REGIONAL ASSOCIATION OF
OIL, GAS AND BIOFUELS SECTOR COMPANIES
IN LATIN AMERICA AND THE CARIBBEAN

Opportunities for the development of unconventional oil and gas in Latin America and the Caribbean

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Content

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1 Objective

Recently, there has been an international increased interest in the development of hydrocarbon resources in low-permeability reservoirs, commonly known as unconventionals (shale/tight oil/gas). Technological advances and the experience gained allow some of these projects to be technically and economically viable in a sustainable framework. This is of interest to many countries that may see their hydrocarbon reserves and production increased and their energy security -and industrial development- strengthened.

In this context, the Regional Oil, Gas and Biofuels Sector Companies in Latin America and the Caribbean (ARPEL) developed this document with the purpose of sharing with all stakeholders the **most significant aspects relating to the exploration and exploitation of these unconventional hydrocarbons**, as well as **proposals for the development of these resources in Latin America and the Caribbean to take place in a sustainable manner and for the benefit of the countries in the Region**.

These alternatives are aligned with the key concepts established in the "Golden rules for a golden age of gas" developed for the International Energy Agency by a multi-stakeholders group (IEA, 2012) and are described as tables at the end of each chapter. The alternatives are intended to serve as a guide for a rational and sustainability approach to exploration and exploitation of unconventional resources with a focus on:

- regulatory aspects
- best industry practices to strengthen the management throughout the value chain of the oil and gas sector

The document makes proposals for industry and governments to accomplish the sustainable development of unconventional oil and gas in Latin America and the Caribbean

Location of unconventional resources basins in Latin America and the Caribbean

(Source: EIA, 2013 and YPF)

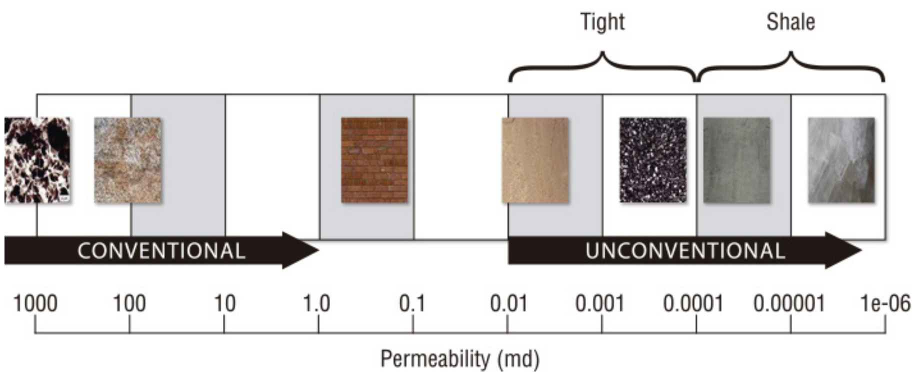
2 What are unconventional reservoirs and what is their significance for Latin America and the Caribbean?

Hydraulic stimulation has been used in more than 2 million wells throughout the world since the 1940s

Hydrocarbons in a reservoir accumulate in pores that may be more or less connected among themselves, which implies having a higher or lower permeability, i.e. the property by which the hydrocarbon can flow through the rock more or less easily. In conventional reservoirs, the permeability of the rock may be enough for the hydrocarbon to flow to the surface naturally, without the need to carry out any well intervention. When the permeability of a reservoir is low (as is the case of unconventional reservoirs), it is necessary to artificially enhance it.

For this purpose, a combination of techniques -that have been used in the hydrocarbon industry for decades- is required, including hydraulic stimulation, which consists in the generation of cracks in the target rock by means of the injection of a mixture of water, proppant and chemical additives at high pressure in the reservoir (IAPG, 2013). Hydraulic stimulation has been used in more than 2 million wells throughout the world since the 1940s.

Scale of permeability (in milidarcy) showing the range for conventional and unconventional reservoirs *(Source: Courtesy of YPF and Schlumberger)*



Between 2005 and 2015, the Latin American and Caribbean region experienced a growth of its Gross Domestic Product of approximately 3.5% per year (CEPAL, 2014) and unconventional hydrocarbons offer a historic opportunity to supply to the region the energy that is required to continue along that path.

In a study conducted by the US Energy Information Administration (EIA, 2013) in several countries in the world, Argentina and Mexico rank second and sixth, respectively in shale gas recoverable resources. If we consider shale oil, Argentina ranks fourth and Mexico eighth. Both countries have 18.5% and 11.5% of the global recoverable shale gas and shale oil resources, respectively.

