Comisión Nacional
de Hidrocarburos

Classification of hydrocarbons' exploration and exploitation projects

Profitability and uncertainty statistics

Technical Paper - 3

Content

I. Introduction

Purpose

Technical paper TP–3 main purpose is to rank hydrocarbons' exploration and exploitation projects considering their expected profitability, uncertainty and materiality. In order to do so, it is important to identify the relevant economic unit to be used throughout the paper, known as "investment project". On that basis, the above indicators were estimated for each investment project.

All indicators were calculated utilizing commonly-used methodologies with information provided by *Petróleos Mexicanos* (Pemex). These methodologies include: net present value, investment net value, financial ratios and standard deviation both for reserves and prospective resources.

In this paper, TP-3, the following projects are neither assessed nor identified:

- EOR projects,
- Sub-salt projects, and
- Shale gas projects.

While these are key projects for proper classification of all projects in the country, there is not enough information to properly rank them. It is noteworthy that some of the projects discussed above could be highly profitable and compete with those currently under development.

The paper also excludes added-value from the possibility to modify the investment plan throughout the projects' life (this is commonly valued using real options).

Identification and evaluation of projects not yet documented by Pemex, as well as, the methodology to evaluate the possibility to modify investment plans over the project's life, will be included in subsequent technical papers. This paper is part of a series of documents from the CNH which provide technical elements for the design and definition of the country's hydrocarbon policy.

Main findings

Project's characterization based on defined indicators (profitability, uncertainty and materiality) yields the following conclusions:

- If all projects (exploration and exploitation) are classified according to profitability and materiality (2P reserves or mean resources), 28% of the

most profitable and largest ones (in terms of resources) are exploration projects.

- Within the exploration projects, shallow water projects are among the ones with highest profitability and least uncertainty.
- By ranking all exploitation projects, including non-associated gas ones, according to profitability and uncertainty, all projects (100%) in Chicontepec (Aceite Terciario del Golfo) are located in the group with least profitability and highest uncertainty.
- While non-associated gas projects are economically attractive, when compared to oil projects, they are handicapped. According to the methodology presented and hydrocarbon's current prices, oil projects are about 5 times more profitable than non-associated gas ones.

Technical paper organization

The document (TP-3) is divided into 6 sections. The first defines the concept of "project" as an economic unit for which profitability, uncertainty and materiality statistics are reported; afterwards, projects are listed and classified by region.

The second section defines the profitability indicator and presents the corresponding descriptive statistics, including materiality ones. The third section presents the uncertainty indicator and shows both, profitability and uncertainty statistics. The fourth section presents an analysis of only non-associated gas projects, considering the indicators presented previously. The fifth section suggests how budget could be allocated considering the identified indicators. The last section summarizes the main results and describes future work.

II. Project definition

The first step to rank exploration and exploitation projects is to conceptualize them; this means, to identify the relevant economic unit known as "investment project" or "project".

Companies certifying hydrocarbons reserves use an "oil field" as the relevant economic unit. Thus, the project's definition will be:

- For exploitation projects (development of reserves), a field whose 2P reserves exceed 10 million barrels oil equivalent.

- For exploration projects, an approved location whose average prospective resources are above 10 million barrels oil equivalent.

Under this definition, from a total of 683 fields with hydrocarbons' reserves and 275 approved exploratory locations, a total of 383 projects were identified, from which 184 are exploitation projects and 199 are exploration projects.

Figure 1 shows the analyzed exploration projects and their corresponding project according to Pemex current classification. Also, Figure 2 presents the exploitation projects included in this document and its respective match with Pemex grouping.

Figure 1. Exploration projects

Region	Pemex project	Projects by field					#
Marina Noreste	Campeche Oriente	Akal-301	Chapabil-201	Ku-2001	Lum-301	Utsil-101	35
		Ayatsil-1001	Chapabil-301	Ku-201	Maloob-201	Zaap-3001	
		Bacab-501	Chapabil-401	Ku-3001	Nohoch-101	Zazilha-101	
		Balam-1001	Ek-1001	Ku-301	Nohoch-201	Sihil-101	
		Bisik-1	Ek-201	Ku-5001	Numan-101	Tson-1001	
		Chac-301	Ek-301	Lum-101	Pit-1001	Tson-101	
		Chapabil-1001	Kaxanbil-1	Lum-201	Pit-2001	Tson-201	
	Evaluación del Potencial Campeche Oriente Terciario	Tomba-1	Tomon-1				2
Marina Suroeste	Campeche Poniente	Abkatun-2001	Esah-1	Kay-1001	Yut-1	Taratunich-3001	14
		Alak-101	Cheek-1	Ken-1	Tach-1	Uech-201	
		Ayin-3dl	Ichal-1	Och-301	Talan-1		
	Coatzacoalcos	Canin-1	Mizton-1	Tonalli-1			3
	Golfo de México B	Ahawbil-1	Bisba-1	Lakach-1001	Naajal-1	Tabscoob-201	14
		Alaw-1	Chelan-1	Lakach-2001	Nen-1	Tumtah-1	
		Atal-1	Kajkunaj-1	Makkab-1	Nox-1		
	Integral Crudo Ligero Marino	Hayabil-101	Tlacame-1	Uchbal-1	Xulum-1001	Yum-1001	13
		Mekpal-1	Tsanlah-1	Xikin-1	Xupal-1		
		Suuk-1	Tsimin-3dl	Xipal-1	Yaxche-201		
Norte	Área Pérdido	Magnanimo-1	Maximino-1	Pep-1			3
	Cazones	Bentonico-1	Isurus-1	Myliobatis-1	Picon-1		4
	Evaluación del Potencial Delta del Bravo	Kama-1					1
	Evaluación del Potencial Lamprea	Gema-1	Hermes-1	Necora-1	Zarpador-1		4
	Evaluación del Potencial Papaloapan B	Bedel-1	Ejemplar-1	Lucido-1	Pampas-1	Ramie-1	9
		Chiltepec-1	Gasifero-1	Nuevaera-1	Quixote-1		
	Golfo de México Sur Primera Etapa	Chat-1	Eslipua-1	Macalican-1			3
	Sardina	Beluga-1	Charales-1	Molusco-1	Salmon-1a		7
		Camaron-1	Jurel-101	Ostracodo-1			
	Integral Burgos	Arroyan-1	Caudillo-1	Feliz-1	Oroval-1	Saltarin-1	35
		Atacama-1	Clonado-1	Galocha-1	Pachache-1	Siroco-1	
		Bombin-1	Cobrizo-1	Garson-1	Picota-1	Titanico-1	
		Burbuja-1	Corcel-1	Gato-1001	Progreso-101	Tlamaya-1	
		Campeon-1	Corsario-1	Lluvia-1	Rapel-1	Tomahua-1	
		Capitolio-1	Cuatrocienegas-10	Mercalli-1	Rodrigueno-1	Ventisca-1	
		Catavina-1	Era-1	Organdi-1	Saguaro-1	Virtuoso-1	
	Integral Cuenca de Veracruz	Alir-1	Clausico-1	Lagar-1	Marmol-1		8
		Cazadero-1	Kanon-1	Maceral-1	Organico-1		
	Integral Lankahuasa	Tatziquim-1					1
Sur	Comalcalco	Jachim-1	Mexhu-1	Pacoco-1	Tijib-1		7
		Jujo-1001	Pache-1001	Pepino-1			
	Cuichapa	Achote-1	Bombo-1	Multi-1	Sanramon-1001	Xumapa-1	9
		Azti-1	Laventa-1001	Puan-1	Tembac-1		
	Evaluación del Potencial Julivá	Enebro-101	Kanemi-1	Navegante-1	Terra-2DL		4
	Incorporación de Reservas Litoral de Tabasco Terrestre	Altamonti-1					1
	Incorporación de Reservas Simojovel	Arroyozanapa-201	Giraldas-201	Lumija-1	Nicapa-201		4
	Malpaso	Cheej-1	Genes-1	Robusto-1			3
	Integral Macuspana	Alebrije-1	Epico-1	Jejen-1	Saraguato-101	Triunfo-201	15
		Chichicaxtle-1	Gaia-1	Longo-1	Sitala-1	Vanguardia-1	
		Choco-1	Jaule-1	Muyil-1	Tilico-1	Zanate-1	
Total	24	-					199

Figure 2. Exploitation projects

Region	Pemex project	Projects by field					#
Marina Noreste	Cantarell	Akal Nohoch	Chac Sihil	Ixtoc Takín	Kambesah	Kutz	8
	Ek-Balam	Balam	Ek				2
	Ku-Maloob-Zaap	Ayatsil Maloob	Bacab Pit	Baksha Utsil	Ku Zaap	Lum	9
	En proceso de incorporación a proyecto	Kayab	Tekel	Chapabil	Pohp	Tson	5
Marina Suroeste	Ayin-Alux	Alux	Ayín	Xulum			3
	Caan	Abkatún	Caan	Kanaab	Taratunich		4
	Chuc	Batab Ché Chuc	Chuhuk Etkal Homol	Kuil Onel Pokoch	Pol Tumut Toloc	Wayil	13
	Coatzacoalcos-Marino	Amoca	Tecoalli	Poctli			3
	Gas del Terciario	Akpul	Chukua				2
	Ixtal-Manik	Ixtal	Manik				2
	Lakach	Lakach	Lalail				2
	Och-Uech-Kax	Kax	Och	Uech			3
	Yaxche	Xanab	Yaxché				2
	Integral Crudo Ligero Marino	May Men Xux	Bolontikú Misón Yum	Hokchi Sinan	Ichalkil Teekit	Kab Tsimin	12
	En proceso de incorporación a proyecto	Alak	Kach	Makech			3
Norte	Agua Fría-Coapechaca	Agua Fría	Coapechaca	Coyula	Escobal		4
	Amatitlán-Agua Nacida	Agua Nacida	Ahuatepec	Amatitlán	Cacahuatengo	Palo Blanco	5
	Arenque	Arenque	Atún	Bagre	Carpa	Mejillón	5
	Coyol-Humapa	Coyol	Humapa				2
	Miquetla-Mihuapán	Miahuapán	Miquetla_ATG				2
	Poza Rica	Poza Rica	Tres Hermanos	San Andrés			3
	Presidente Alemán-Furbero	Furbero	Remolino	Presidente Alemán			3
	Reingeniería del sistema de recuperación secundaria del campo Tamaulipas-Constituciones	Cacalilao	Ebano Chapacao	Pánuco	Tamaulipas Constituciones		4
	Sitio-Tenexcuila	Aragón Sitio	Pastoría	Sabana Grande	Tenexcuila	Tlacolula	6
	Soledad-Coyotes	Coyotes	Gallo	Horcones	Soledad		4
	Tajín-Corralillo	Corralillo	Tajín				2
	Integral Burgos	Arcabuz Culebra Santa Anita	Arcos Fundador	Cuatro Milpas Géminis	Cuervito Nejo	Cuitláhuac Palmito	11
	Integral Cuenca de Veracruz	Gasífero	Cauchy	Lizamba	Papán		4
	Integral Lankahuasa	Lankahuasa					1
Sur	Bellota-Chinchorro	Bellota Yagual	Bricol Cobra	Chinchorro Mora	Edén-Jolote Paché	Madrefil	9
	Cactus-Sitio Grande	Cactus	Juspi	Níspero	Teotleco		4
	Cárdenas	Cárdenas					1
	Carmito-Artesa	Gaucho	Giraldas				2
	Complejo Antonio J. Bermúdez	Blasillo Cinco Presidentes Cunduacán	Guaricho Iride Oxiacaque	Nelash Ogarrio Magallanes-Tucán-Pajona	Rabasa Rodador Brillante	Samaria San ramón	14
	Costero Terrestre	Costero	Ribereño				2
	Delta del Grijalva	Cráter Caparroso-Pijije-Escuintle	Luna-Palapa	Sen	Terra	Tizón	6
	El Golpe-Puerto Ceiba	Paraíso El Golpe	Puerto Ceiba Pareto	Santuario	Tintal	Tupilco	7
	Jujo-Tecominoacán	Jacinto	Tepeyil	Paredón	Jujo-tecominoacán		4
	San Manuel	Chiapas-Copanó	Chintul	Nicapa	Sunuapa		4
	Integral Macuspana	Narváez	Tepetitán				2
Total	45	-					184

III. Expected profitability indicator

Definitions

Once projects are identified, the next step is to define a profitability indicator. This indicator has two elements, the expected monetary value and the expected value of total expenditure.

