Grimaldo Guerrero, John William; Rivera-Alvarado, Juan; Acosta-Bustamante, Jainer et al.

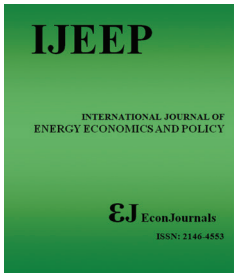
Article

Colombian oil energy security through a framework of risks and vulnerabilities

International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Grimaldo Guerrero, John William/Rivera-Alvarado, Juan et. al. (2024). Colombian oil energy security through a framework of risks and vulnerabilities. In: International Journal of Energy Economics and Policy 14 (5), S. 479 - 486. https://www.econjournals.com/index.php/ijeep/article/download/16337/8196/39043. doi:10.32479/ijeep.16337.



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2024, 14(5), 479-486.

Colombian Oil Energy Security through a Framework of Risks and Vulnerabilities

John Grimaldo-Guerrero[1]*, Juan Rivera-Alvarado[2], Jainer Acosta-Bustamante[1], Tulio Cabeza-Abello[1], Jose Osorio-Tovar[3]

[1]Universidad de la Costa, Colombia, [2]Universidad Simón Bolívar, Facultad de Administración y Negocios. Barranquilla, Colombia, [3]Estudiante de Ingeniería Eléctrica, Universidad de la Costa, Colombia, Instituto Universitario Politécnico "Santiago Mariño", Colombia. *Email: juan.rivera@unisimon.edu.co

Received: 02 April 2024 **Accepted:** 18 July 2024 **DOI:** https://doi.org/10.32479/ijeep.16337

ABSTRACT

The dynamics of oil markets are influenced by both international and local contexts, which determine their potential for success and sustainability. This article uses a conceptual methodology to analyze the characteristics that are present in successful energy markets. These characteristics can help identify inhibitors and barriers that may hinder the growth and development of the market. The analytical-propositive methodological design consists of three phases: Firstly, a diagnosis is conducted to describe the costs associated with oil production, which will allow for the identification of economic characteristics. Secondly, attributes of the Colombian oil market are identified through a documentary and regulatory analysis. Finally, strategic guidelines are inferred, which can be used as inputs for the formulation of energy policies. The results highlight that sustainable development policies must involve both public and private actors to strengthen decision-making and the quality of processes, thereby providing greater scope.

Keywords: Oil Market, Energetic Policy, Sustainable Development, Barriers, Inhibitors
JEL Classifications: Q35, Q38

1. INTRODUCTION

World energy consumption statistics present renewable energies as a replacement option, but there is a dominant position of fossil resources (Ortega & Marín, 2021). Energy commodities such as oil and gas play a strategic role in the growth of a country (Henriques and Sadorsky, 2011); having resources available is important to not put energy security at risk and ensure demand for processes. productive (Krishnan, 2016). Government agendas consider points such as possessing and maintaining a varied offer in the energy basket, to provide a reliable supply, prevent rationing, and plan supply scenarios (Cardozo, 2007; Villacís Espín, 2015); Due to fluctuations in the price of hydrocarbons, economic instabilities arise (Regnier, 2007), which modify the plans and budgets of governments (Tang et al., 2010).

World energy consumption statistics present renewable energies as a replacement option, but there is a dominant position of fossil resources. Energy commodities such as oil and gas play a strategic role in the growth of a country (Henriques and Sadorsky, 2011); having resources available is important to not put energy security at risk and ensure demand for processes. productive (Krishnan, 2016). Government agendas consider points such as possessing and maintaining a varied offer in the energy basket, to provide a reliable supply, prevent rationing, and plan supply scenarios (Cardozo, 2007; Villacís Espín, 2015); due to fluctuations in the price of hydrocarbons, economic instabilities arise (Regnier, 2007), which modify the plans and budgets of governments (Tang et al., 2010).

The Colombian government predicted that by 2021 the country will lose oil self-sufficiency (CGR, 2017a). This scenario establishes that all the crude oil produced in the national territory will not

be enough to supply the refineries and the missing resources will have to be imported. The Colombian government raised the need to accelerate mining-energy development (DPN, 2015; Ley 1753, 2015) and exposed the need to maintain self-sufficiency in fossil fuels (UPME, 2015), to avoid the loss of self-sufficiency. They proposed alternatives such as the exploitation of unconventional hydrocarbons, the exploitation of offshore hydrocarbons, and the import of gas.

At present, commercial exploitation of offshore hydrocarbons is in the department of La Guajira, and discoveries in different areas of the Colombian Caribbean Sea (Castellanos et al., 2017; Bogotá Sanabria et al., 2018; ANH, 2018). The start of offshore activities requires the preparation of the Caribbean region to optimize its development and growth (Castellanos et al., 2017); due to the economic, environmental, and social implications, there is a great challenge to achieve convergence and generate sustainable development.

The Colombian oil sector is a strategic asset for the nation's finances due to its economic contributions (López et al., 2013), it contributed from 30% to 50% of total exports, by 2018 it had 40% of total exports (DANE, 2019); during the years 2006 to 2013, they maintained participation above 30% of foreign direct investment (UPME, 2015). By the end of 2014, the fall in hydrocarbon prices caused a fiscal deficit in the government in subsequent years (CGR, 2017b; González Tique and Hernández García, 2016), forcing the restructuring of the contractual model (ANH, 2018). And the increase in 2D and 3D seismic exploration activities by the ANH (ANH, 2018).