Technically recoverable shale gas resources and proven reserves of conventional natural gas - Latin American countries *(Sources: EIA, 2013 - EIA, 2015 - BP, 2015)*

Country	Proven reserves of conventional natural gas (Tcf)	Technically recoverable resources of shale gas (Tcf)	2014 gas production (Tcf)
Argentina	12	802	1.24
Mexico	12	545	2.04
Brazil	16	245	0.69
Venezuela	197	167	1.02
Paraguay	0	75	0
Colombia	6	55	0.40
Chile	4	48	0.04
Bolivia	11	36	0.77
Uruguay	0	2	0

Technically recoverable shale oil resources and proven reserves of conventional oil - Latin American countries *(Sources: EIA, 2013 - EIA, 2015 - BP, 2015)*

Country	Proven reserves of conventional oil (millions of barrels)	Technically recoverable resources of shale oil (millions of barrels)	Oil Production[1] in 2014 (millions of barrels)
Argentina	2,327	27,000	229.6
Venezuela	298,350	13,400	992.4
Mexico	11,079	13,100	1,016.2
Colombia	2,445	6,800	361.4
Brazil	16,154	5,300	856.3
Paraguay	0	3,700	0
Chile	150	2,300	5.5
Bolivia	210	600	24.5
Uruguay	0	600	0

Unconventional hydrocarbons offer a historic opportunity to supply to the region the energy that is required to continue its economic and social growth

[1] Includes natural gas liquids

3 Economic viability

The aspects associated with investments and costs of exploration and development of unconventional reservoirs have significant differences with respect to conventional reservoirs along their life cycle. In addition, the logistics, infrastructure and operations required for the production of hydrocarbons from unconventional reservoirs are particularly challenging due to their scale.

3.1 Estimated investments required

The life cycles of unconventional hydrocarbons reservoirs are different from those of conventional hydrocarbons reservoirs. The decline rates of the former are much higher than those of the latter. This characteristic of the unconventional reservoirs requires that the production curve be maintained by drilling new wells, with their respective stimulation tasks. All this requires significant investments to maintain a production profile that allows achieving economically viable margins in the development project.

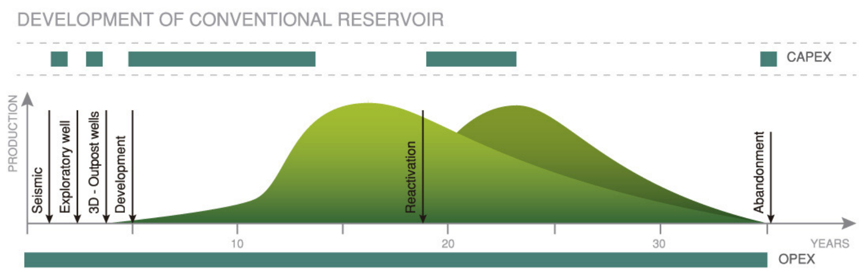
Maintaining the production curve of unconventional hydrocarbons reservoirs requires a higher CAPEX than that for conventional hydrocarbons reservoirs

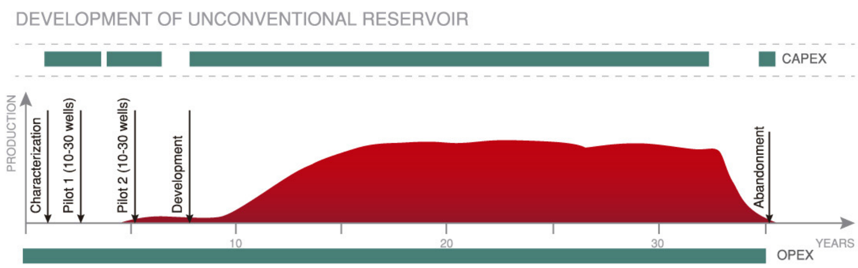
The life cycle of production of conventional reservoirs goes from a maximum production to then start to decline. Later, large investments must be made to increase production reduced through -for example- secondary recovery techniques.

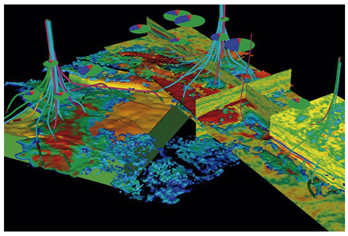
In both cases (i.e., conventional and unconventional reservoirs), there are operating expenses (OPEX) along the life cycle.

This is clearly shown in the charts below.

Comparison of the production profile and investments required in the life cycle of exploration and development of reservoirs of conventional and unconventional hydrocarbon reservoirs







On the other hand, the heterogeneity of unconventional reservoirs is such that there are practically no two analogous reservoirs. Therefore, the investment required in their characterization is much higher than that for conventional reservoirs, especially in its initial stage; hence the need to develop pilots to identify the techniques to be applied to make the development of each reservoir more efficient.

