how this combination may affect the design of the ETS in terms of the cap to be set.

Furthermore, renewables support policies such as feed-in tariffs or green certificates provide low-carbon electricity generators with a financial incentive in addition to the competitive advantage provided by a carbon price. While working in the same direction, these policies may affect the carbon price signal and increase the overall social cost of reducing emissions. This is often because they provide additional financial support or create additional financial costs to activities that the carbon price also incentivizes or penalizes (World Bank et al., 2016). Therefore, to analyze if the RES-E support schemes reinforce the carbon price signal suggests another perspective for the analysis. Especially, when the carbon pricing instrument is an ETS, as the price depends on the market and can be affected by the GHG mitigation provided by renewable energy sources. In addition, while Colombian electricity sources can be considered mainly clean- 71 percent of electricity comes from hydropower (IDEAM et al., 2015), RES-E development targets need to be considered in setting the cap of the ETS (Sonnenschein, 2016).

Besides, the analysis of possible leakage due to the exemption of coal from the carbon tax is recommended. Leakage occurs when partial regulation results in an increase in emissions in unregulated parts of the economy (Bushnell & Mansur, 2011). A significant share of Colombia's coal is exported, however, the use trend of this fossil fuel as a source of electricity shall be studied because of its exemption from the carbon tax. Another issue to consider is that AFOLU sector emits the most in Colombia. Therefore, policy instruments to control this trend shall be explored. However, some of these might be less political feasible or require structural law changes.

8 Annex

Annex 1. List of interviewees in the order of the timing of the interviews

Name	**Organization**	**Position**	**Date**	**Mode and place**
Sebastián Lema	Departamento Nacional de Planeación (National Planning Department)	Climate Finance Group Coordinator	July 14th, 2017	In person, DNP
Erika Amaya	Ministerio de Ambiente y Desarrollo Sostenible- MADS (Ministry of Environment and Sustainable Development)	Professional from the Mitigation group	July 17th, 2017	In person, MADS
Marcela Jaramillo	Inter American Development Bank	Climate Change Officer	July 17th, 2017	Online via Skype
Diego Grajales	Ministerio de Minas y Energía (Ministry of Mining and Energy)	Professional from the Environmental and Social Affairs Office	July 21st, 2017	In person, Ministry of mining and energy
Margarita Pava	Corporación Ambiental Empresarial- CAEM (Enterprise Environmental Corporation)	Project Coordinator	July 21st, 2017	In person, CAEM
Sebastián Carranza	Ministerio de Ambiente y Desarrollo Sostenible - MADS (Ministry of Environment and Sustainable Development)	Professional from the Mitigation Group	August 1st, 2017	In person, MADS
María Alejandra González	World Wildlife Fund- WWF	Sectoral Climate Change Mitigation Officer	August 2nd, 2017	Online via Skype
Marcos Castro	World Bank	Member of the Technical Secretariat of the Partnership for	August 4th, 2017	Online via Skype

		Market Readiness (PMR)		
Carolina Sánchez	Unidad de Planeación Minero Energética-UPME (Mining and Energy Planning Unit)	General Directorate Advisor	August 4th, 2017	In person, UPME
Marcela Bonilla	Unidad de Planeación Minero Energética-UPME (Mining and Energy Planning Unit)	Environmental Advisor	August 4th, 2017	In person, UPME
Germán Romero	Departamento Nacional de Planeación (National Planning Department)	Climate change economic impacts study coordinator	August 8th, 2017	In person, DNP
Thomas Kansy	Vivid Economics	Engagement manager	August 14th, 2017	Online via Skype

Annex 2. Interview guide[5]:

Introductory question

- What is your professional relation with climate change and what is your current role in this field?