The present research conducts a review of the Colombian oil market and the identification of gaps that can serve as facilitators for the sustainable development of the sector (Idemudia, 2012; Adams et al., 2019). The work begins with Section 1, which presents the motivation to maintain the oil market as a strategic sector for the nation's development. Section 2 outlines the stages and procedure of this analytical-propositional research. The institutional framework involved in the development of oil projects is depicted in Section 3. Section 4 presents the relationship of hydrocarbon prices as the final decision-making element for the execution of oil projects. Section 5 links the current situation of the country with the concepts proposed by (Mallon, 2006) to achieve a successful energy market, which will allow the recognition of inhibitors that can be used as key factors for sector development. Section 6 builds upon the concepts of Section 5 and proposes guidelines within a framework of vulnerabilities for the different levels of the oil sector. Section 7 denotes the limitations of the study and future research directions associated with the oil market.

The outcome of the study will enable the identification of specific characteristics of the sector and key points to close gaps, thus facilitating sustainable development in the oil industry, mitigating risks to energy security, and enhancing market conditions.

2. METHODOLOGY

The research design adopts an analytical-propositional approach, aiming to analyze, from both conceptual and methodological dimensions, the standardized characteristics applied to the development of successful oil markets. The methodology involves examining the institutional framework regulating the development of oil projects and analyzing the relationship of hydrocarbon prices as a determinant variable for project execution decisions. Drawing on concepts outlined by Mallon (2006), inhibitors are identified, and through a vulnerability framework, strategies and strategic guidelines are defined for strengthening the Colombian oil market. Procedural systematization is organized into three research phases. The first phase describes costs attributed to the price of oil production. The documentary review was conducted across various information sources regarding costs associated with the design and execution of oil projects, allowing for the identification of economic characteristics affecting production prices, which in turn have a close relationship between energy supply and demand.

The second phase examines the characteristics outlined by Mallon (2006), who presents ten conditions that underpin the success of the renewable energy market; these are analyzed within the context of the Colombian oil sector. These elements are regarded as catalysts for organizational and social development processes in the energy sphere, as they allow for the identification of facilitators, inhibitors, and barriers. Recognizing energy policies entails not only identifying these elements but also understanding the framework within which they are interacting. International experiences from one country to another demonstrate that a lack of understanding of these processes can lead to a chain of doubts or conceptual and procedural gaps concerning the most relevant strategic vision in line with the intended objectives (Estrada Gasca, 2013). From this perspective, the analysis requires identifying the strengths and weaknesses of Colombia's oil sector concerning planning and policy formulation processes, as well as the methodological approaches adopted as inputs for defining and implementing short, medium, and long-term plans.

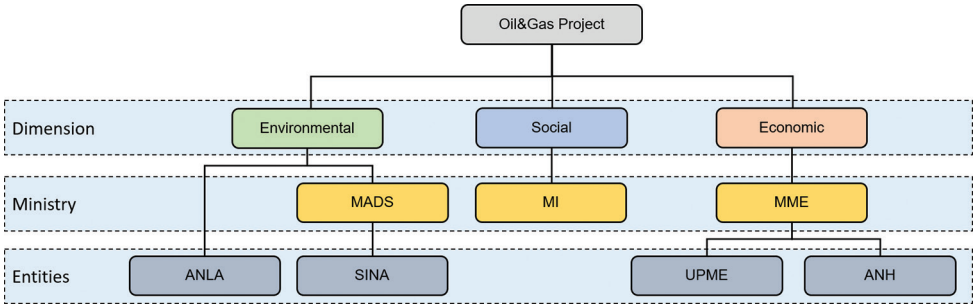
Finally, the third phase entails identifying actions or objectives for the sustainable management of long-term planning processes. The outcomes are articulated as intervention proposals, whose subsequent analysis enables the determination of their relevance for integration into the definition of energy policies suitable for adoption in Colombia.

3. COLOMBIAN INSTITUTIONAL FRAMEWORK FOR THE HYDROCARBONS SECTOR

Colombia's renewable and non-renewable resources are owned by the state, which is responsible for managing and creating development and utilization plans. Ministries are tasked with improving effectiveness and are entrusted with managing and coordinating a strategic sector of the State. Figure 1 presents an organizational chart of entities directly involved in the execution of an oil project, segmented according to the dimension of sustainable development they predominantly affect.

In Colombia, the Ministry of Mines and Energy (MME) is responsible for administering non-renewable natural resources

Figure 1: Organization chart and entities associated with an oil project



and ensuring energy security (MME, 2018). It also formulates policies for the sustainable use of mining and energy resources for Colombia's development. Additionally, the MME manages planning, formulation, and coordination processes in the mining-energy sector through the Mining-Energy Planning Unit (UPME) (UPME, 2018), while the National Hydrocarbons Agency (ANH) administers the utilization of hydrocarbon resources by granting permits for exploration and subsequent exploitation.

Projects conceived within executing units are closely related to other ministries such as the Ministry of Environment and Sustainable Development (MADS), which manages and administers natural resources (MADS, 2018), and the Ministry of the Interior (MI), responsible for ensuring citizen participation (MI, 2018). The Directorate of Territorial Environmental Planning and the National Environmental System (SINA), under the MADS, aims to coordinate policies, plans, and programs in environmental and renewable natural resources, identifying protection areas and ensuring proper use of the territory and its natural resources. Environmental approvals for projects are obtained through an environmental license issued by the Environmental Licensing Authority (ANLA) (ANLA, 2018).

Figure 1 is organized into three levels. The first level encompasses the dimension of sustainable development, while the second level includes the ministries responsible for ensuring the security and compliance of this dimension. Lastly, entities with strong relationships are identified.