Expected monetary value is defined as:

$$VME_i = \propto_i * VPN_i - (1 - \propto_i) * CR_i$$

Where:

- VME_i Expected monetary value for project *i.*
- $\propto_i$ Probability of commercial success for project *i.*
- VPN_i Net present value for project *i,* given commercial success (discounted@12%).
- CR_i Venture capital for project *i.*

For exploitation projects, the probability of commercial success is 1 and, consequently, the component assigned to exploration venture capital is zero, given the fact that resources are already discovered and economically recoverable. In this case, the VME corresponds to conventional calculation of net present value of 2P reserves.

For exploration projects, expected monetary value weighs two possible states of nature: success or failure; both have a probability of occurrence expressed as project's probability of commercial success. If the project is successful, it is developed and a net present value, not risk-adjusted, can be obtained associated to prospective resources; while, if the project fails, it generates only a cost equal to the total exploration expenditure defined as the project's venture capital.

Venture capital is only associated to projects at the exploration stage, and corresponds to the investment associated with exploratory wells, seismic studies and other expenses incurred at the exploratory stage of projects. For exploration projects, the probability of commercial success is the probability of finding hydrocarbons and the viability of extracting them in an economic way. This

probability is estimated by Pemex for the evaluation of prospective resources and documented for each exploration prospect in the BDOE.

Expected value of total expenditure is defined as:

$$GTE_i = \propto_i * VPGT_i + (1 - \propto_i) * CR_i$$

Where:

GTE_i Expected value of total expenditure for project *i.*

$\propto_i$ Probability of commercial success for project *i.*

$VPGT_i$ Total expenditure net value for project *i,* given commercial success (discounted@12%).

CR_i Venture capital for project *i.*

The total expenditure consists of all investments plus operating costs. Generally, in oil industry, the following ratio, VPN/VPI, is used as a profitability indicator, where investments do not consider operating costs. In this paper, total expenditure considers all expenses in order to compare every project under equal terms.

Total expenditure helps to evaluate projects at different stages of maturity or development, given the fact that expenditure changes as project's life develops. For example, a mature field with a pressure maintenance system will have high operating costs due to injection costs and fluids' handling; in this case, if only investment value is considered, this could be close to zero and the project might be valued as highly profitable for a proposed development stage.

Taking that into consideration, the expected profitability indicator is defined as the ratio between the expected monetary value and the expected value of total expenditure:

$$IR_i = \frac{VME_i}{GTE_i}$$

Where,

IR_i Profitability indicator for project *i.*

The profitability indicator (IR) was estimated for the 383 projects defined previously.

Economic premises

Prices. The ones Pemex used in the document "Economic evaluation of hydrocarbons' reserves" (January 1st, 2012). Prices are fixed for the project's horizon.

On average, oil price is 101 US dollars per barrel (USD/bl) (101 for light oil, 94 for heavy oil and 107 for extreme light oil). Average gas price is 4.5 US dollars per thousand cubic feet (Usd/Mcf) and condensates' price is 67.2 US dollars per barrel (USD/bl).

Discount rate. 12%.

Exchange rate. 12.5 peso/dollar.

Reserves and resources. Projects' evaluation considers 2P reserves for exploitation projects and prospective resources mean estimation for exploration projects.

The 184 exploitation projects included in this document have 25,480 Mmboe of 2P reserves (97% of total nation's resources). Also, the 199 exploration projects analyzed, represent a mean volume of resources of 16,848 Mmboe (resources are not risk-adjusted).

Investments and costs

For exploitation projects, the considered investment and operating costs correspond to the ones established at Pemex's document "Economic evaluation of hydrocarbons' reserves" (January 1st, 2012); and, for exploration projects, they correspond to BDOE III 2010 economic evaluation, which is not risk-adjusted.

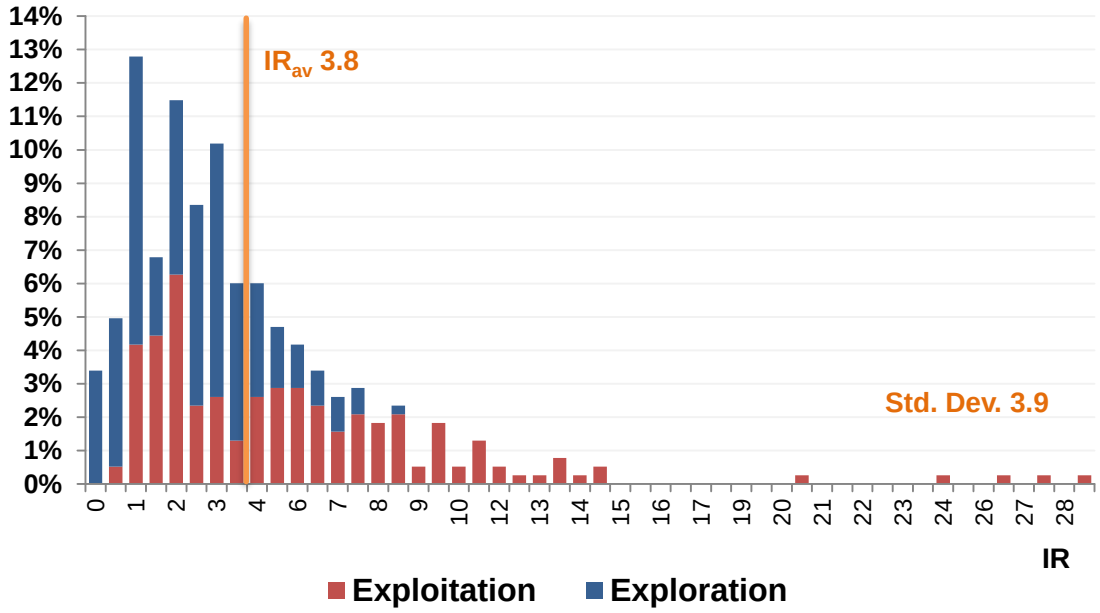
Profitability

The profitability indicator (IR) was estimated for each project, obtaining an average of 3.8; this means that, in present value, for each spent peso, 3.8 pesos are either earned or recovered.

According to the IR estimation, there are 15 exploration projects that have negative profits. These are deep water projects, from which eleven are expected to produce gas and four, oil. In five of these projects, the VPN is positive; however, profitability is less than zero when VME is calculated and when the projects are adjusted by their probability of commercial success.

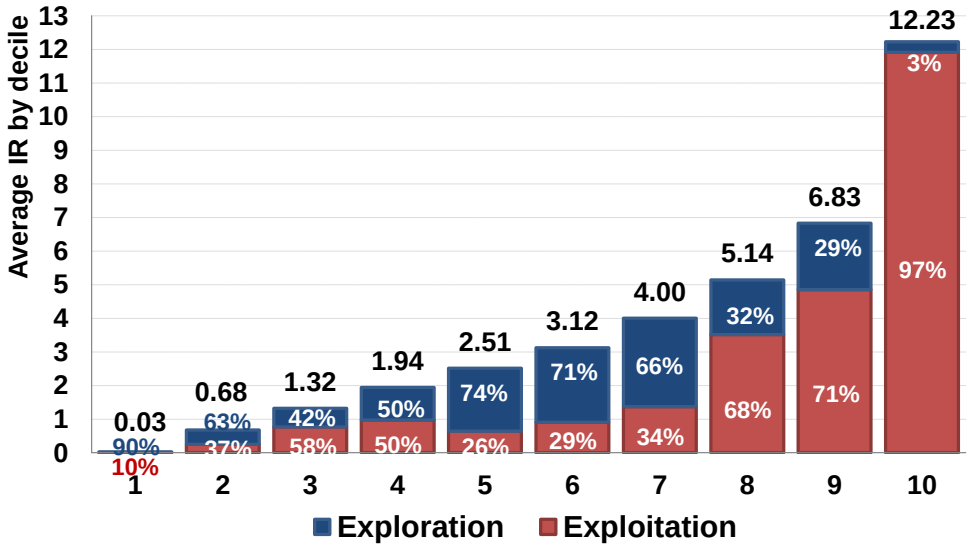
General results are fully described in Graph 1; it shows IR distribution by project's type: exploration or exploitation. From this, it is observed that, even though exploration projects have lower IR's than the exploitation ones, of the 143 projects which IR is higher than the mean (3.8), 29% are exploration projects (42 projects).

Graph 1. Projects distribution by IR and type



By grouping projects in deciles (each decile contains 10% of all projects sample) decile 1 indicates 10% of the projects with the least IR and decile 10 corresponds to 10% of the projects with the highest IR. We can observe that there are exploration projects in each decile, from 1 to 10. Particularly, it is interesting to notice that deciles 8 and 9 contain 33% of the exploration projects.

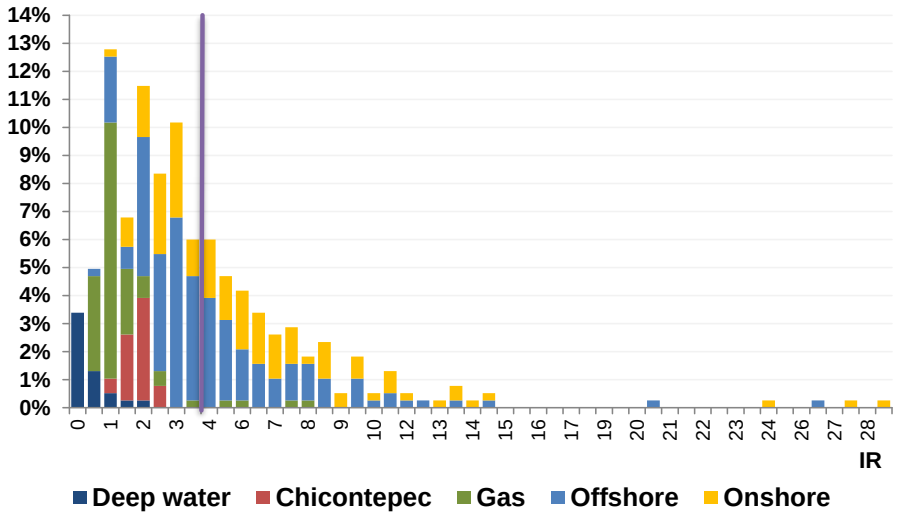
Graph 2. Projects distribution by profitability decile and type



In ranking projects by their location, the following classes are considered: onshore, offshore (shallow water), Chicontepec, deep water and non-associated gas (gas). It is observed that deep water and Chicontepec projects' IRs are significantly lower than every other; all deep water and Chicontepec projects are below average.

Likewise, non-associated gas projects' profitability indicator is lower when compared to oil projects.