All this creates a framework in which the viability of developing unconventional reservoirs requires higher CAPEX, which, added to the typical volatility in the oil price, may affect the flow of investments, thus increasing uncertainty and, therefore, the viability of projects. This situation should be taken into consideration by all stakeholders in the sustainability of the development of unconventional resources.

The high average costs of "finding + development" may require special tax regimes to develop unconventional resources

It is essential to consider that:

- The high average costs of "finding + development" may require special tax regimes to develop unconventional resources;
- As the life cycles of unconventional reservoirs are totally different from those of conventional reservoirs, concession periods should consider this reality;
- Industry associations represent a good mechanism for the exchange of best practices that enable companies to drastically minimize the learning time, thus reducing the costs and times associated with the exploration and development of unconventional reservoirs.

3.2 Logistics, infrastructure and services

The services and the availability of equipment and materials to carry out the drilling and hydraulic stimulation in unconventional reservoirs are one of the challenges of the activity because it requires not only the movement of material for the construction of wells from factories and/or ports to facilities, but also the mobilization of supplies and equipment for hydraulic stimulation. It is estimated that a well with 15 fracturing stages requires 500 trips of water transportation (in the absence of an aqueduct or nearby water sources), 150 trips for proppant transportation, 30 portable pits of 80 m^3 and approximately 20 trucks of pumping equipment for hydraulic fracturing. In addition, once the stimulation is carried out, proper management of the flowback fluid and the produced water (transportation, storage, treatment and final disposal) is required.

In North America, these reservoirs have been developed thanks to the high availability of infrastructure, equipment, skilled labor and capital, which has allowed a way of working known as “factory mode”. However, the challenge in Latin America is to have adequate infrastructure, i.e., road infrastructure, transportation and services, that allows scaling up the development that unconventional reservoirs require.

It is essential to consider that:

- To offset logistical constraints associated with the geographical distribution of equipment it is necessary to understand each reservoir in detail. This allows maximizing the productivity of each well and optimizing operations with limited equipment and infrastructure during the early stages (concept and pilot) of each development;
- In the case of a future development of unconventional reservoirs, it is important to plan well in advance the logistics and infrastructure required for the transportation, ports, railways, pipelines, access of equipment to the operations areas, and transport of the product to the ports and relevant markets for processing or export. This requires a strategy of development, policies that are sustainable and consistent with the levels of investment required, and an adequate framework for companies, governments and communities involved in these developments.

The challenge in Latin America is to have adequate infrastructure that allows scaling up the development that unconventional reservoirs require

4 Sustainable development of resources - Social and environmental aspects

The techniques used for the development of unconventional oil and gas are not new to the industry. Hydraulic stimulation has been safely used by the industry for more than 50 years for the development of low permeability conventional reservoirs. The experience gained from the hydraulic stimulation of over two million wells in the world since 1947 has made it possible to refine this technique to be able to apply it later to unconventional reservoirs. However, given the lack of knowledge in the population, there is concern in the community about the potential impacts of the regular use of this technique for the development of unconventional resources.

As in all human activity, unconventional resources must be developed in a responsible manner, ensuring environmental protection and social responsibility in the framework of sustainable development criteria set by States as regards energy resources. This process needs to be complemented with efficient and transparent communication about the scope of the operations carried out, the prevention/mitigation measures implemented and the impact on the development of the country.

The socially and environmentally responsible development of unconventional resources must be complemented with efficient and transparent communication

In order to provide technically rigorous information, this chapter includes guidelines on policy and best practices in the management of environmental and social aspects that are especially important for the development of unconventional resources. It should also be noted that many of the guidelines of this chapter also apply to conventional oil and gas operations.

4.1 Management of environmental aspects

Various scientific studies, such as those cited in this section, show that unconventional hydrocarbons can be developed in a sustainable manner when adequately managing the main environmental aspects associated with these operations.

4.1.1 Availability of water resources

Drilling and completion of wells in unconventional reservoirs demand a larger amount of water than drilling and completion in conventional reservoirs. For example, to complete a well of gas in a typical, relatively deep, unconventional reservoir with multiple stages of hydraulic fracturing, between 5,000 and 20,000 cubic meters of water are used in a period of two weeks. However, it is necessary to take into account that during the useful life of the development of a conventional reservoir, the volumes of water to be used for assisted stimulation or secondary recovery projects (which have been implemented in the world for over 40 years) will be several orders of magnitude higher than those required for unconventional reservoirs.