Political economy

- Why did Colombia decide to implement the carbon tax?
- Aside from the OECD, what other political context occurred to introduce the carbon tax?
- How would you consider analyzing the political economy of the instruments?
- How important is it to review the political economy of each of the instruments?
- How does the negotiation process with sectors work?
- Which factors could influence the design and implementation of a given mitigation instrument?
- What was the reason for the coal being exempted from the carbon tax?
- How was the process of price negotiation?

Colombian context in terms of GHG and energy

- Why is it important to talk about mitigation in Colombia when the country emits less than 1 percent at global level?
- Which policy instruments are supporting the NDC?
- How is the NDC related to the Sectoral Actional Plans?

[5] Not all questions were asked in all interviews. The evolution of research influenced the nature of questions, ranging from general to specific ones. The questions are grouped by themes.

- Why, from your perspective, is important to review climate and energy topics?
- What mitigation instrument is missing in Colombia?
- What is the relation between the carbon tax and the NDC?
- Which ministry needs to work more on mitigation? Why agriculture? Why transport?
- Do Payment for Ecosystem Services play an important role in reducing deforestation rate?

Instruments' nature

- Which instruments: regulatory, economic or informative are supporting Colombia's mitigation target?
- Is the carbon tax levied for transport sector?
- Is it probable that the tax will increase?
- Do RES investment costs influence their penetration in the market?
- Are RES-E support schemes more subsidies than tax exemptions?
- How to know the quantity the country has reduced in terms of GHG due to the tax?
- The objectives of the renewable energy law are not related to mitigation but climate resilience?
- Does the law establish goals in terms of renewable energy?
- The price signal is oriented to whom specifically? Producer, distributor, importer?
- What market failures are addressing each of the mentioned instruments?
- How does the carbon tax work in institutional terms?
- The carbon tax level is 5 USD per ton, is this price ambitious or not?
- Who pays the carbon tax? The wholesale buyer a sector specifically?
- What entity verifies the tons that can be offset or that have been offset?
- What economic instruments exist in the law that support or promote energy efficiency?
- The price is being marginalized in the chain?
- Who buys has the possibility to offset?
- Is mainly for gasoline stations?
- Is that what is called upstream regulation?
- The tax sets what is called a price floor with an ETS?
- What criteria would you use to classify a carbon tax as low or high?
- When you refer to carbon leakage is when one sector is out of the regulated sectors and the carbon emissions increase in that sector?
- How is the fossil fuel price transmission?
- Which of these instruments (renewable energy sources incentives and energy efficiency) has a higher impact in GHG emissions reduction?
- Are these incentives at the beginning of the project? When the machines are being imported?
- Who oversees verifying, registering and verifying that projects are being energy efficient?
- In terms of environmental effectiveness, which instruments would be more effective?
- In economic terms, which instrument would be more efficient?
- When the carbon tax was designed, do you know if the existence of a RES-E support scheme was considered?
- Is there a need to buy carbon credits in other countries? How could an ETS support this?
- Are there not enough carbon credits to offset in Colombia?

- Is there a way to know how many GHG had been offset till today?

Instruments' interaction

- How can the carbon tax be complemented with an ETS? Would the ETS cover more sectors? Which sectors are affected by the carbon tax?
- How would an ETS work in Colombia? Would it complement the carbon tax? How would the carbon tax change?
- In your perspective, how can the Non-Conventional Energy sources law complement the carbon tax?
- When there exist multiple objectives that each policy is aiming and only in one objective they coincide, it is possible to mention that they are complementary?
- In your opinion, is it good way to analyze the instrument's design areas to understand if they are complementary or overlapping?
- Do you think the carbon tax becomes more effective when it interacts with an incentive such as the one of renewable energy?
- Regarding the ETS, has it been considered in the instrument's design its interaction with other instruments such as the carbon tax or the RES-E support schemes?
- What is your perception of the combination of a carbon tax with an ETS?
- Which countries have implemented successful mitigation instruments interactions?
- Which is the perfect mitigation policy mix? Why would you consider this combination?
- How to avoid overlap between instruments?
- Do you consider the relation between the carbon tax and the RES-E support schemes complementary or overlapping?
- In terms of reducing GHG emissions, what is your opinion about the interaction?