Graph 3. Projects distribution by IR and class

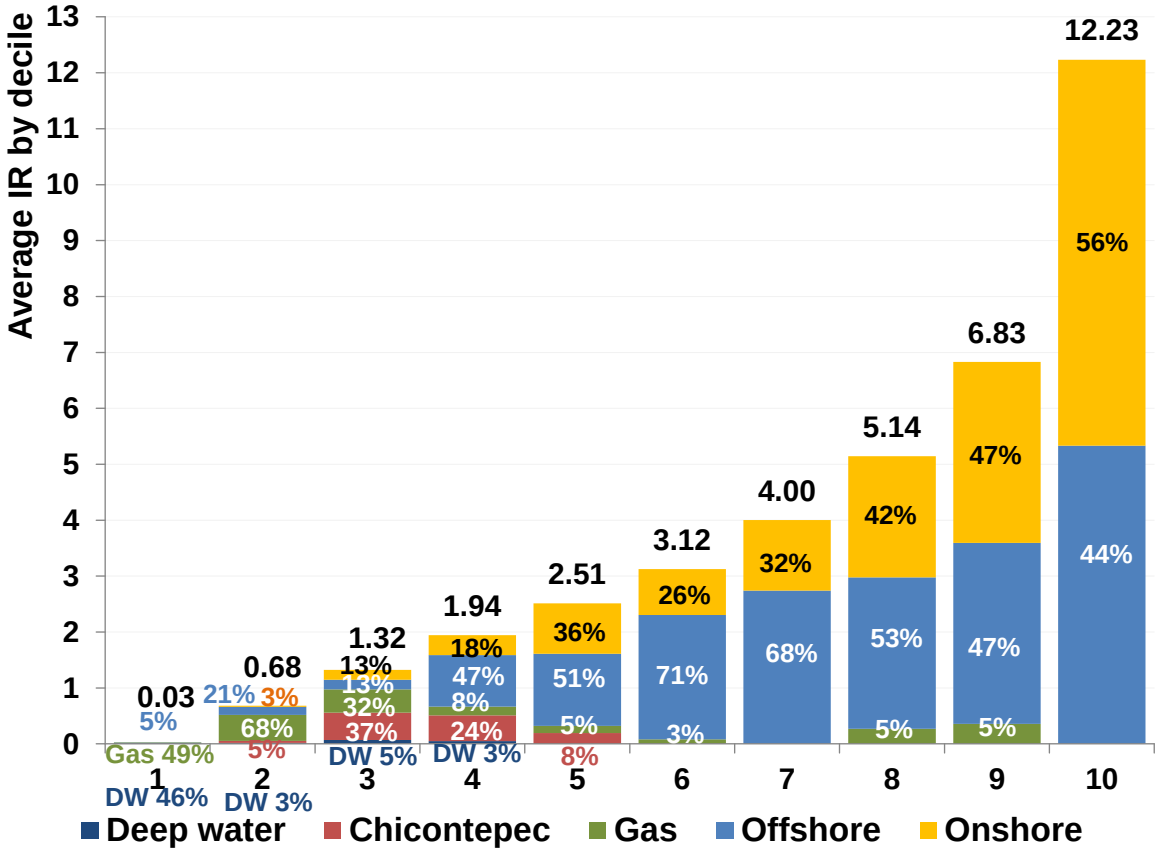


When sorted by profitability deciles, it is observed that shallow water and onshore (other than Chicontepec) projects are among the ones with highest profitability.

Deep water and Chicontepec are located at the deciles with the least profitability (between deciles 1 and 5).

The first two profitability deciles show non-associated gas projects mainly.

Graph 4. Project distribution by profitability decile and class



Projects profitability and materiality

In addition to profitability, an indicator used in the "oil industry" that helps to describe investment projects' is materiality; this metric considers project's magnitude. Even though it is important to know how much is earned by each peso spent, it is also important to know the project's scale (amount of resources).

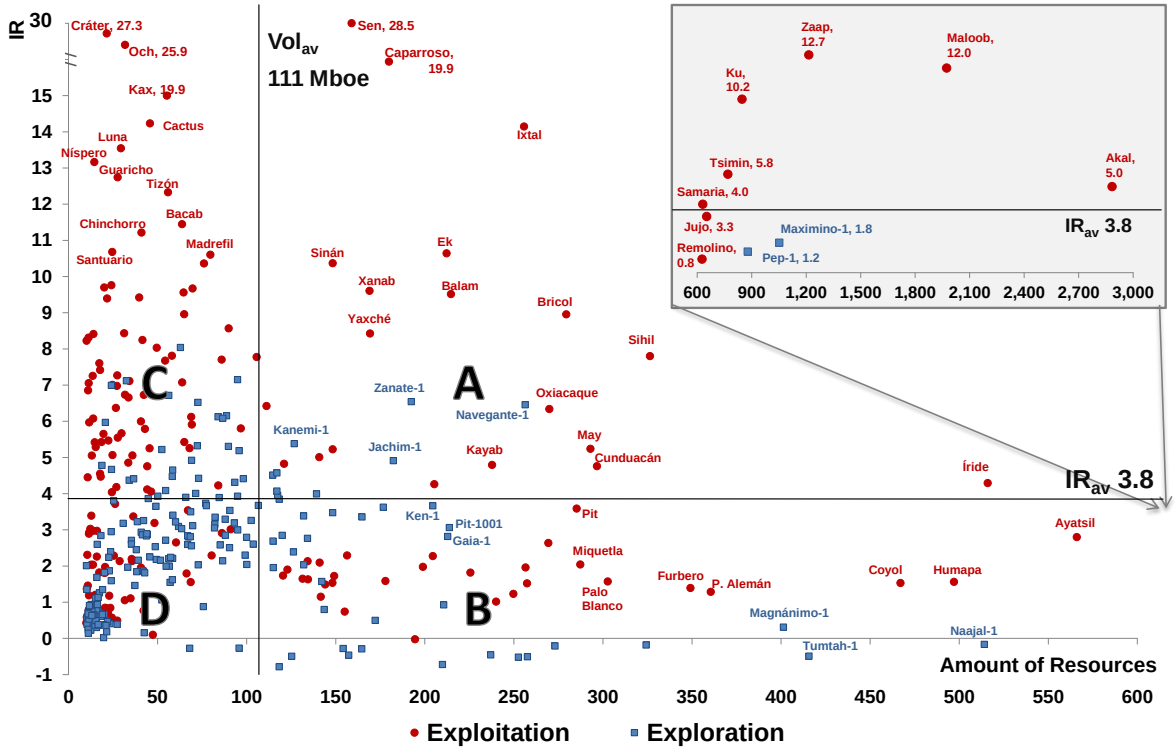
Projects' materiality is defined as the amount of resources contained in 2P reserves (proved + probable) for exploitation projects, and for exploration projects as the mean volume of prospective resources (PR).

The methodology used to estimate materiality for exploration and exploitation projects is similar; though, there is an important difference between them: when referring to exploitation projects reserves are resources already discovered, on the contrary for exploration projects, resources have not been discovered (which is considered as the probability of geological success).

The following graph maps each project's IR and materiality. For characterization effects, the Cartesian plane is divided in four quadrants; A shows projects with profitability and materiality above average; B shows projects with profitability below average but, materiality above average; C shows projects with profitability above average but, materiality below average; and, D shows projects with profitability and materiality below average.

Exploitation projects located in quadrant A with resources above 600 Mmboe are: Samaria, Tsimin, Ku, Maloob, Zaap, and Akal. Outstanding exploitation and exploration projects in quadrant B are Jujo-Tecominoacán and Remolino, and Maximino-1 and Pep-1, respectively; notice that they all have resources over 600 Mmboe, but have profitability below average.

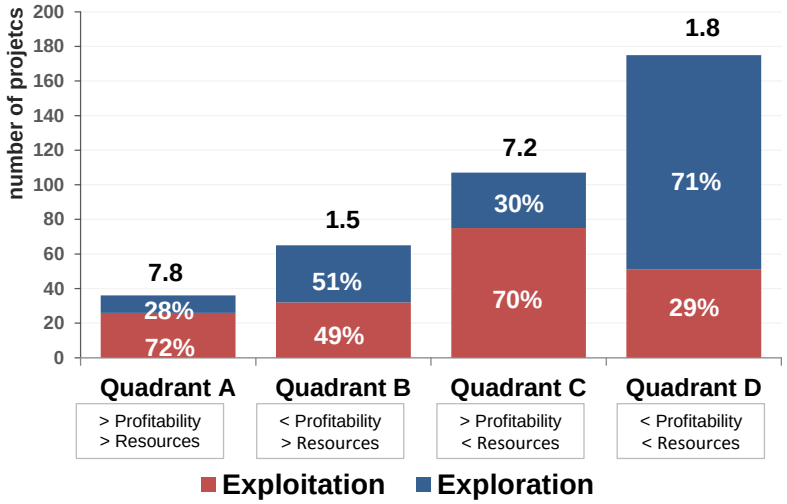
Graph 5. Projects mapped by type, profitability and amount of resources



In the distribution of projects according to quadrant (Graph 6), 72% of the projects in quadrant A are exploitation ones and they show higher profitability and reserves; notice that 33% are exploration projects.

In quadrant B (large materiality and low profitability) 51% are exploration projects, this means that they have high potential to add reserves.

Graph 6. Projects distribution by type and quadrant

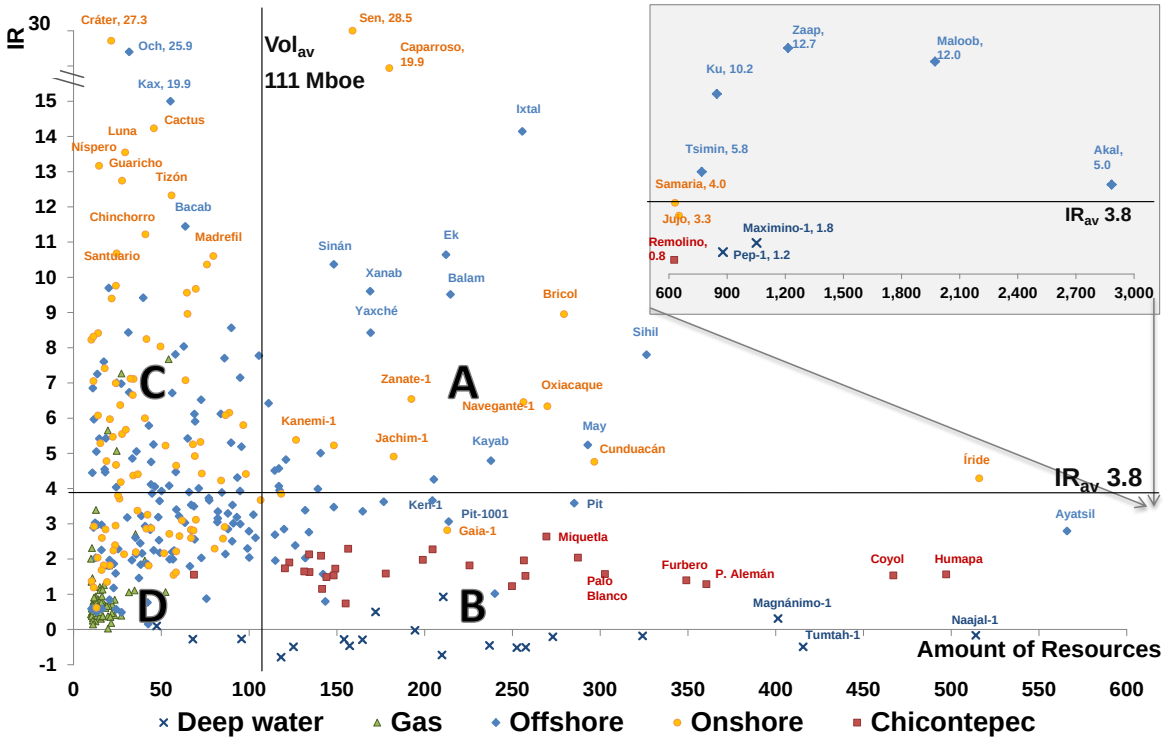


Graph 7 presents projects according to their profitability and materiality, classified by class: onshore, offshore (shallow water), Chicontepec, deep water and non-associated gas (gas).