In several countries, the use of water resources is regulated by the competent authorities and compliance with these regulations is compulsory for the industry (Stark et al., 2012). However, the regulation and monitoring of water use in unconventional hydrocarbon development projects must accompany the new technological advances to reduce the water footprint of operations (WRI, 2014).

The regulation and monitoring of water use must accompany the new technological advances to reduce the water footprint of operations

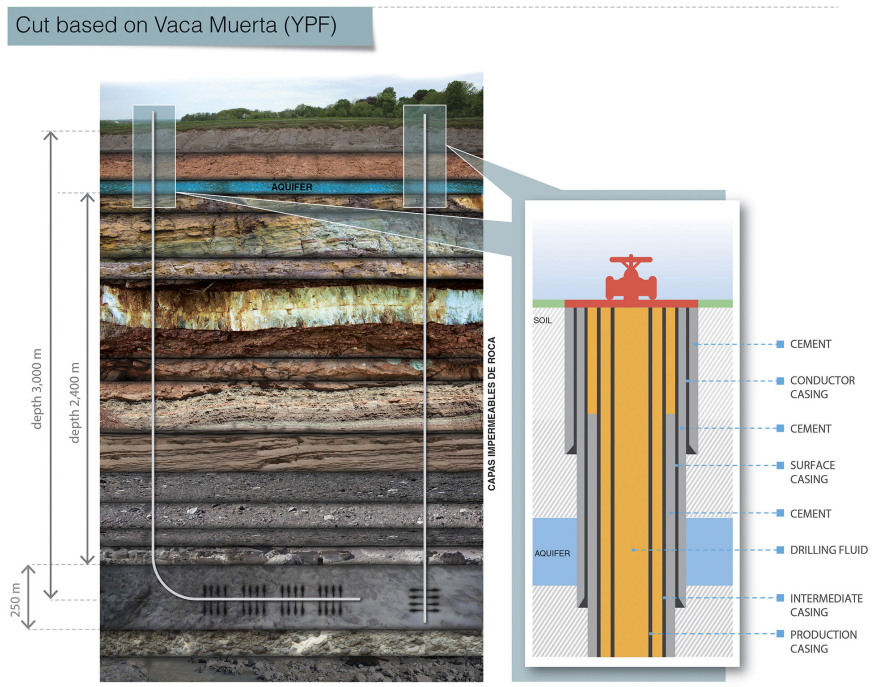
It is necessary:

* To evaluate - locally and regionally - the availability and the level of demand, the natural water cycles and other factors of pressure on the water resource to determine appropriate levels of use, depending on the demand associated with hydraulic stimulation activities (see http://www.ipieca.org/topic/water/global-water-tool and http://www.wri.org/resources/maps/water-for-shale);
* That governments and the industry take advantage of collaborative initiatives to establish and implement water management policies and best practices that are efficient and enable the sustainable development of unconventional hydrocarbon resources, such as Thirsty Energy (World Bank, 2013);
* To promote research and development of new technologies and the implementation of innovative practices to improve efficiency in the use of the water resource;
* That industry, government and civil society coordinate the method of calculation, as well as the conditions for monitoring and reporting the water footprint of hydraulic stimulation operations;
* To evaluate whether companies could incorporate a commitment to the right to water in their human rights policy, as for example the CEO Water Mandate (UNGC, 2015).

4.1.2 Prevention of groundwater pollution

Hydraulic stimulation requires the addition of chemical additives, most of which are present in commercial and home applications (FracFocus, 2015 and IAPG, 2013). In spite of the fact that these chemical additives are commonly used in the industry, the lack of knowledge of the chemical composition of the stimulation fluid by the public opinion has generated mistrust with regard to potential groundwater contamination.

Example of hydraulic stimulation for development of shale based on information from the Vaca Muerta formation *(courtesy YPF)*



However, it is worth noting that:

- The most widely known unconventional gas/oil formations are at depths between 1,000 and 4,000 meters (EIA, 2013), while the aquifers for domestaic use are generally found at depths of up to 300 meters, and it is therefore highly unlikely that the fluid injected could permeate into superficial aquifers through the various rock formations.
- In addition, all the wells that are drilled into conventional and unconventional reservoirs have double tubing, first a steel tubing and then a cementation that allows to isolate aquifers from productive areas with hydrocarbons, which minimizes the risk of groundwater contamination at all stages of the production process. However, just as in the case of conventional wells, if the integrity of the well fails, it is possible that fluids migrate from the inside of the borehole into aquifers or toward the surface. If such an accident occurred, it is always possible to remediate it minimizing the impact.
- Large-scale hydraulic stimulation has been used in tens of thousands of wells and there are no records of peer-reviewed scientific studies of cases where hydraulic stimulation *per se* has led to the contamination of groundwater (EPA, 2015a).