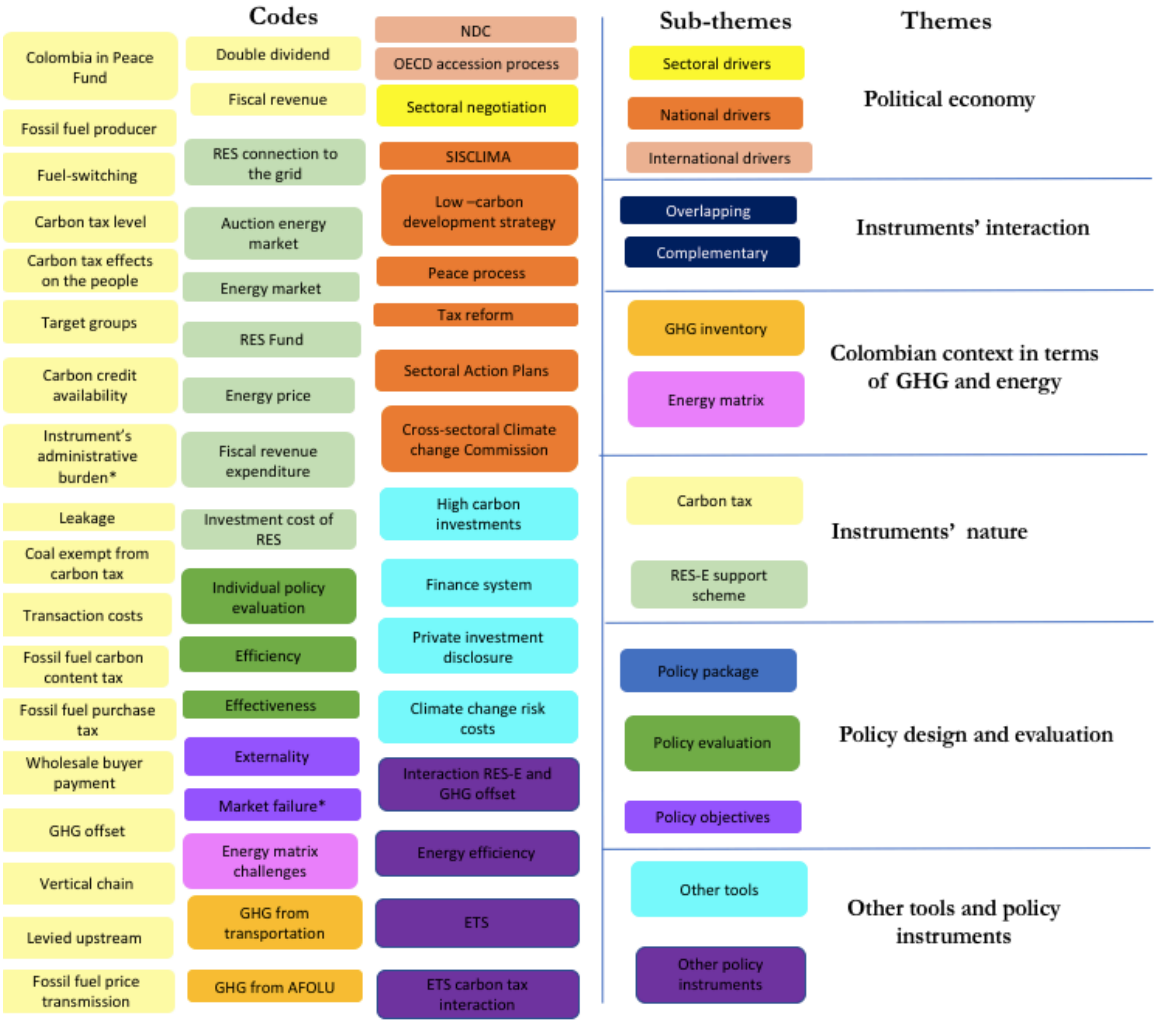
Policy design and evaluation

- What are the main hinders in the implementation of a given instrument?
- Regarding the ETS, has it been considered in the instrument's design its interaction with other instruments such as the carbon tax or the RES-E support schemes?
- How could the RES-E aside from hydropower become feasible?
- Is there any incentive that turns renewable energy into a more affordable one?