Within the economic dimension, the Ministry of Mines and Energy (MME), along with the UPME and ANH, are situated. They are tasked with maintaining the hydrocarbon resources necessary to meet demand. The exploitation of mining and oil resources accounts for approximately 5% of the nation's GDP (BANREP, s.f.), and the hydrocarbon sector represents 60% of the mining-oil GDP (ANDI, 2018), making it a strategic sector for state finances.

The social dimension is managed by the Ministry of the Interior (MI), which certifies the presence and ensures the participation rights of the population and ethnic minorities in the project's area of influence through the mechanism of prior consultation (MI, 2019). This mechanism facilitates the dissemination, socialization, and training of different concepts and regulations to ethnic communities, public institutions, and companies, to formulate agreements and enable project development (Castillo, 2012; Morris et al., 2009).

The environmental dimension is overseen by the Ministry of Environment and Sustainable Development (MADS), along with the SINA and ANLA entities. The MADS enables territorial planning to identify strategic zones for resource utilization and creates protection zones according to environmental guidelines (MADS, 2019). ANLA is an autonomous entity responsible for granting or denying environmental licenses following the law (FB, 2017).

The relationship among these entities facilitates the conception and unhindered development of the oil project. Negative concepts could lead to delays and even project cancellation. These impacts would have economic ramifications and, depending on the generated revenues, could jeopardize continuity.

4. PRODUCTION COST SENSITIVITY

The final investment decision, where profitability in the project is defined within the existing context, primarily considers the probability of success, political stability, fiscal regime, and product price (Daniel, 2002; Lagos León, 2010; Long, 2008; Njeru, 2010; Adams et al., 2019; Davis and Lund, 2018). The first factor tends to have a high success rate due to investments and steps taken to gather information and reduce uncertainty (Lagos León, 2010). Political stability instills confidence in investors, which improves depending on the political leaders in office and their statements regarding support for the sector (Daniel, 2002; Long, 2008; Adams et al., 2019). Fiscal policies within the sector can either be favorable or unfavorable, and this relationship may improve depending on the market price of the product (Daniel, 2002; Corkin, 2009; Njeru, 2010; Metcalf, 2018).

The design and execution of projects aimed at mining-energy development face the main challenge of high costs and the time required to achieve a return on invested capital. Two components associated with this dynamic categorize costs as Capital Expenditure (CAPEX) and Operational Expenditure (OPEX). Figure 1 presents the concepts and elements to consider for calculating costs integrated into the structuring of an energy project.

In the specific case of extractive industries such as oil and mining, investment, execution, administration, operation, maintenance, and other associated expenses are high (Daniel, 2002; Al-Saadoon and Nsa, 2009; Davis and Lund, 2018). In Colombia, production

costs vary depending on the region. The average extraction cost (placing a barrel of crude from the reservoir to the surface) in the country is USD 19.4 (Malagón, 2016). For oil prices below 40 dollars, production is not profitable because the extraction activity has a value close to 25 dollars, with the remaining costs attributed to activities such as transportation and processing (Malagón, 2016).

Cost variations depend on logistics, reservoir type, and the quality of the crude produced (Oyewole, 2016). Figure 2 presents CAPEX and OPEX values for oil barrel production in countries with oil production. The graph lists them in descending order based on their total cost.

Compared to other countries, Colombia ranks seventh (7th) with a total cost of 35.3 USD, placing it alongside countries such as Norway, Angola, and Nigeria, whose production sources lie in offshore exploitation. Regarding CAPEX costs, it has an average value of 15.5 USD, ranking twelfth (12th), while OPEX costs have an average value of 19.8 USD, placing it fourth (4th). Figure 3 presents the components that contribute to CAPEX and OPEX costs. Partially, it can be concluded that costs are rooted in the following three components: Equipment values, field administration and operation, and payments of taxes and royalties agreed upon by the E&P contract of the ANH (ANH, 2018). Literature highlights the need for clarity and stability in fiscal policy to maintain low volatility and aid in economic recovery (Daniel, 2002; Long, 2008; Adams et al., 2019; Bernanke, 2012; Fernández-Villaverde et al., 2015; Davis and Lund, 2018; Brown et al., 2018; Metcalf, 2018). The relationship between utility, income, and deductions can be formulated (Njeru, 2010; Castillo and Dorao, 2012):

TU=TI−TC−RT (1)	Where:
TI=P*Q (2)	TU=Total Utility
TC=CAPEX+OPEX (3)	TI=Total Income
TU=P*Q−(CAPEX+OPEX)−RT (4)	TC=Total Costs
	RT=Royalties and Taxes
	P=Price of a barrel of hydrocarbon
	Q=Number of barrels of hydrocarbon