It is highly unlikely that the fluid injected to make hydraulic stimulation could permeate into superficial aquifers

Industry must develop a participatory monitoring of groundwater quality and make the results available to the public at large

- The average composition of the fluid used for hydraulic stimulation varies between 91-96% of water (base fluid), 4-8% of proppant (usually sand) and 0.5-1 % of 3 to 14 chemical additives (IAPG, 2013 and EPA, 2015b). It is known that no reactions or interactions occur among the additives that may engender adverse impacts.

It is important:

- ✱ To evaluate the minimum distance between the aquifer for human consumption and the unconventional reservoir for hydraulic stimulation in order to avoid the risk of migration of gas/oil and/or hydraulic stimulation or flowback fluids to the aquifer, as well as to ensure that this information is part of the environmental impact study or related documents, which are technically supported by the relevant authorities;
- ✱ To ensure that internationally accepted standards, such as API standards (2009), are duly followed and enforced regarding lining and cementation of wells and well integrity management for the proper insulation of fresh groundwater reservoirs;
- ✱ To monitor the quality of fresh groundwater with participation of representatives of the government and of the adjacent communities, both before project commencement and throughout the life cycle of the project, and to make the results available to the public at large. In addition, the results of this evaluation should be periodically confirmed by independent certified companies;
- ✱ To allow free access to information on the chemical additives used in hydraulic stimulation operations;
- ✱ To encourage industry to invest in technology and innovation for the continuous improvement in environmentally sustainable management;
- ✱ To keep a rigorous control of contractors, quality assurance programs, audit and training;
- ✱ To preserve the conditions of groundwater and surface water as an integral part of the environmental management system approved at the stage of environmental impact assessment.

4.1.3 Flowback water management

Depending on the reservoir, it is estimated that between 20% and 50% of the water injected in a well during the hydraulic stimulation process returns to the surface as flowback water (IEA, 2012). This wastewater must be disposed of safely and/or recycled. Concerns about the environmental impact of the management of flowback water from hydraulic stimulation are based on the need to ensure its containment in secure facilities for storage until treatment and disposal, and on the fact that all reservoirs are different, and therefore, the composition of the fluid will be different in each play.

It is important:

- To apply good practices to minimize the environmental impacts associated with the management, treatment and disposal of flowback water and other hydraulic stimulation fluids, such as those described by API (2010);
- To ensure the existence and enforcement of regulations regarding the disposal of flowback water, and the features and controls of injection and disposal wells, encouraging a greater use of recycling as a good management practice;
- To consider that there are advanced alternative procedures for centralized management of flowback water and produced water to improve the efficiency of the operation;
- That companies establish objectives of annual increase in water recycling.

A greater use of recycling of flowback water must be encouraged as a good management practice

4.1.4 Other environmental issues

Competition for land use

There is a perception that drilling of unconventional wells requires a larger area than the production of conventional wells. Actually, production takes place at great depths in the subsoil and requires some alteration to the surface, as wells, roads and production facilities must be constructed. However, thanks to the directional and horizontal drilling techniques, and to multi-well pads, the area actually used to produce unconventional gas/oil is equal or smaller than that required to produce traditional oil and gas, or electricity from solar or wind energy (IGU, 2012).

Induction of seismic movements

There is public concern that the injection of high pressure fluids in hydraulic stimulation operations could induce seismic events. However, it has been demonstrated that a large part of the energy used in hydraulic stimulation is dissipated without generating seismic activity, and that the intensity of the seismic activity resulting from the stimulation is approximately 100,000 times less than that detectable by humans[2] (IGU, 2012).

Concern has also been expressed about the fact that the injection of large volumes of flowback water in disposal wells can reactivate existing geological faults. Studies carried out in the United States show that the injection of flowback water in disposal wells generated less than 0.003% of the events of induced seismicity (NAS, 2013). While there is minimal seismicity, this is localized and could only have effects in areas of active geological faults (USGS, 2015 and OGS, 2011).

The intensity of the seismic activity resulting from the stimulation is approximately 100,000 times less than that detectable by humans

Greenhouse gas emissions

It has been demonstrated that properly designed and constructed wells contribute to ensuring that there is no leakage that may lead to releases of gases into the atmosphere. Studies that measured and characterized the emissions of several gas production components (flowback from wells, venting of wells for liquids discharge, losses of equipment and pneumatic controllers) concluded that there is no difference in methane emissions between gas fields where conventional techniques are used and those where hydraulic stimulation is used (see, for example: Bond et al, 2014; Stamford and Azapagic, 2014).