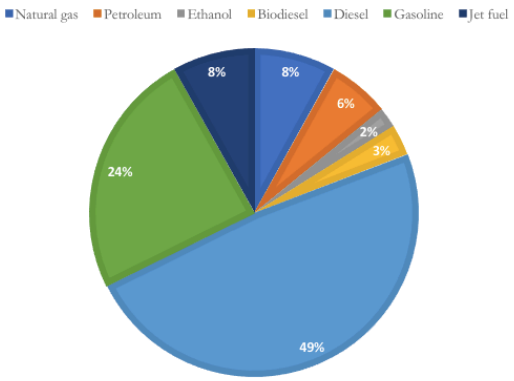
Other tools and policy instruments

- How can the SISCLIMA support identification of clean investments in the country?
- Which countries in LAC are more advanced in identifying their clean investments through private disclosure?

Annex 3. Codes, sub-themes and themes relevant in the content analysis

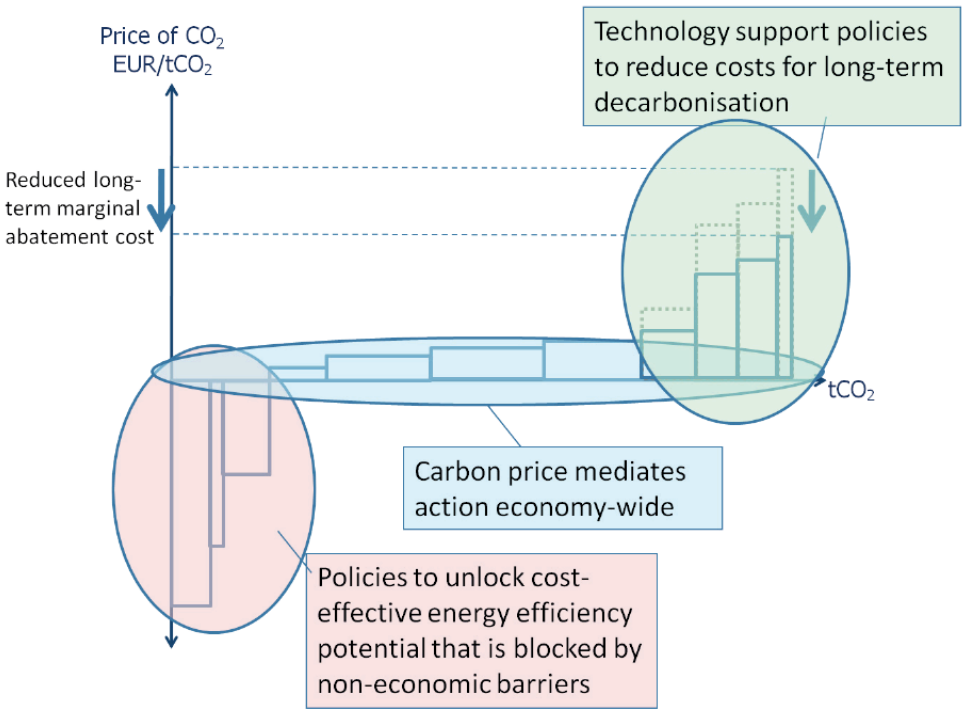


Annex 4. Fossil fuel shares in Colombia



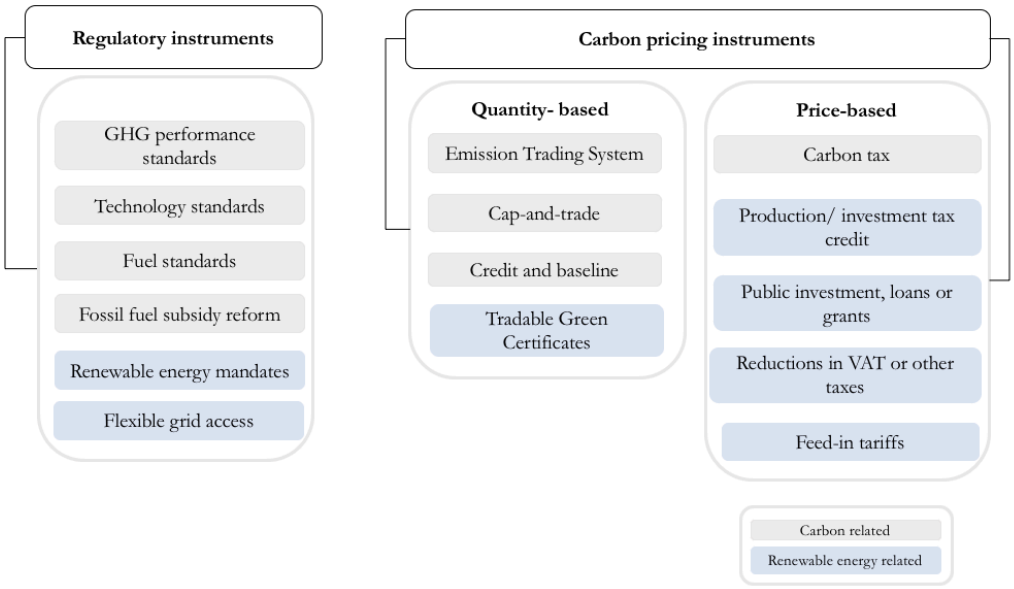