In quadrant A, 64% are shallow water projects; among them, the giant and supergiant fields in Marina Noreste Region (Ku, Maloob, Zaap and Akal, respectively). In quadrant B with large materiality and low profitability, deep water and Chicontepec projects.

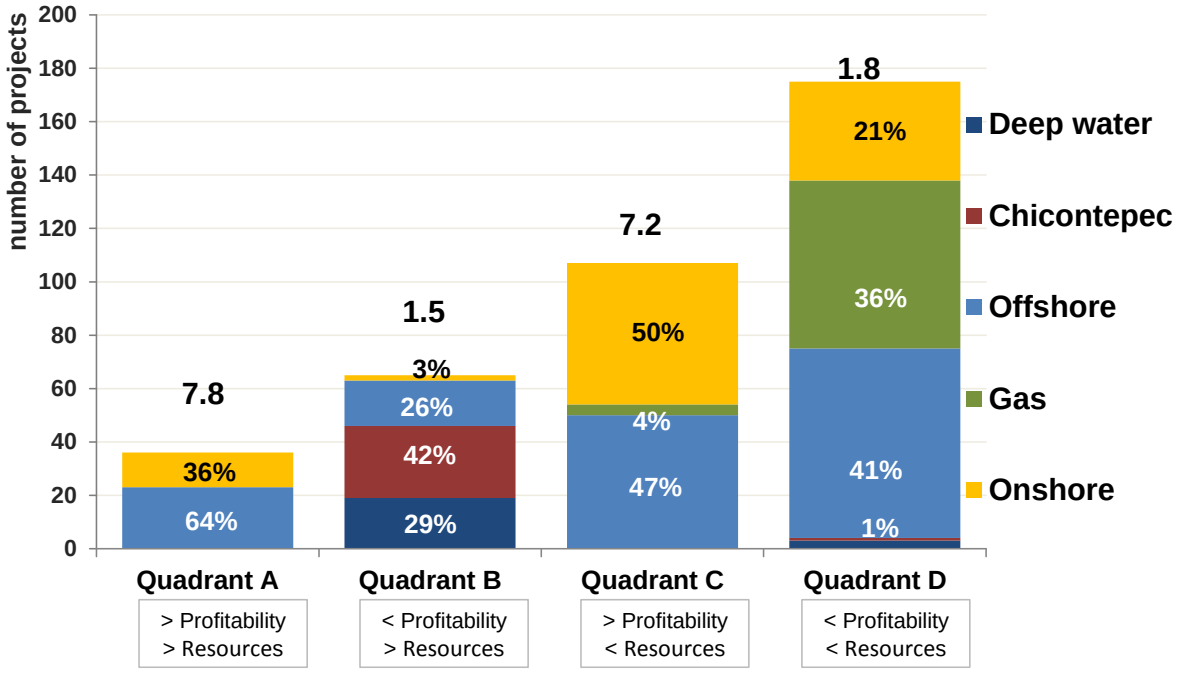
Non-associated gas projects are primarily located in quadrant D, with both, low materiality and profitability.

Graph 7. Projects mapped by class, profitability and amount of resources



In projects' distribution according to quadrant (Graph 8), 36% of the projects in quadrant D (low profitability and materiality) are non-associated gas projects; 96% of Chicontepec projects (27 out of 28) are located in quadrant B, low profitability and large materiality.

Graph 8. Projects distribution by class and quadrant



IV. Uncertainty indicator

Definitions

The first point to consider in this section is the difference between risk and uncertainty. Risk is defined as the probability of loss or failure and is usually associated to either a positive or negative result, given a probability of occurrence.[1] In this paper, geological risk, for exploratory projects, is defined as the probability that an exploration well results in the discovery or not of hydrocarbons.

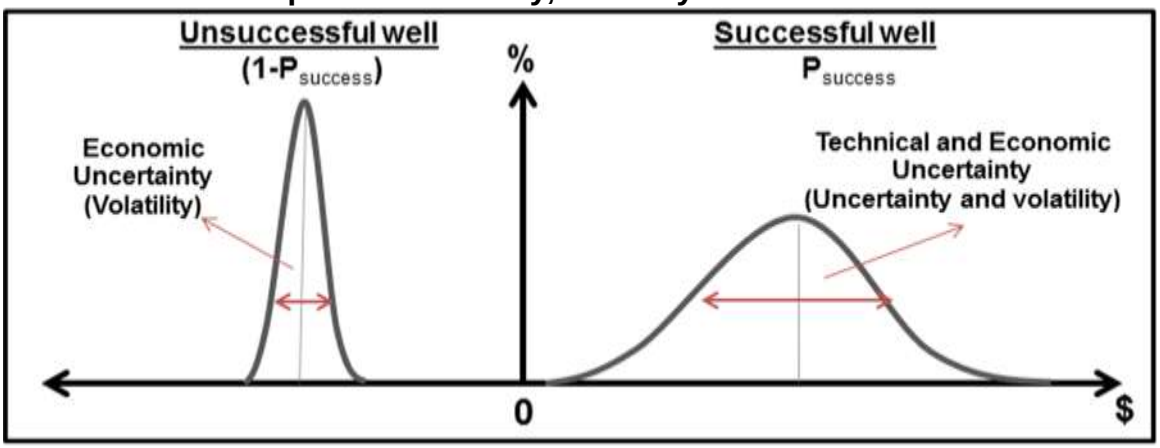
In contrast, uncertainty is defined as a range of possible results in a series of calculations. For recoverable resources' estimations, uncertainty range shows reasonable estimated quantities that are potentially recoverable for an individual accumulation or a project.[2] Uncertainty is represented as a continuous function that describes recoverable estimated values and associated probabilities to each of them; this is a distribution function that has values to recover.

In the oil industry, volatility has been used as an uncertainty synonym; but there is no general consensus. Literature has identified two types of uncertainty: technical and economical.[3] Technical uncertainty refers to a certain calculated value; for example, reservoir's oil in place (OIP) calculation. OIP does not change in time, though, its estimation does. In contrast, economic uncertainty or volatility refers, for example, to hydrocarbons' prices or production costs variation. From now on, economic uncertainty will be referred as volatility and technical uncertainty as uncertainty.

As an example of previously defined concepts, exploration risk (geological risk), uncertainty and volatility are considered in Graph 9. This graph shows possible scenarios for an exploration project; "*x"-axis* represents project's economic value and "*y"-axis* probability of occurrence.

[1] *Petroleum Resources Management System* (PRMS), sponsored by SPE, WPC, AAPG y SPEE.
[2] *Ibídem*.
[3] J.G. Ross, *Risk and uncertainty in portfolio characterization*, Journal of Petroleum Science and Engineering (2004).

Graph 9. Uncertainty, volatility and risk scheme



The geological risk is represented in two possible scenarios: when the well is successful and when it is not; and it is measured by each event's associated probability, which in this document is defined as the probability of commercial success. Graph's left side shows a not successful well, where no hydrocarbons are discovered and with associated probability ($1\text{-}P_{success}$).Graph's right side shows a successful exploratory well, where hydrocarbons are discovered and with probability $P_{success}$.

On one hand, if an exploratory well is not successful, only volatility is associated to drilling cost; it is very hard to determine exactly how much is going to cost to drill a well, even at project's initial stage.

On the other hand, if an exploratory well is successful, geological risk has been overcome and only uncertainty and volatility are faced. The first associated with estimating the materiality of oil extraction and, the second related to changes in prices and production costs. In this paper volatility is not considered and prices and costs are fixed (provided by Pemex).

Given the above, an exploration project shows both, risk and uncertainty. Risk is captured through probability of commercial success and uncertainty is measured by the estimation of prospective resources, which are estimated by Pemex under a probabilistic approach.

Prospective Resources P90 (Low estimate). There is at least a 90% probability (P90) that the volume of oil actually recovered will equal or exceed the estimated volume.[4]

[4] *Petroleum Resources Management System* (PRMS), sponsored by SPE, WPC, AAPG y SPEE.

Prospective Resources P50 (Best estimate). There is at least a 50% probability (P50) that the volume of oil actually recovered will equal or exceed the estimated volume.[5]

Prospective Resources P10 (High estimate). There is at least a 10% probability (P10) that the volume of oil actually recovered will equal or exceed the estimated volume.[6]

When projects are at an exploitation stage, only the right side of the distribution in Graph 9 is observed (resources are already discovered). As the field is developed and new information attained, uncertainty decreases and the bell-shaped graph shrinks. Thereby, reserves are defined as:

Proved Reserves (1P). Proved reserves correspond to the volume of oil evaluated with probabilistic methods and have a probability of at least 90% that the volume actually recovered will equal or exceed the estimation.[7]

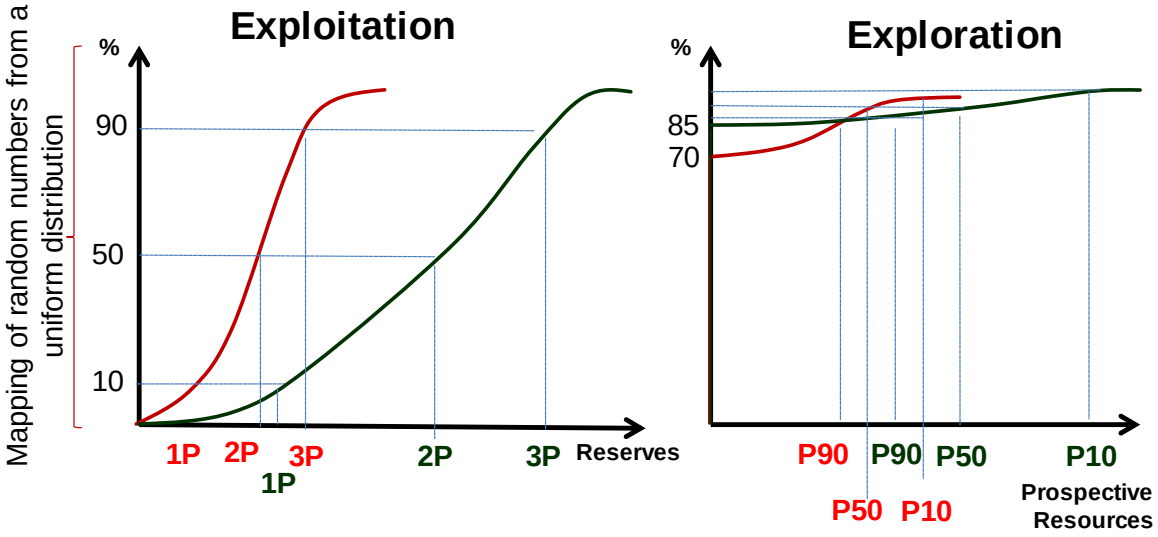
Reserves 2P. Sum of proved plus probable reserves. When probabilistic methods are used, there is a probability of at least 50% that the actual volume recovered will equal or exceed the sum of proved plus probable reserves estimation.[8]

Reserves 3P. Sum of proved plus probable plus possible reserves. When probabilistic methods are used, there is a probability of at least 10% that the actual volume recovered will equal or exceed the sum of proved plus probable plus possible reserves estimation.[9]

Reserves and prospective resources' probability functions correspond to log-normal type functions. If both probabilistic values (1P, 2P and 3P, or P90, P50 and P10) and associated probabilities are known, reserves and prospective resources' cumulative production functions can be estimated (including success probability). This is observed in the following graph.