In the framework of the global objectives of reducing greenhouse gas emissions resulting from the generation of electricity, shale gas will provide greater availability of natural gas to rapidly reduce carbon emissions on a cost-competitive basis. Natural gas used in the generation of electricity emits 350 kg of CO_2/MWh, compared with 850 kg of CO_2/MWh for coal (MacDonald, 2010).

[2] The minimum seismic activity detectable by humans is of 3.0 on the Richter Scale

It is important:

- To regulate and implement good industry practices to minimize impacts in the land, as well as in biodiversity and ecosystem services in the lands where hydraulic stimulation operations will be developed (API, 2011), including the development and refinement of directional drilling, horizontal drilling and multi-well pads;
- To promote the implementation of ambitious gas emissions management programs that include recovery, reduction of flaring to a minimum, flaring efficiency standards higher than 98 %, elimination of venting (except for safety reasons), periodic monitoring and the minimization of fugitive emissions, among other actions;
- To consider the use of green completion systems to maximize the recovery of methane (EPA, 2012);
- To re-inject the flowback water only after having made a pre-drilling assessment to establish a geological baseline to identify porosity and pressure of the candidate reservoir rock as well as the presence of nearby faults, that quantifies the potential risk of seismic activity that could be induced in terms of the volume of flowback water injected into the disposal wells. This activity must be complemented with a permanent monitoring of the injection pressure and the superficial seismicity.

The implementation of ambitious gas emissions management of programs including the use of green completion systems must be fostered

4.2 About the social license to operate

ARPEL member companies are committed to implementing responsible practices of community relations and to adopting the best operational and management practices to minimize the potential negative impact of their operations associated to the development of conventional and unconventional resources.

The purpose of this section is to highlight particularly significant social issues - in the light of the experience gained so far - regarding hydraulic stimulation operations.

The information on the operations -provided by industry- must be complemented with that from independent organizations and disseminated by governmental entities to obtain the consent of society

Most social controversies generated by the exploration and development of unconventional resources regarding hydraulic stimulation are largely due to the lack of information and to the dissemination of particular aspects of the development of these resources. However, public opinion is very important in this process, so it is important that the information on hydraulic stimulation comes not only from the industry but also from independent organizations, and is disseminated by governmental entities to obtain the consent of society (CEPAL, 2015), as well as by other respected organizations of civil society, e.g., national and international technically renowned associations, NGOs and universities.

For this reason, it is important for both governments and industry to implement strategies and plans of transparent communication and involvement of the community and other stakeholders from the earliest stages of exploration and development of unconventional resources. This communication process must be part of both the socio-environmental impact assessment and management stages throughout the project life cycle.

Particularly in the case of unconventional hydrocarbon reservoirs located in indigenous territories, both governments and companies must work together to develop specific approaches that consider the provisions of ILO Convention No. 169 (1989) in order to foster a more favorable climate for investment and the development of projects that benefit the communities established in the areas of direct and indirect impact.

It is important:

- ∗ To carry out a constructive dialogue, through bi-univocal communication with stakeholders before and during the activities, agreeing on a process and on management and performance objectives, encouraging the participatory monitoring of socio-environmental management;
- ∗ To ensure that there are opportunities for communities to express their concerns in the forums and time frames established by law, and consider these concerns when establishing the areas of the calls for bids and developing socio-environmental plans;
- ∗ To openly share information and studies -as far as possible from scientific institutions or governmental agencies- regarding the potential impacts of the activity;
- ∗ To ensure that the States and the industry recognize and respect the traditional values, heritage, culture and legal rights of indigenous communities in accordance with the national and international regulatory frameworks and the international standards applicable in the industry;
- ∗ To maximize the transparent communication with the communities with regard to the operations, for example, levels and sources of water consumption, chemical additives used in hydraulic stimulation and treatment alternatives, by establishing an appropriate and commonly agreed process;
- ∗ To expand the scope of communication by using mechanisms similar to those used in Europe (NGS Facts) and in the United States of America and Canada (FracFocus);
- ∗ That operators ensure collaboration with local authorities to optimize emergency planning and response;
- ∗ To manage in particular environmental impacts regarding visual aspects, noise and use of roads, as well as health and safety standards that minimize the potential impact on communities.

Based on ARPEL (2009), OGP/IPIECA (2013) and Equitable Origin (2015)

A constructive dialogue with social groups and governmental stakeholders must be promoted, encouraging the participatory monitoring of socio-environmental management

5 Regulatory aspects

ARPEL and ECLAC suggest regulations that provide tax incentives for the sustainable development of unconventional resources

This document has shown that there are economic, logistical, social, environmental and technical challenges that must - and can - be solved for the sustainable development of unconventional resources in Latin America and the Caribbean. For this purpose, it is important that the regulatory framework of exploration and production of unconventional resources consider the differences between the operation of unconventional resources and that of conventional resources.