Annex 4. Fossil fuel shares in transportation sector in Colombia. 2012. Source: UPME (2015)

Annex 5. The core policy mix



Annex 5. The core policy mix: a carbon price, energy efficiency and technology policies. Source :Hood (2013)

Annex 6. Mitigation policy instrument portfolio



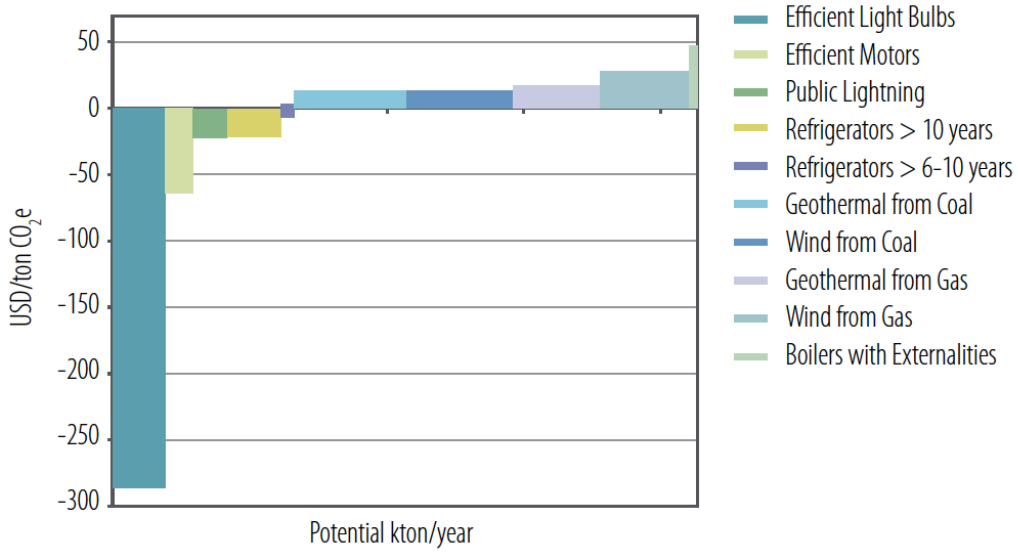
Annex 6. Mitigation policy instrument portfolio. Source: Own elaboration, Adapted from Benitez, (2012);. Castro (2017) and with inputs from European Commission (2008)