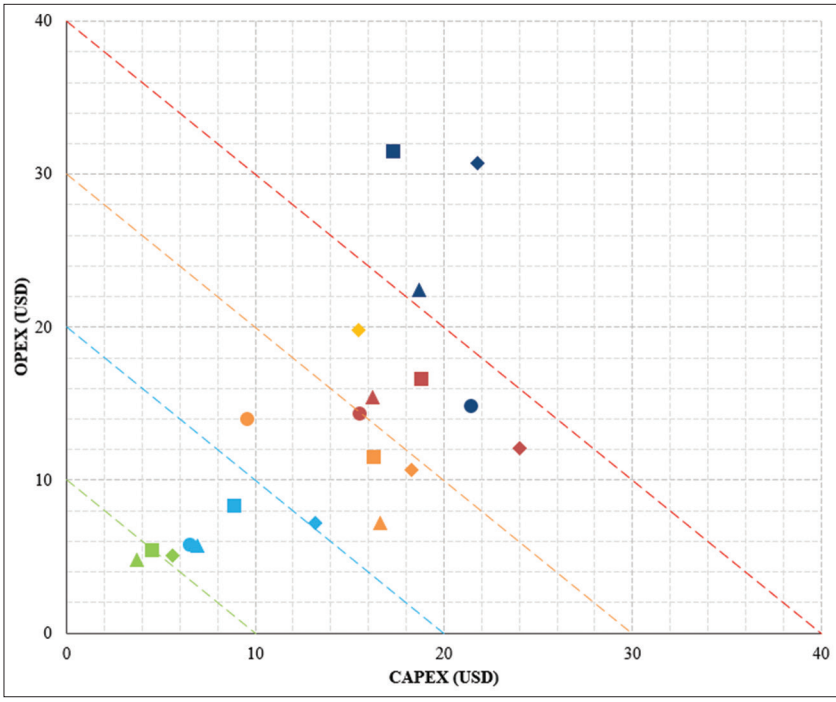
In this sense, it can be inferred from (4) that to achieve high profitability, the following conditions may exist: (1) High hydrocarbon prices, (2) High production, (3) Low production costs, and/or (4) Incentivizing fiscal policies. It is worth noting that the price of hydrocarbons is uniform across all markets (Lanteri, 2014), thus becoming a variable dependent on the global economy and difficult to control. Conversely, production can be adjusted to achieve lower or higher production volumes based on administrative and operational decisions in the field, and costs can be reduced through excellent management; the latter two variables are manageable, primarily the latter. Fiscal policy is the only instrument within the government's control that can attract investors through tax deductions, royalties, or charges in line with market conditions (Brown, 2018; Metcalf, 2018).

The relationship (4) depicts a dependence on profits and the volatility of hydrocarbon prices (Tang et al, 2010), which in turn relies on the approval of oil projects, as it enables short investment return times.

5. KEY FACTORS FOR INHIBITOR IDENTIFICATION

Mallon (2006) proposes, based on lessons learned and errors in energy market policies, key factors for designing and

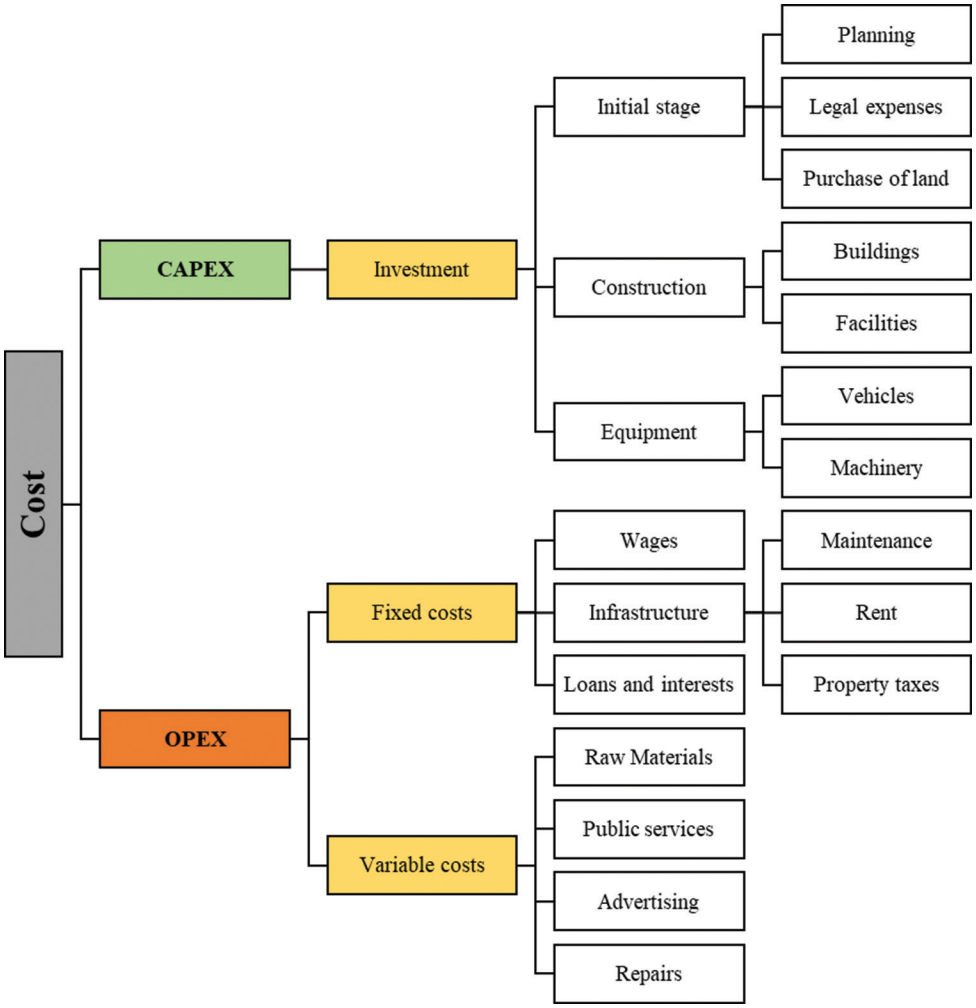
Figure 2: CAPEX, OPEX and Total costs in dollars to produce a barrel of oil in different countries