In order to have a representative opinion of the industry in Latin America and the Caribbean, ARPEL conducted a survey among its member companies about the regulatory aspects associated with the operation of unconventional resources.

Most of the survey respondents agreed on the need to have different regulations (in most cases, complementary) for the exploration and exploitation of unconventional hydrocarbons, mainly because:

- It requires different extraction and assessment techniques,
- The exploration stage is longer and more complex,
- Operational costs are higher,
- The facilities of the value chain are more specialized.

5.1 Fiscal and contractual aspects

ARPEL member companies agree on the need for regulations that provide incentives that address the greater financial efforts associated with the development of reservoirs, the advanced stimulation technology and the greater time required to recover the investments. This consensus is supported by the best practices suggested by intergovernmental development institutions, such as ECLAC -the United Nations Economic Commission for Latin America and the Caribbean (CEPAL, 2015)- which recommends that States set a fiscal regime and possible tax incentives in an attempt to balance tax requirements on the part of the State and the generation of profits on the part of the investor. In this regard, the same ECLAC study considers important *"the establishment and design of progressive tax regimes which consider the price volatility, the costs and the production profile."*

The well drilling and completion technologies used for both types of reservoirs are the same. For this reason, it is considered that from the point of view of the contractual regime, the current regulations could be complemented, as long as there are specific clauses, particularly regarding royalties, profits, differential pricing, environmental protection and deadlines for the development of reservoirs.

5.1.1 Some regulatory aspects in force

The current specific regulations on the development of unconventional resources in some countries of Latin America and the Caribbean contain positive aspects related to:

- Payment of lower royalties;
- Extension of current concessions for up to ten years and new concessions with longer terms of up to 35 years;
- Longer exploration periods;
- Incentives through differential pricing of hydrocarbons and freedom for commercialization;
- In the event of farm outs, possibility of returning it divided into lots;
- Incentives for export without price discounts.

Some countries of Latin America and the Caribbean consider the extension of current concessions for up to ten years and new concessions with terms of up to 35 years

5.1.2 Challenges and possible alternatives

ARPEL member companies have identified some important challenges to maintain the viability of unconventional projects in the long term and propose some alternatives to mitigate them.

In some countries, the requirements for operators can be very demanding, which could exclude smaller companies that could bring ideas, concepts and innovation to make projects economically viable. Fifty percent of the survey participants stated that in order to attract the required private investment, it is necessary to have tax incentives that allow recovering initial investments, and where taxation is carried out in an incremental manner during the production phase of the contract.

Following are some alternatives proposed by ARPEL member companies to enable States to avoid the reduction of investments or the fall in production, even in situations such as drops in the international price of oil or gas:

- Establishing differentiated royalties for the production of unconventional hydrocarbons; and in particular, significantly reducing the payment of royalties and taxes during the initial exploitation period;
- Allowing the free import of goods for exploration and exploitation by eliminating taxation on the procurement of goods and services associated with the exploration and exploitation of unconventional reservoirs;
- Making exploration and production contract terms more flexible;
- Accelerating the depreciation of investments in exploration;

- In the case of projects with a high social component, ensuring the support of the State to the operating companies during the consultation, socialization and licensing processes so as to obtain the permits to operate and implement activities without major inconveniences.

5.2 Sustainability principles for regulations related to unconventional resources

Regulations must guarantee a transparent communication with society, defining alternatives from a technical point of view and analyzed with all stakeholders

The States are facing major challenges to establish a specific regulatory framework for the development of their unconventional resources. These challenges are closely linked to the definition of a strategy of the States to solve their energy trilemma of ensuring a competitive energy supply, while providing society with universal access to energy and promoting environmental protection.

In addition to the fiscal and contractual aspects mentioned in this chapter and the policy alternatives and best practices for operational, economic, technical and social-environmental issues suggested in the other chapters, below are some guidelines suggested for the development of specific regulations with regard to the sustainable development of unconventional resources in Latin America and the Caribbean:

- Political agreements that guarantee legal stability;
- Transparent communication with society, defining alternatives from a technical point of view and analyzed with all stakeholders;
- Certainty that the risk assessment for the areas in question is based on the best available and periodically updated techniques;
- Application of strategic environmental assessment as a tool associated with the calls for bids for areas with unconventional resources and use of the results of generic corrective measures for projects with similar characteristics;
- Innovative initiatives which could be implemented in the short, medium and long term with regard to the use of water for hydrocarbon operations, which competes with human use;
- Access of competent authorities to adequate budget and human resources duly trained for the performance of their functions;
- Considerations on the financial guarantees of operators covering the potential liabilities for environmental damage, before beginning operations.