Annex 7. Fees per fossil fuel type in the carbon tax

Fuel	Unit	Fee (COP)/unit	Fuel conversion factor (kg CO_2)
Natural gas	Cubic meter	$\frac{COP\ 29}{m^3}$	1,952 $\frac{Kg\ CO_2}{m^3\ ST}$
Petroleum liquid gas	Gallon	$\frac{COP\ 95}{Gallon}$	6,333$\frac{Kg\ CO_2}{gallon}$
Gasoline	Gallon	$\frac{COP\ 135}{Gallon}$	9,000 $\frac{Kg\ CO_2}{gallon}$
Kerosene and jet fuel	Gallon	$\frac{COP\ 148}{Gallon}$	9,867 $\frac{Kg\ CO_2}{gallon}$
Diesel	Gallon	$\frac{COP\ 152}{Gallon}$	10,133 $\frac{Kg\ CO_2}{gallon}$
Fuel oil	Gallon	$\frac{COP\ 177}{Gallon}$	11,800 $\frac{Kg\ CO_2}{gallon}$

Annex. 7 Own elaboration based on the Law 1819 of 2016 and the Decree 926 of 2017(Congreso de la República, 2016; Ministerio de Hacienda y Crédito Público, 2017)

Annex 8. Abatement curve in the energy sector in Colombia



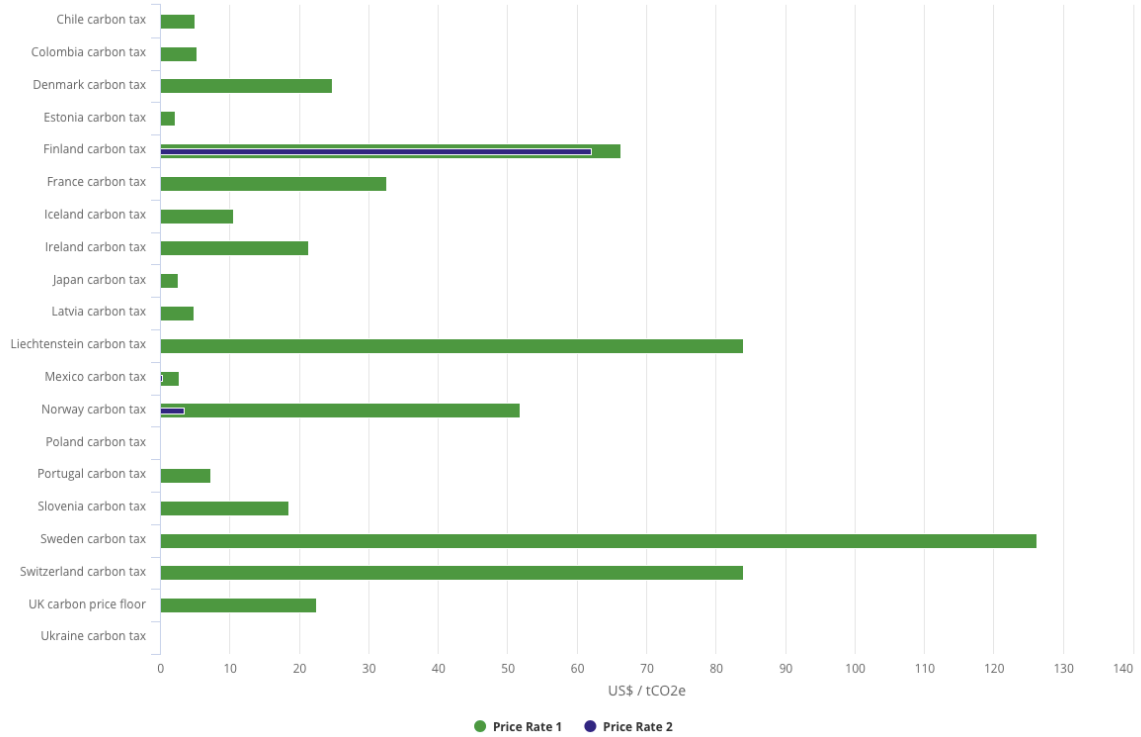
Annex 8. Marginal abatement cost for the energy efficiency, fuel replacement and technology deployment measures. Source: World Bank and DNP (2014)