[5] *Ibídem.*
[6] *Ibídem*
[7] CNH, GUIDELINES *to regulate projects' assessment procedure for evaluation and quantification reports' elaborated by Pemex and approval for final reports' certification by an independent or third party* (2010).
[8] *Ibídem.*
[9] *Ibídem.*

Graph 10. Reserves and prospective resources cumulative distribution function for exploration and exploitation projects



Based on cumulative distribution functions (cdf's), standard deviation is estimated by bootstrapping, a sampling method which uses cdf's to measure function's mean and standard deviation. Sampling was done by mapping random numbers to either reserves or prospective resources using cdf's. Finally, mean and standard deviation were calculated by 1,000 simulations done for every exploration and exploitation project.

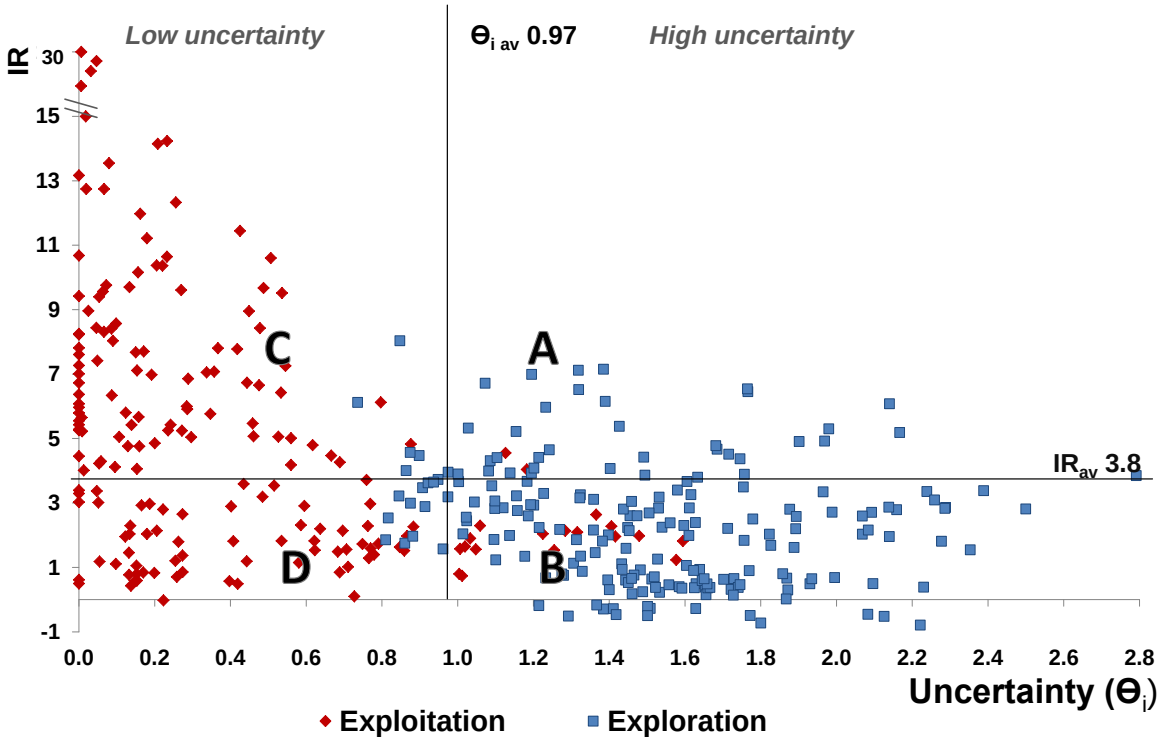
The uncertainty indicator (θ_i) corresponds to the estimated standard deviation for each project *i* divided by its estimated average, based on the simulation process described.

Profitability and uncertainty

Once profitability and uncertainty indicators were estimated, hydrocarbons' exploration and exploitation projects were mapped using both of them. As observed in the following graph, exploration projects, in comparison to exploitation ones, show higher uncertainty and less profitability, locating themselves in quadrant B (higher uncertainty, less profitability).

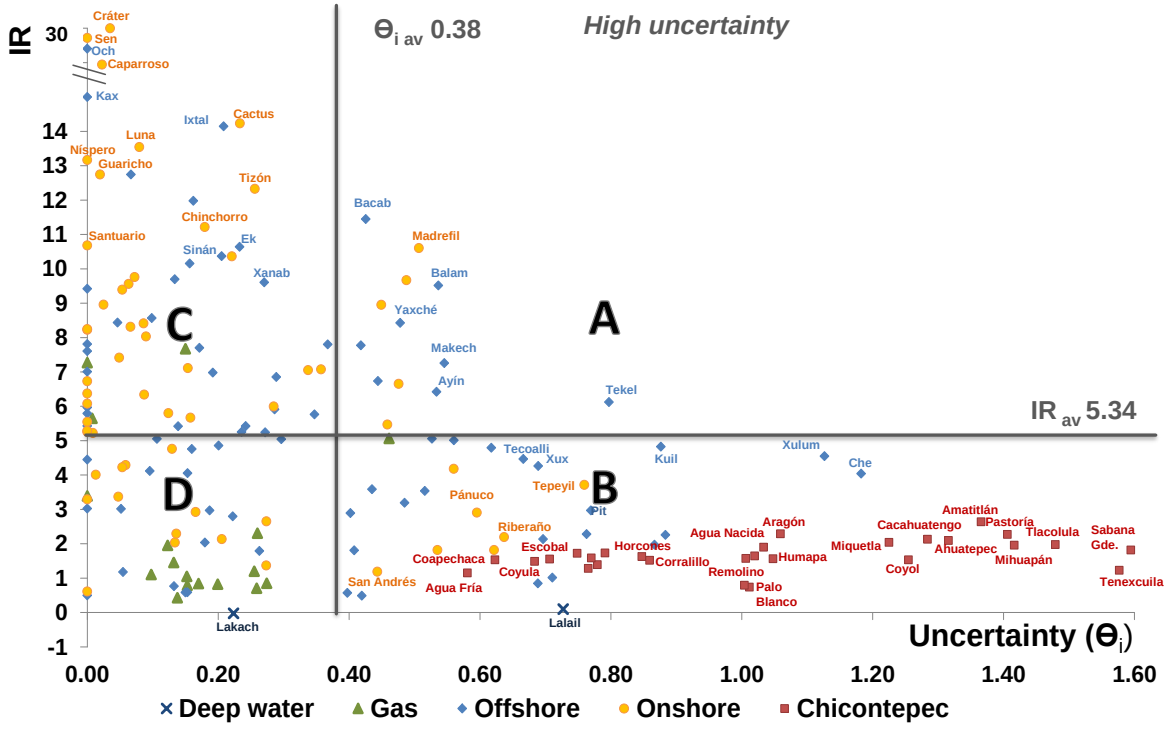
For now on, quadrant A corresponds to projects with high profitability and high uncertainty, B to projects with high uncertainty and low profitability, C to projects with low uncertainty and high profitability, and D to projects with both, low uncertainty and profitability.

Graph 11. Projects mapped by type, profitability and uncertainty



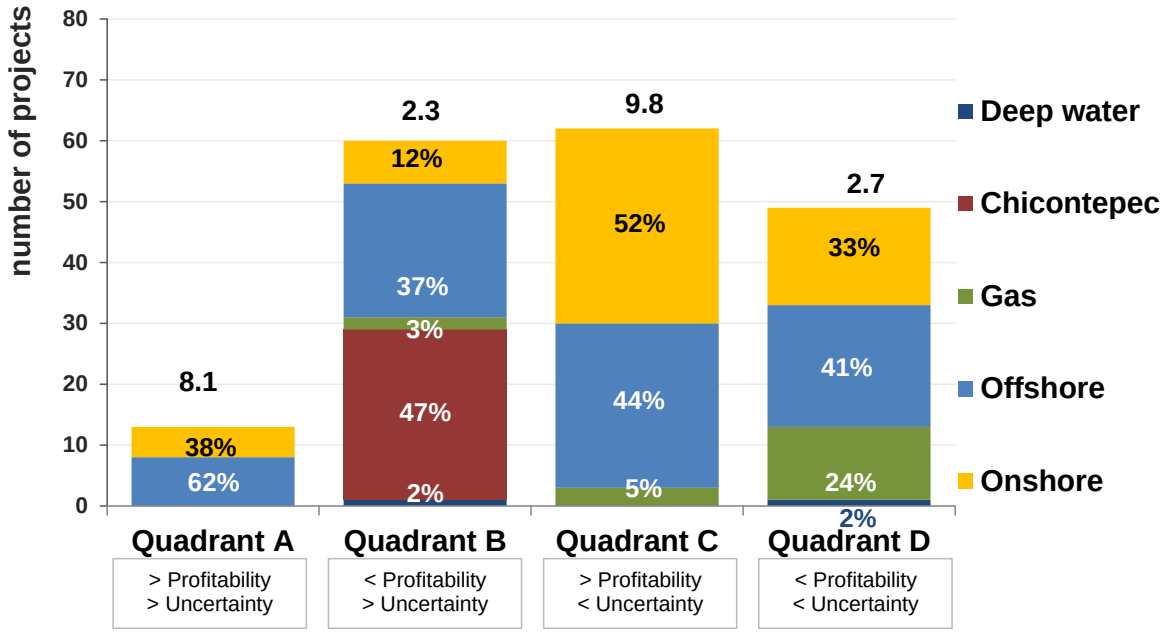
If only exploitation projects are analyzed, shallow water and onshore projects show low uncertainty levels and high profitability, differing themselves from non-associated gas and Chicontepec's projects which show low profitability and high uncertainty.

Graph 12. Exploitation projects mapped by type, profitability and uncertainty



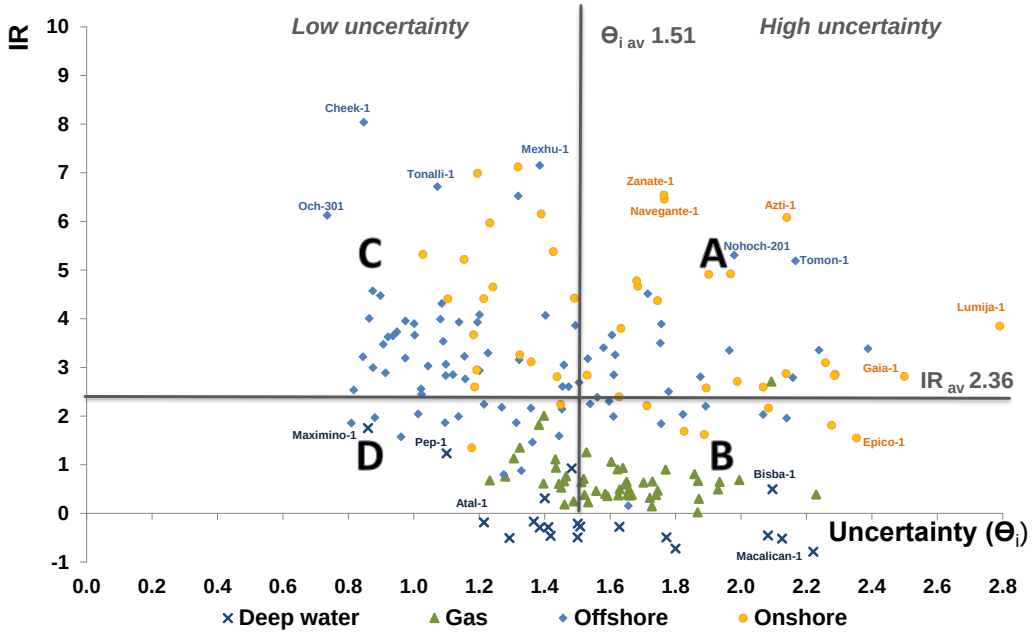
Distribution by quadrant for exploitation projects shows the following remarks: non-associated gas projects are mainly located in low profitability quadrants, B and D; while Chicontepec is located in quadrant B, low profitability and high uncertainty.