Country	CAPEX (USD)	OPEX (USD)	Total (USD)
United Kingdom	21,8	30,7	52,5
Brazil	17,3	31,5	48,8
Canada	18,7	22,4	41,1
USA	21,5	14,8	36,3
Norway	24,0	12,1	36,1
Angola	18,8	16,6	35,4
Colombia	15,5	19,8	35,3
Nigeria	16,2	15,4	31,6
China	15,6	14,3	29,9
Mexico	18,3	10,7	29,0
Kazakhstan	16,3	11,5	27,8
Libya	16,6	7,2	23,8
Venezuela	9,6	13,9	23,5
Algeria	13,2	7,2	20,4
Russia	8,9	8,3	17,2
Iran	6,9	5,7	12,6
U.A.	6,6	5,7	12,3
Iraq	5,6	5,1	10,7
Saudi Arabia	4,5	5,4	9,9
Kuwait	3,7	4,8	8,5

Source: Statista, 2015

Figure 3: Costs imputed to mining-energy development projects. Adapted from: Al-Saadoon and Nsa, 2009; Lagos León, 2010; Njeru, 2010



implementing energy policies. He suggests the following 10 concepts: (1) Transparency, (2) Defined objectives, (3) Contextual frameworks, (4) New resources and technologies, (5) Appropriately applied incentives, (6) Land use planning, (7) Risk distribution improving cost-benefit, (8) Energy market reform, (9) Suitability, and (10) Stability. These factors allow for the creation of a conceptual framework regarding Colombia's social, environmental, and economic context, which influence the oil market and can generate schemes for designing energy policies for sustainable development.

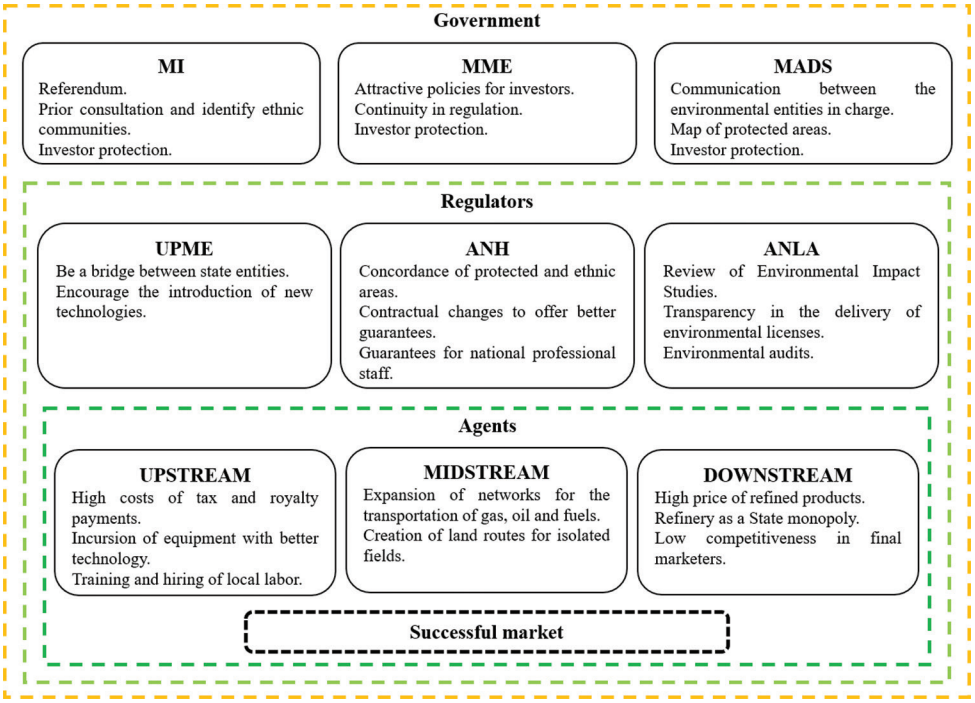
The definition of clear and straightforward policies, not subject to free interpretation, covering all necessary bases, is crucial. Providing transparency allows market freedom and encourages greater stakeholder participation (Kozulj, 2002). Defined objectives must be offered with clarity regarding expected outcomes, to focus goals and relate to those with common ends, ensuring better impacts and results. Proposals for energy policies should fit within contextual frameworks guided by international agreements, as they provide clarity and enable international cooperation (Toro, Garavito, López, & Montes, 2015).

The introduction of new resources and technologies will entail process improvements and higher CAPEX and OPEX compared to previous values (Kong and Ohadi, 2010), necessitating policies to incentivize technological migration in the market. With appropriately applied incentives, investment will follow a route in selecting technologies under a profitable CAPEX and OPEX strategy (Metcalf, 2018), which must be adjusted to maximize long-term utilization and enable sequential migration.

The lack of clarity in environmental protection boundaries (T-445/16, 2016), areas of ethnic communities (ICESCR, 1966; T-129/11, 2011), and characterization for their use (SU217/17, 2017) underscores the need for land use planning to remove obstacles and delays, providing assurances to investors. Environmental impacts on oil projects are significant; integrating new technologies and land use planning will allow for risk distribution, improving cost-benefit (Martínez Alier, 2004; Alfaro Ramos and Guevara, 2013).

Energy market reform should aim for market liberalization (Kozulj, 2002), allowing new participants to enter and generate market changes. The suitability of the policy to be implemented must be linked to its efficiency and deficiency, which should be tested for self-sufficiency and profitability. The success of a project is tied to its CAPEX and OPEX; they will define profitability, necessitating a long-term vision policy to provide stability and ensure market security for stakeholders.