Annex 9. Milestones in adoption of carbon tax worldwide.

1990	Finland adopts first carbon tax Poland carbon tax
1991	Sweden carbon tax Norway carbon tax
1992	Denmark carbon tax
1995	Latvia carbon tax
1996	Slovenia carbon tax
2000	Estonia carbon tax
2008	Switzerland carbon tax British Columbia carbon tax
2010	Ireland carbon tax Iceland carbon tax India Clean Environment Cess
2012	Australia Carbon Pricing Mechanism
2013	United Kingdom Carbon Price Floor
2014	France carbon tax Mexico carbon tax Australia Carbon Pricing Mechanism repealed
2015	South Africa publishes Carbon Tax Bill Portugal carbon tax
2016	Canada announces national Carbon Price Floor
2017	Alberta carbon tax Chile carbon tax Colombia carbon tax Singapore carbon tax announced

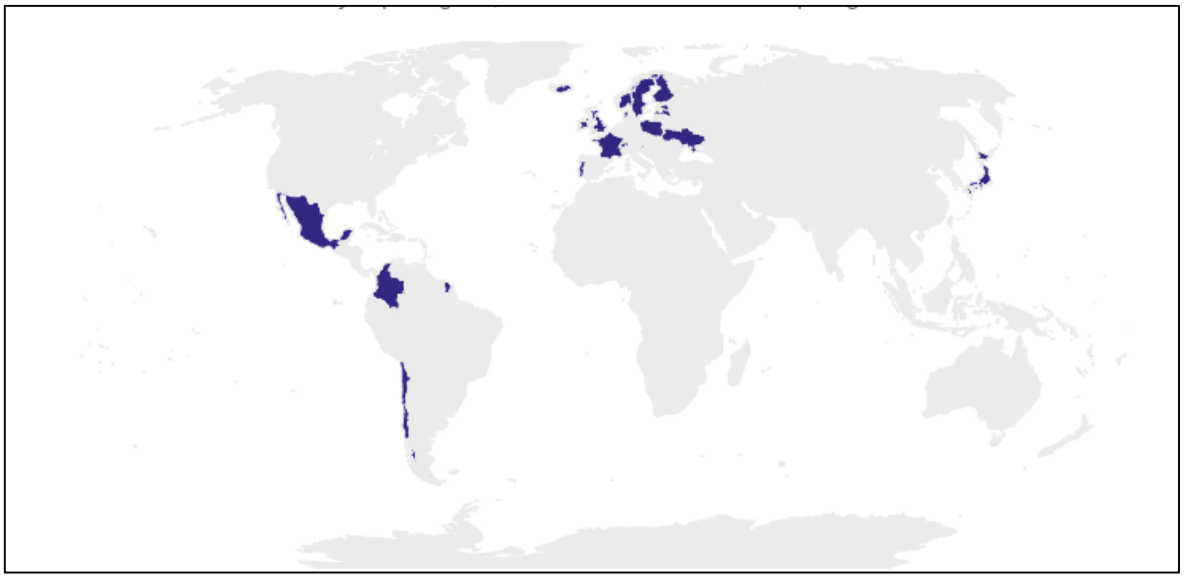
Annex 9. Milestones in adoption of carbon tax worldwide. Source: World Bank (2017c)