Graph 13. Exploitation projects distribution by type and quadrant



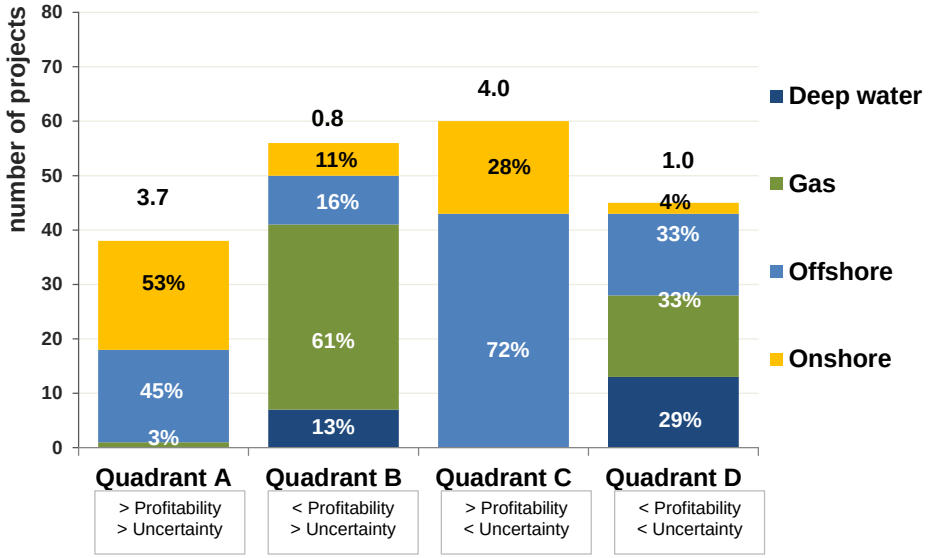
Deep water and non-associated gas exploration projects are located in low profitability quadrants, B and D.

Graph 14. Exploration projects mapped by type, profitability and uncertainty



Distribution analysis by quadrant shows that shallow water and onshore projects are located in quadrant C, high profitability and low uncertainty; 74% of the projects that show less profitability and higher uncertainty are deep water and non-associated gas projects

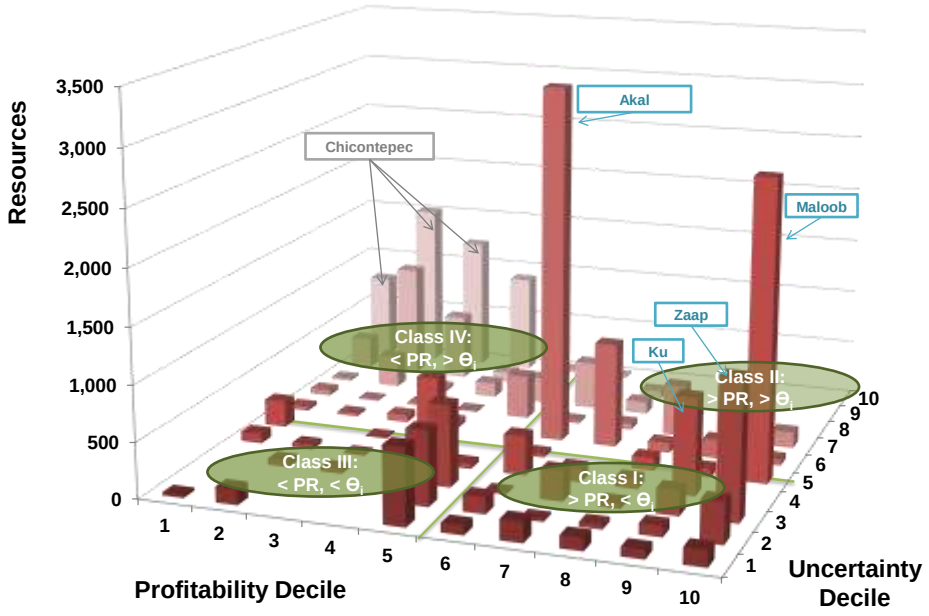
Graph 15. Exploration projects distribution according to type and quadrant



Profitability, uncertainty and materiality

Projects' profitability, as well as, uncertainty and materiality are elements that must be jointly analyzed in order to better conceptualize investment opportunities. To observe and compare all three indicators, all projects were divided by type: exploration and exploitation; and profitability and uncertainty deciles were built. Exploitation projects' results are presented in the following graph.

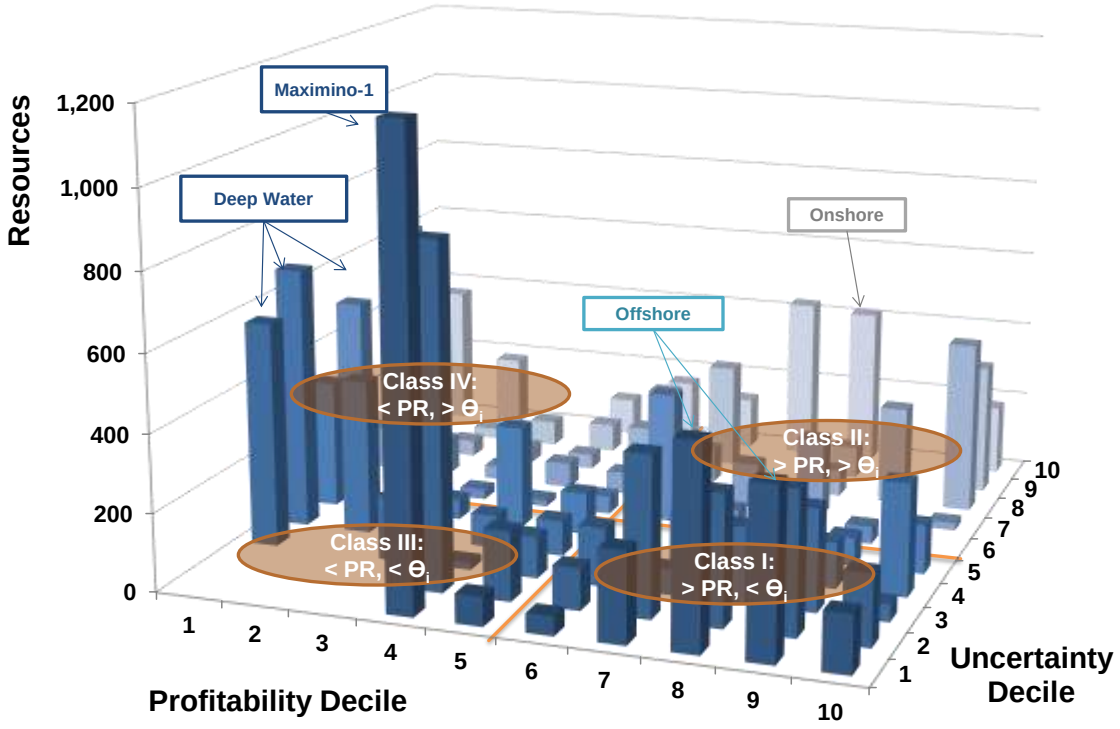
Graph 16. Exploitation projects divided by profitability, uncertainty and amount of resources



As shown in Graph 16, exploitation projects with low uncertainty, above average profitability and large materiality are: Ku, Maloob and Zaap. Notice that Chicontepec is located in the quadrant of low profitability and high uncertainty; although, it shows large amounts of resources.

Exploration projects classification is similar to the one of exploitation projects. As observed in the following graph, shallow water projects have high profitability and low uncertainty; and, deep water projects show high uncertainty and low profitability, however, notice that Maximino-1 and Pep-1 projects have large materiality and low uncertainty.

Graph 17. Exploration projects divided by profitability, uncertainty and amount of resources



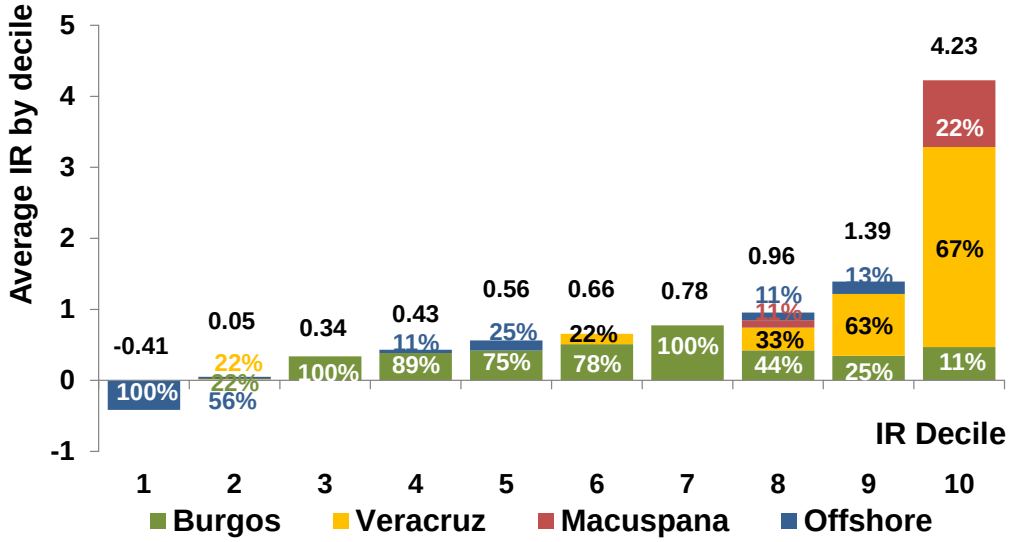
V. Non-associated gas projects

Due to current gas *vs*. oil-prices juncture, non-associated gas projects have a disadvantage compared to oil and associated gas projects; so, in this section, those projects will be analyzed exclusively to evaluate Mexico's gas basins using previously presented indicators.

Non-associated gas projects show, on average, a 0.9 profitability indicator; while for oil and associated gas projects is 4.6; this means that oil projects are, on average, 5 times more profitable.

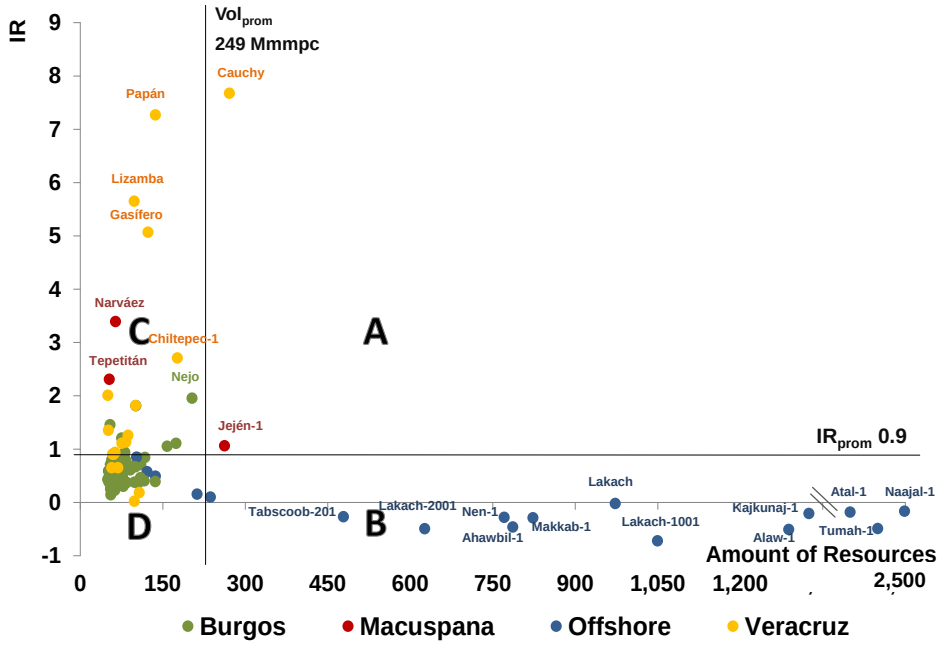
If non-associated gas projects are grouped by profitability decile, those in Veracruz and Macuspana basins are among the most profitable.