Figure 4: Vulnerability framework within the levels of the colombian oil sector



6. FRAMEWORK OF RISKS AND VULNERABILITIES

Security is based on the ability to prevent, avoid, and control as many risks as possible and to create a secure environment based on facts and perceptions. Achieving this requires identifying vulnerabilities within the system, reducing their effects, and strengthening reaction capacities to hazards. This allows for improvements in security in terms of availability, accessibility, affordability, and acceptability (Cherp and Jewell, 2014); this is achieved through the integration of different stakeholders involved in the sector.

As discussed in Section 5, it enables the approximation and identification of vulnerabilities within the Colombian oil market, presented in Figure 4. This relational framework is proactive, integrating management guidelines for sustainable and competitive development within the institutional framework of the Colombian oil market. The framework comprises three levels: government, regulators/state entities, and market agents, reflecting the responsibility that involves the government and public entities, requiring collaboration with the private sector for plan execution.

At the first level, where ministries are situated, emphasis is placed on investor protection, regulatory stability, and transparency in mechanisms defining citizen participation and environmental limitations within the project's area of influence, aiming to prevent low credibility and distrust among the population. The second level presents administrative vulnerabilities stemming from communication gaps, extended time lapses, and insufficient guarantees for the population. Market agents within the oil sector occupy the innermost zone, as most of the investment comes from the private sector. Their vulnerabilities primarily concern infrastructure and project cost structure.

The results obtained from the vulnerability framework suggest that current conditions are amenable to improvement, and it is necessary to quantify the degree of vulnerability through energy security assessments considering variables such as government, infrastructure, and market resilience.

7. CONCLUSIONS

The development of nations is determined by their ability to supply their own resources, but in scenarios of scarcity, they must rely on suppliers to meet demand. There are not inherently more efficient and/or productive regulatory models; they merely prioritize the needs and functions of technical and administrative bodies related to the sector.

The research presented the institutional framework concerning the petroleum sector in its various sections, establishing the relationship between profits and variables such as price, production, and costs/expenses. Price emerges as the decisive variable in project approval, while royalties and taxes represent variables that the government can manage to generate incentives. A methodology used to define a framework for market success in the context of the Colombian oil market was related, and a vulnerability framework was designed from this, which can serve as input for designing new assessments and guidelines for market management and operation.

The methodology allowed for the identification of risks and vulnerabilities, emphasizing that private sector participation and government support are key factors for the performance of the oil market, primarily to instill confidence and credibility. Incentives for investment must be considered, along with fostering an environment of stability and reliability, especially in times when hydrocarbon prices are not high.

The literature presents the relationship between state finances and the profitability outcomes of the oil production chain; thus, investment is necessary to achieve the goals set forth in (DPN, 2015; Ley 1753, 2015).

The results obtained from the vulnerability framework suggest that current conditions are amenable to improvement, and it is necessary to quantify the degree of vulnerability through energy security assessments considering variables such as government, infrastructure, and market resilience. Pragmatic research and analysis are being conducted related to the sustainable development of the oil market using international models, forming supportive frameworks for decision-making in the Colombian oil sector. It is expected that the research will contribute to the conception of strategic energy planning processes and a policy roadmap to manage the growth of the hydrocarbon sector.

REFERENCES

Adams, D., Adams, K., Ullah, S., Ullah, F. (2019), Globalisation, governance, accountability and the natural resource "curse": Implications for socio-economic growth of oil-rich developing countries. Resources Policy, 61, 128-140.

Alfaro Ramos, A., Guevara, M. (2013), Relación Costo-beneficio de los Mecanismos de Compensación que Entrega Ecopetrol a la Comunidad Afectada, en Relación a los Pasivos Ambientales Propiciados por los Derrames de Petróleo en Barrancabermeja. Colombia: Corporación Universitaria Iberoamericana.

Al-Saadoon, F.T., Nsa, A. (2009), Economics of LNG Projects. In SPE Oklahoma City Oil and Gas Symposium/Production and Operations Symposium (pp. SPE-120745).

ANDI. (2018), Informe Balance 2018 Prespectivas 2019. Asociación Nacional de Empresarios de Colombia. Available from: https://www.andi.com.co/Uploads/ANDI%20-%20Balance%202018%20y%20Perspectivas%202019%20-%20Diciembre%2025.pdf

ANH. (2018), Contrato E&P-TEA. Agencia Nacional de Hidrocarburos. Available from: https://www.anh.gov.co/asignacion-de-areas/relacion-de-areas-asignadas/paginas/contrato-eandp-tea.aspx

ANH. (2018), Funciones. Obtenido de Agencia Nacional de Hidrocarburos. Available from: https://www.anh.gov.co/la-anh/paginas/funciones.aspx

ANH. (2018), Informe de Gestión 2018. Agencia Nacional de Hidrocarburos. Available from: https://www.anh.gov.co/la-anh/Informes%20de%20Gestin/Informe%20de%20gesti%C3%B3n%20ANH%202018.pdf

ANH. (2018), Nuevo Modelo de Contrato Para Fomentar Mayor Inversión De Hidrocarburos en Colombia. Obtenido de Agencia Nacional de Hidrocarburos. Available from: https://www.anh.gov.co/sala-de-prensa/lists/anuncios/noticias.aspx?id=312

ANLA. (2018), Funciones. Available from: https://www.anla.gov.co/funciones-anla

Art 105. (1991), In Constitución Política de Colombia.

BANREP. (s.f.), PIB, Metodología año Base 2015. Available from: https://www.banrep.gov.co/es/pib

Bernanke, B.S. (2012), The Economic Recovery and Economic Policy. (T. a. Club, Ed.). Available from: https://www.federalreserve.gov/newsevents/speech/bernanke20121120a.pdf

Bogotá Sanabria, G.H., Flórez García, A.C., Guzman Manrique, J.A. (2018), Sensibilidad ambiental ante un posible derrame offshore aplicando tecnologías geoespaciales, Costa Caribe Colombiana. Revista AIDIS de Ingeniería y Ciencias Ambientales: Investigación, Desarrollo y Práctica, 11(1), 95-109.