Annex 10. Carbon tax prices at national level



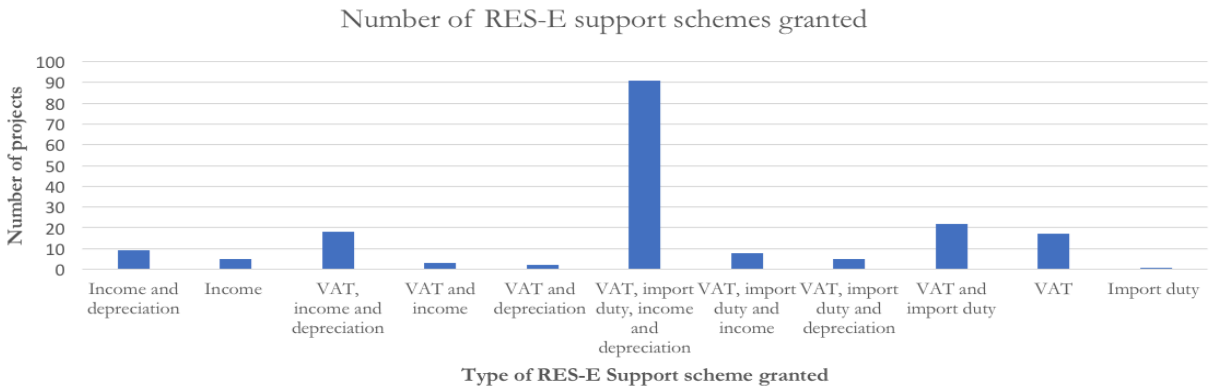
Annex 10. Carbon tax prices at national level as of April 2017. Source: (World Bank, 2017a)

Annex 11. Countries with a carbon tax implemented at national level



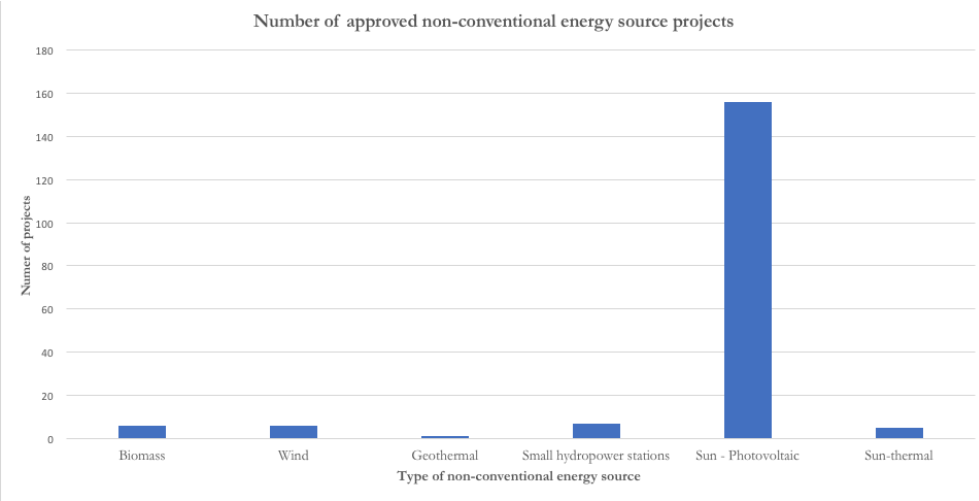
Annex 11. Countries with a carbon tax implemented at a national level as of April 2017. Source: World Bank (2017a)

Annex 12. Number of RES-E support schemes granted in Colombia



Annex 12. Number of RES-E support schemes granted since 2014. Source: UPME (2017) Translation: Author

Annex 13. Approved non-conventional energy source projects in Colombia



Annex 13. Number of approved non-conventional energy source projects. Source: UPME (2017) Translation: Author

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