6 Conclusions

Unconventional resources represent a significant fraction of hydrocarbon resources in several countries of Latin America and the Caribbean. Therefore, the sustainable development of these resources will ensure an additional source of energy to diversify the energy matrix and accompany the efforts of States to achieve increasingly higher levels of prosperity.

The regional production of unconventional hydrocarbons can provide additional economic benefits to local, regional and national economies, and may extend the diversity of hydrocarbons supplies with the reduction of import costs and the increase in indirect economic benefits, such as employment and the development of a supply industry, which could be important opportunities for the communities and the countries where production takes place. In addition, income from taxes and royalties, at the regional and national levels, represent a positive added value.

In particular, the development of shale gas provides additional benefits for the transition to a low-carbon global economy, offering an unprecedented opportunity to some States of Latin America and the Caribbean for greater diversification of their sources of supply of natural gas.

ARPEL member companies agree that the exploitation of unconventional hydrocarbons, such as shale hydrocarbons, demand great challenges from the regulatory point of view and that the existing regulations in countries such as Argentina, Colombia and Brazil - and countries outside the region - can certainly help to generate policies and practices that are required in Latin America and the Caribbean in the long term.

The regional industry is constantly investing in research and development to understand and minimize the impact of the production of unconventional hydrocarbons. ARPEL member companies are willing to work together with governments and other important stakeholders for a long-term solution that is suitable for Latin America and the Caribbean.

ARPEL member companies are willing to work together with governments and other relevant stakeholders towards a sustainable solution that is suitable for Latin America and the Caribbean

7 Glossary

Back Flow	Flow generated immediately after hydraulic stimulation that contains part of the hydraulic stimulation fluid and other components of natural origin that may have been carried over from the reservoir where the fracture is taking place.
Brent	Type of crude oil extracted mainly from the North Sea. Used as a benchmark in European markets.
CAPEX	(CAPital EXpenditures) - Capital investments that generate benefits. CAPEX are funds used by a company to acquire assets or upgrade existing assets with a useful life extending beyond the taxable year.
Darcy	Unit of measurement of permeability.
Disposal wells	Also called *Deep Injection Wells*. Facilities designed to inject wastewater in formations under structural entrapment and seal rock conditions, which ensure the oil tightness of the fluids, preventing any contact with fresh groundwater.
Factory mode	Advance design of operations consisting in the continued operation of wells located side-by-side covering the entire horizontal surface of the shale, and then fracturing and production, thus saving time, materials and human resources. The number of wells drilled under this mode is higher and enables to reduce the cost by well drilled.
Finding + Development	Operational cost associated with the resources required to locate new oil/gas reservoirs and the continuous expenditures of extraction of hydrocarbons throughout the life cycle of the reserves.
Flaring	Burning of unwanted gas through a pipe (also called flare). This means of disposal of gas is used when there is no way to transport gas to the market and the operator cannot use the gas for another purpose.
Flowback Water	Fluid that returns, immediately after fracturing, when the well is left to flow. It consists of the injected water and the returns of rotated plugs, cement, proppant and degraded fracturing fluid. As time passes, it also includes produced water, oil and/or gas and dissolved minerals.
OPEC	Organization of Petroleum Exporting Countries (www.opec.org)
OPEX	OPerating EXpenditure - Permanent cost for the operation of a product, business or system. Also called*, operating expenses or operational costs*.
Permeability	Ability of a material to transmit fluids without altering its internal structure
Play	Family of reservoirs and/or prospects with the same source rock, seal rock and background of generation, migration and load of hydrocarbons.
Produced Water	Water naturally present in the pores of reservoir rocks.
Proppant	Constituent of the hydraulic stimulation fluid, usually sand or ceramic particles, used to hold fractures open once the hydraulic stimulation pressure is reduced.
Tcf	Trillion Cubic Feet
Venting	Gas venting consists of not utilizing the gas emerging from a petroleum or gas producing well, releasing it to the atmosphere. This measure is only utilized in case of an emergency where there is no flaring capacity.
Well Integrity	Application of technical, operational and organizational measures to reduce the risk of uncontrolled release of fluids from a reservoir throughout the life cycle of a well.
WTI	West Texas Intermediate. Grade of crude oil produced in Texas and southern Oklahoma that is used as benchmark in oil pricing.

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ARPEL is a non-profit association gathering oil, gas and biofuels sector companies and institutions in Latin America and the Caribbean. Founded in 1965 as a vehicle ofcooperation and reciprocal assistance among sector companies, its main purpose is to actively contribute to industry integration and competitive growth, and to sustainable energy development in the region.
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