BP. (2018), Statistical Review of World Energy. Available from: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

Brown, J., Maniloff, P., Manning, D. (2018), Effects of State Taxation on Investment: Evidence from the Oil Industry. Federal Reserve Bank of Kansas City Working Paper, 18-07.

Cardozo, E. (2007), La Integración Energética Regional: Factor de (in) Gobernabilidad/(in) Seguridad. Retos y Perspectivas de la Integración Energética en América Latina. p101-112. Available from: https://www.ildis.org.ve/website/administrador/uploads/DocumentoCardozoIntegracionenergeticapdf

Castellanos, A., Lombana, J., Riomalo, A.M. (2017), Exploración y explotación de hidrocarburos aguas afuera (offshore). Estrategia logística para Barranquilla, una ciudad en transformación. Equidad and Desarrollo, 28, 85-11.

Castillo, L., Dorao, C. (2012), Consensual decision-making model based on game theory for LNG processes. Energy Conversion and Management, 64, 387-396.

Castillo, Y. (2012), El rol de la empresa transnacional extractiva de petróleo en la con sulta previa con las comunidades indígenas: La experiencia en Colombia. Revista de derecho: División de Ciencias Jurídicas de la Universidad del Norte, 37, 1-35.

CGR. (2017a), Autosuficiencia Petrolera en Colombia. Bogotá: Boletín Macro Sectorial. Contraloría General de la Republica. Available from https://www.contraloria.gov.co/documents/463406/484739/bolet%c3%adn+macrosectorial+no.+06+%28pdf%29/f01dfce0-493c-423a-9148-244fce46edc1?version=1.2

CGR. (2017b), Fundamentales Del Mercado Petrolero y la Economía Colombiana. Bogotá: Boletín Macro Sectorial. Contraloría General de la Republica. Available from: https://www.contraloria.gov.co/documents/463406/484739/bolet%c3%83%c2%adn+macrosectorial+no.+07+(pdf)/fdf3b8ad-64e1-4659-8879-796dea60fd27?version=1.0

Cherp, A., Jewell, J. (2014), The concept of energy security: Beyond the four as. Energy Policy, 75, 415-421.

Corkin, L. (2009). Angola's current economic prospects: Oil Curse or Blessing? Análisis del Real Instituto Elcano, 4, 1.

DANE. (2019), Departamento Administrativo Nacional de Estadística. Exports of Colombia/Coffee, Coal, Oil and its Derivatives, Ferronickel and Non-Traditional. Available from: https://www.dane.gov.co/index.php/estadisticas-por-tema/comercio-internacional/exportaciones

Daniel, P. (2002), Petroleum Revenue Management. An Overview. Washington, DC: World Bank.

Davis, G.A., Lund, D. (2018), Taxation and investment decisions in petroleum. The Energy Journal, 39(6), 189-208.

DPN. (2015), Departamento de Planeación Nacional. Retrieved from Plan Nacional de Desarrollo 2014-2018. Available from: https://colaboracion.dnp.gov.co/CDT/PND/PND%202014-2018%20Tomo%201%20internet.pdf

Estrada Gasca, C.A. (2013), Transición energética, energías renovables y energía solar de potencia. Revista Mexicana de Física, 59(2), 75-84.

FB. (2017), Manual Estrutura del Estado: Sector Ambiente y Desarrollo Sostenible. Available from: https://www.funcionpublica.gov.co/documents/418537/7869206/13+sector+ambiente.pdf/181ecde0-31c7-410e-950b-fb0d721451fb

Fernández-Villaverde, J., Guerrón-Quintana, P., Kuester, K., Rubio-Ramírez, J. (2015), Fiscal volatility shocks and economic activity. American Economic Review, 105(11), 3352-3384.

González Tique, S.L., Hernández García, E.A. (2016), Impactos indirectos de los precios del petróleo en el crecimiento económico colombiano. Lecturas de Economía, 84, 103-141.