Graph 18. Non-associated gas projects distribution by profitability decile and region



Regarding materiality and profitability of non-associated gas exploitation projects, those with largest amount of resources are offshore.Meanwhile, for exploration projects the deep water projects are the ones with largest amount of resources; though, most of them show negative profits. Most profitable projects are: Cauchy, Papán, Lizamba, Gasífero and Narváez; the first four correspond to Veracruz basin and the last one to Macuspana.

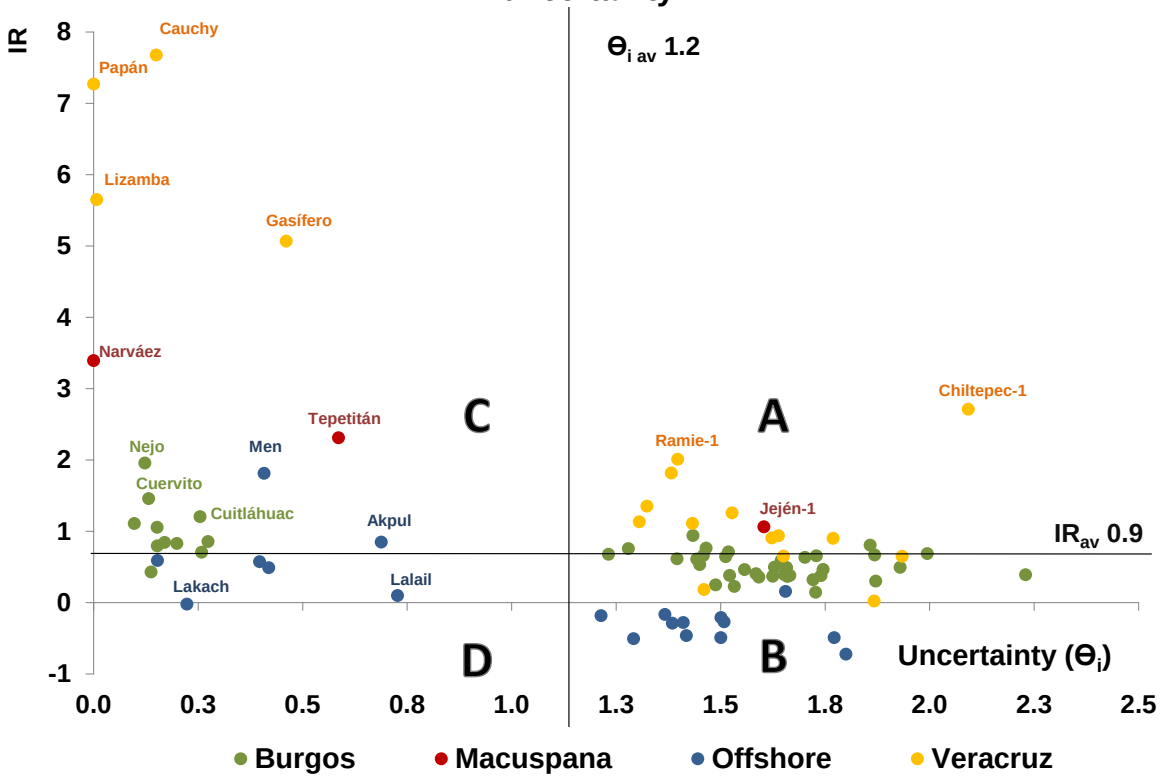
Graph 19. Non-associated gas projects mapped by region, profitability and amount of resources



If non-associated gas projects are classified by profitability and uncertainty indicators, projects in Veracruz and Macuspana basins are by far the best ones.

The following graph maps non-associated gas projects and their respective indicators. The comparison includes both exploration and exploitation projects, the first ones are located in quadrants A and B, high uncertainty-high profitability and high uncertainty-low profitability, respectively. Exploitation projects are located in quadrants C and D.

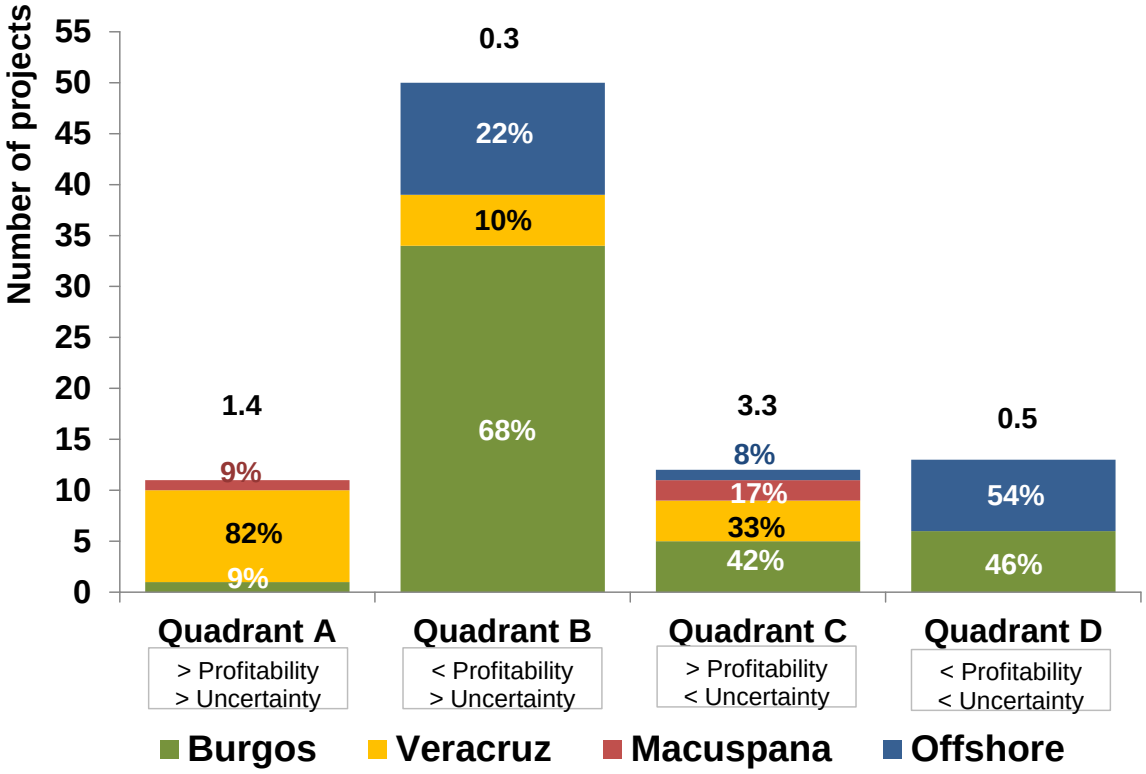
Graph 20. Non-associated gas projects mapped by region, profitability and uncertainty



Projects in the quadrant with high profitability and low uncertainty are located mainly in Burgos basin, followed by Veracruz and Macuspana.

All offshore projects are located in quadrants B and D, which holds the least profitability.

Graph 21. Non-associated gas projects distribution by region and quadrant



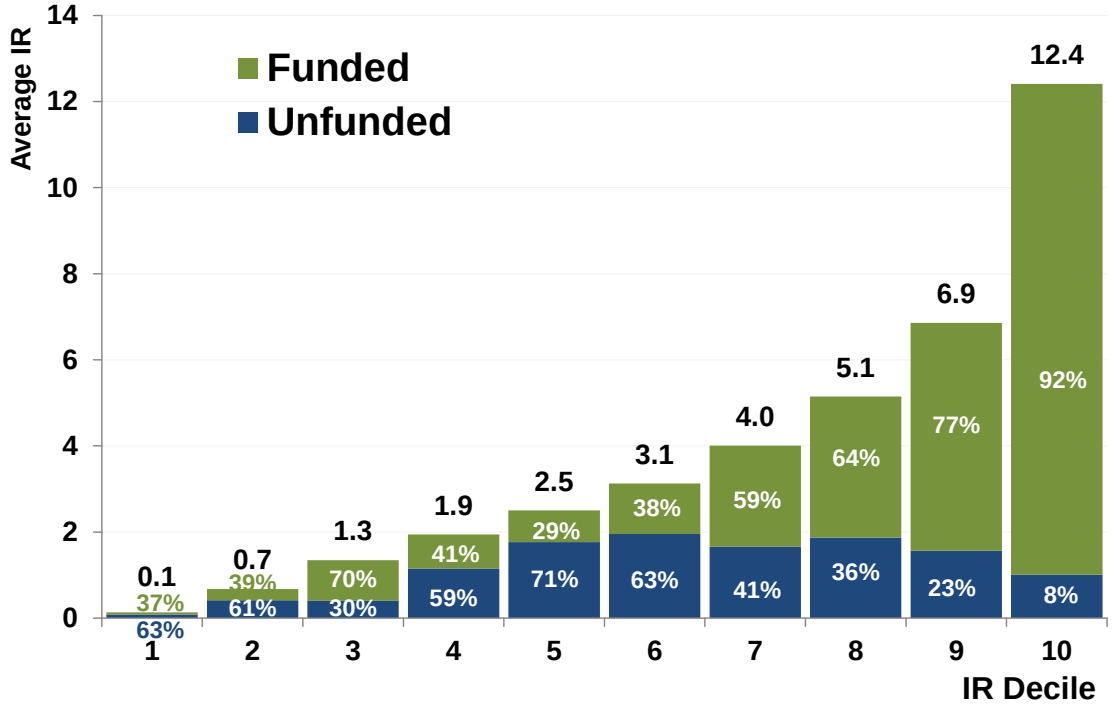
VI. Budget allocation

Funding for hydrocarbons projects

Based on Pemex 2011 projects' portfolio, this paper presents an analysis that shows which projects were and were not funded during that year and 2012. Taking that into consideration, first, funding was analyzed according to profitability indicator (IR); results are shown in Graph 22. Afterwards, funding was studied according to projects' IR distribution and materiality; results are presented in Graph 23. Finally, projects' distributions were built considering funding, profitability (IR) and uncertainty θ_i, which is shown in Graph 24.