Henriques, I., Sadorsky, P. (2011), The effect of oil price volatility on strategic investment. Energy Economics, 33(1), 79-87.
ICESCR. (1966), Art 01. ICESCR - International Covenant on Economic, Social and Cultural Rights. Available from: https://www.ohchr.org/EN/professionalinterest/pages/cescr.aspx
Idemudia, U. (2012), The resource curse and the decentralization of oil revenue: The case of Nigeria. Journal of Cleaner Production, 35, 183-193.
Kong, X., Ohadi, M. (2010), Applications of Micro and Nano Technologies in the Oil and Gas Industry - Overview of the Recent Progress. In: Abu Dhabi International Petroleum Exhibition and Conference.
Kozulj, R. (2002), Balance de la Privatización de la Industria Petrolera en Argentina y su Impacto Sobre las Inversiones y la Competencia en los Mercados Minoristas de Combustibles. Vol. 46. Santiago de Chile: United Nations Publications.
Krishnan, R. (2016), Energy security through a framework of country risks and vulnerabilities. Energy Sources, Part B: Economics, Planning, and Policy, 11(1), 32-37.
Lagos León, E. (2010), Evaluación Del Riesgo financiero en Proyectos Mineros Marginales. Lima, Perú: Universidad Nacional de Ingeniería.
Lanteri, L. (2014), Determinantes De Los Precios Reales Del Petróleo y su Impacto Sobre Las Principales Variables Macroeconómicas: Eu, España, Noruega y Argentina. Scientific Electronic Library Online(41). Available from: https://scielo.unam.mx/pdf/etp/n41/n41a3.pdf
Ley 1753. (2015). Available from: https://www.secretariasenado.gov.co/senado/basedoc/ley_1753_2015.html
Long, G. (2008), El mito de la inestabilidad: Estabilidad política y crecimiento económico en Ecuador. Ecuador Debate, 74, 155-186.
López, E., Montes, E., Garavito-Acosta, A.L., Collazos-Gaitán, M.M. (2013), Capítulo 9. La economía petrolera en Colombia. En B. d. Republica, Flujos de Capitales, Choques Externos y Respuestas De Política En Países Emergentes. Banco de la República-Colombia. p.337-406.
MADS. (2018), Objetivos y Funciones. Available from: https://www.minambiente.gov.co/index.php/ministerio/objetivos-y-funciones
MADS. (2019), Ministerio de Ambiente y Desarrollo Sostenible. Obtenido de Sistema Nacional Ambiental SINA. Available from: https://www.minambiente.gov.co/index.php/ordenamiento-ambiental-territorial-y-coordinacion-del-sina/sistema-nacional-ambiental-sina#documentos-de-int%C3%A9res
Malagón, J. (2016), La Competitividad del Sector de Hidrocarburos en las Diferentes Regiones de Colombia. In: Programa de la Naciones Unidas para el Desarrollo - PNUD.
Mallon, K., editor. (2006), Ten features of successful renewable markets. En: Renewable Energy Policy and Politics: A Handbook for Decision-making. Londres: Earthscan. p35-84.
Martínez Alier, J. (2004), Los conflictos ecológico-distributivos y los indicadores de sustentabilidad. Revibec: Revista de la Red Iberoamericana de Economía Ecológica, 1, 21-30.
Metcalf, G.E. (2018), The impact of removing tax preferences for US oil and natural gas production: Measuring tax subsidies by an equivalent price impact approach. Journal of the Association of Environmental and Resource Economists, 5(1), 1-37.
MI. (2018), Funciones. Available from: https://www.mininterior.gov.co/el-ministerio/funciones-y-deberes
MI. (2019), Consulta Previa. Ministerio del Interior. Available from: https://consultaprevia.mininterior.gov.co/node/21329
MME. (2018), Misión y Visión. Available from: https://www.minminas.gov.co/mision-y-vision
Morris, M., Garavito, C.R., Salinas, N.O., Buriticá, P. (2009), La Consulta Previa a Pueblos Indígenas: Los Estándares Del Derecho Internacional. Documentos Número 2. In: Programa de Justicia Global y Derechos Humanos. p1-52.
Njeru, K.A. (2010), Kenya oil and gas fiscal regime: An economic analysis on attainment of the government objectives. CAR CEPMLP Annual Review, 12(1), 1-34.
Ortega, A. T., & Marin, D. F. (2021), Fracking como garantía de Seguridad Energética en países con bajas reservas de petróleo convencional. Inge CUC, 17(1), 201-215.
Oyewole, P. (2016), Artificial Lift Selection Strategy to Maximize Unconventional Oil and Gas Assets Value. In: SPE North America Artificial Lift Conference and Exhibition. Society of Petroleum Engineers.
Regnier, E. (2007), Oil and energy price volatility. Energy Economics, 29(3), 405-427.
Statista. (2015), The Statistics Portal. Available from: https://www.statista.com/statistics/597669/cost-breakdown-of-producing-one-barrel-of-oil-in-the-worlds-leading-oil-producing-countries [Last accessed on 2018 Jan 09].
SU217/17. (2017), Sentencia SU217/17 - Derecho a La Consulta Previa De Comunidad Indigena (Corte Constitucional 18 De Abril De 2017).
T-129/11. (2011), Sentencia T-129/11 - Licencia Ambiental y del Plan De Manejo Arqueologico Para La Proteccion De Bienes De Interes Cultural (Corte Constitucional 03 de Marzo de 2011).
T-445/16. (2016), Sentencia T-445/16-Principio De Coordinacion, Concurrencia y Subsidiariedad En El Reparto De Competencias Entre La Nacion Y Las Entidades Territoriales (Corte Constitucional 19 de Agosto de 2016).
Tang, W., Wu, L., Zhang, Z. (2010), Oil price shocks and their short-and long-term effects on the Chinese economy. Energy Economics, 32, S3-S14.
Toro, J., Garavito, A., López, D. C., & Montes, E. (2015), El choque petrolero y sus implicaciones en la economía colombiana. Borradores de economía, 906, 1-65.
UPME. (2015), Evaluación de la Contribución Económica Del Sector de Hidrocarburos Colombiano Frente a Diversos Escenarios de Producción. Bogota, Colombia: UPME.
UPME. (2015), Plan Energético Nacional Colombia: Ideario Energético 2050. Available from: https://www.upme.gov.co/docs/pen/pen_idearioenergetico2050.pdf
UPME. (2018), Quiénes Somos. UPME: https://www1.upme.gov.co/entornoinstitucional/nuestraentidad/paginas/quienes-somos.aspx
Villacís Espín, R.A. (2015), Análisis Político-Económico de la Inclusión de la República Popular de China en la Agenda Hidroeléctrica y Petrolera de la República del Ecuador Durante la Administración de Rafael Correa 2007-2012. Master's thesis, Quito, Ecuador: Flacso Ecuador. Available from: https://hdl.handle.net/10469/8783