The analysis made according to IR decile distribution shows that, from all projects with highest profitability (those in deciles 6, 7, 8, 9 and 10), 30% do not have assigned funds either for 2011 or 2012.[10]

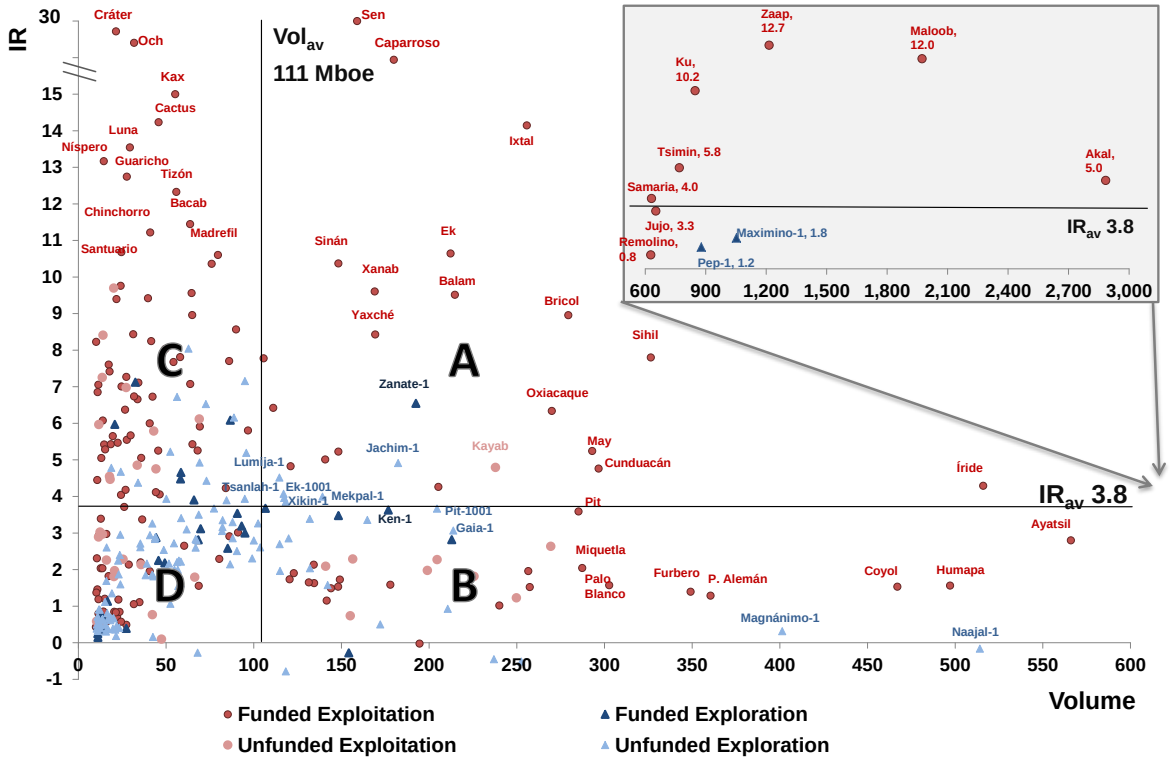
Graph 22. Profitability indicator by projects decile and funding



[10] In this exercise there were only included those projects with available information in 2011 Pemex portfolio, this is 326 out of 383 analyzed projects.

Graph 23 presents either funded or unfunded projects; all fields with 2P reserves above 600 Mmboe were funded; though, some projects with high profitability and large materiality were not.

Graph 23. Projects mapped by funding, profitability and amount of resources



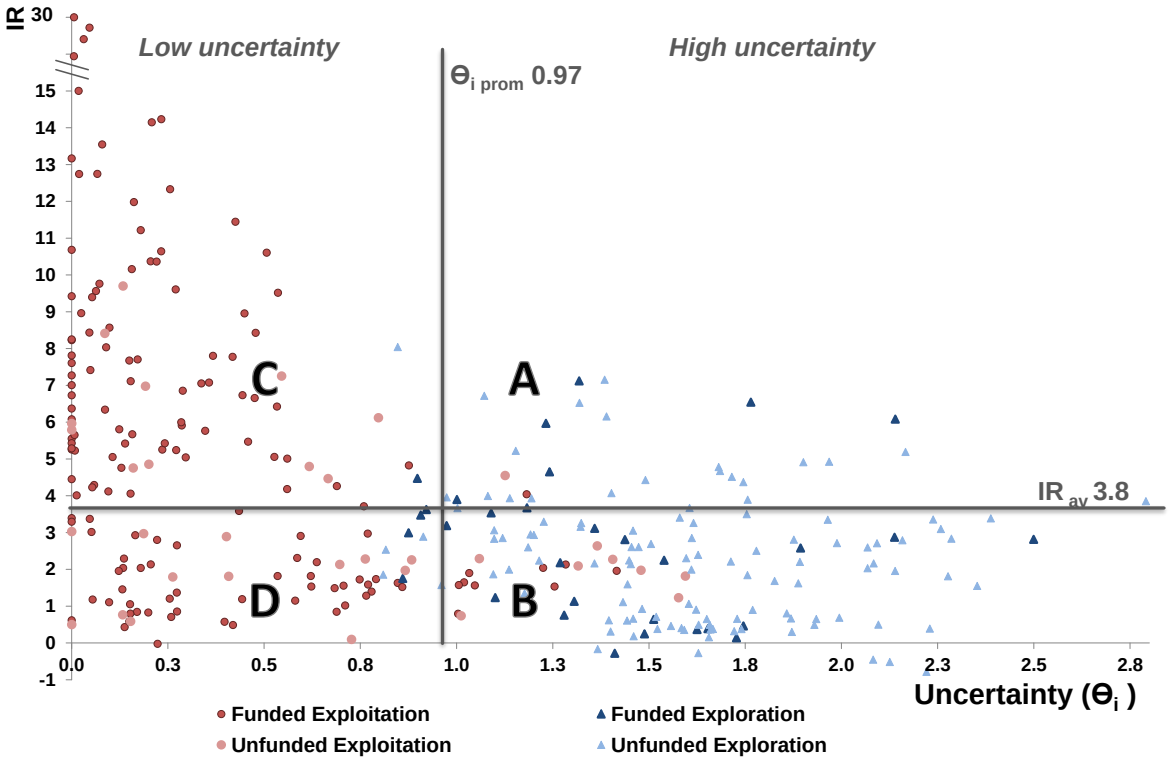
Graph 23 presents 7 projects in quadrant A (large materiality, high profitability) which are unfunded. From those, 4 are exploration projects located in shallow water (Tsalah-1, Xikin-1, Mekpal-1 y Ek-1001), 2 are onshore exploration projects (Lumija-1 and Jachim-1) and 1 is an exploitation project in shallow water (Kayab).

In quadrant B there are 24 unfunded projects, 8 exploitation projects in Chicontepec and 16 exploration projects (9 in shallow water and 7 in deep water). Generally, funding for exploration projects is low, even if profitability is high and materiality large.

Finally, Graph 24 presents projects according to their profitability (IR) and uncertainty (θ_i). There are 12 projects in quadrant C (low uncertainty, high profitability) which are unfunded; from them, 11 are exploitation projects and only 1 is an exploration one.

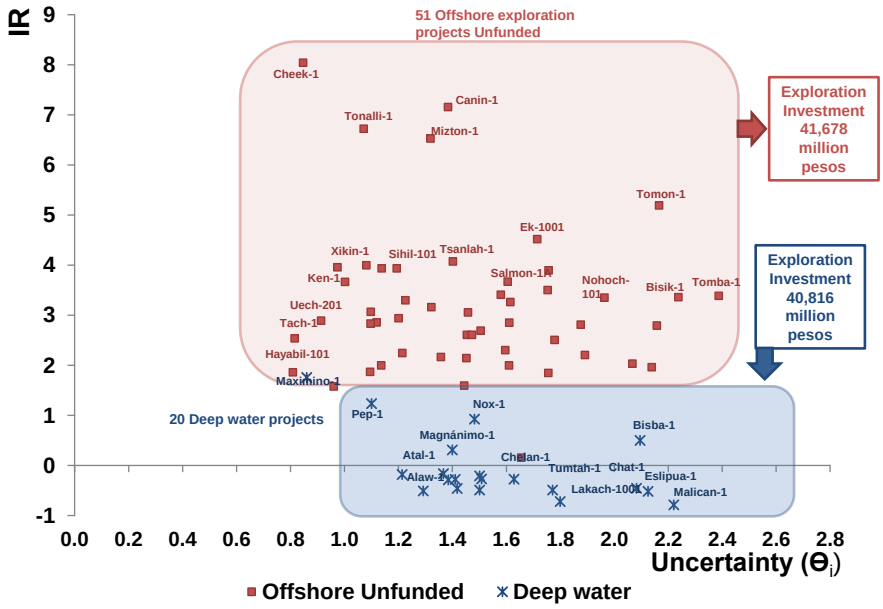
There are several unfunded exploration projects in quadrant A, their profitability is higher than other funded projects, although, they show similar uncertainty levels.

Graph 24. Projects mapped by funding, profitability and uncertainty



In order to show how the proposed methodology works, profitability and uncertainty are compared taking both, deep water and shallow water exploration projects. The second ones, with no funding, are better than those in deep water. It is important to notice that exploratory investment is similar.

Graph 25. Projects to be drilled: deep water vs. shallow water



VII. Final remarks

Identified oil fields (Certifying companies) and exploratory opportunities (Pemex) used as project definitions, given a minimum amount of resources (materiality), allowed to identify the relevant economic unit and to focus on decision-making and economic value creation.

Using this economic unit, 383 projects were identified throughout the paper: 184 exploitation projects and 199 exploration projects.

It is important to notice that TP-3 findings are not enough to justify projects' budget allocation; however, they can be used as tools to assess if former investment decisions pursued value creation.

Projects' characteristics, identified through profitability and uncertainty indicators, materiality and funding, show the following remarks:

- Chicontepec projects present the least profitability and highest uncertainty when they are compared to every other project.

  All Chicontepec projects are located in the group with least profitability and highest uncertainty; nevertheless, 75% of these projects were funded either in 2011 or 2012.

  Chicontepec budget during 2011 was 26,744 million pesos,[11] which represents 12% of Pemex exploration and exploitation total budget; also, it represented 86% of exploration budget in the same year.

- Many exploration projects, if compared to exploitation ones, show favorable profitability and materiality indicators.

  From all projects, 30% with high profitability and large materiality are exploration projects; however, only 22% were funded. Exploratory budget for 2011 was 31,133 million pesos, which only represented 13.5% of Pemex Exploration and Exploitation total budget.

[11] Current pesos. Pemex information (Oficio SPE-149-2012).

In terms of profitability and materiality, exploration projects are competitive, even when VPN methodology underestimates their real profitability. Current analysis does not consider dependencies among exploratory objectives; if that was considered, then profitability would be higher, given possible modifications to investment plans through project's development (this is commonly calculated through real options). This analysis will be considered in subsequent work.

- Exploration projects in shallow water present higher profitability than deep water projects, and also, less uncertainty. Shallow water projects are better than deep water ones both in profitability and uncertainty.

  According to this paper's methodology, 75% of deep water exploration projects have negative profitability indicators.

- Non-associated gas projects are economically attractive; though, if compared to oil projects, they cannot compete. Oil projects profitability indicator is 5 times higher than non-associated gas projects.

  Non-associated gas most profitable projects are those located in Veracruz and Macuspana basins.

Annex I. References

- *Manual para la estimación de recursos prospectivos de hidrocarburos y de probabilidad de éxito de oportunidades y localizaciones exploratorias*, Subdirección Técnica de Exploración, Pemex Exploración y Producción (PEP), marzo de 2011.
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Annex II. Definitions and abbreviations

TP-3 Technical Paper-3; National Hydrocarbons Commission.

1P Proved reserves. Hydrocarbons' minimum volume expected to be recovered with a probability of 90%. In this document, reserve 1P is defined as the P90 estimation.

2P Proved + probable reserves. Hydrocarbons' minimum volume expected to be recovered with a probability of 50%.

3P Proved + probable + possible reserves. Hydrocarbons' minimum volume expected to be recovered with a probability of 10%. In this document, reserve 3P is defined as the P10 estimation.

Resource 90 Estimated volume for prospective resources recovered with a 90% probability. In this document, resource 90 is defined as the P90 estimation.

RP Refers to prospective resources mean volume estimation subject to be discovered and developed through an exploratory project.

Resource 10 Estimated volume for prospective resources recovered with a 10% probability. In this document, resource 10 is defined as the P10 estimation.

VPN_i Net Present Value for project i (discounted @12%)

VME_i Expected Monetary Value for project i

$\propto_i$ Probability of commercial success for project i.

CR_i Venture capital for project i.

GTE_i Expected total value of expenditure for project i.

$VPGT_i$ Present value for total expenditure for project i, given commercial success.

IR_i Profitability indicator for project i.

Θ_i Uncertainty indicator for project i.

Annex III. Information sources

Approved hydrocarbons' reserves by CNH.

- **Marina Noreste Region.** Pemex economic evaluation of hydrocarbons' reserves, January 1st, 2012.
- **Marina Suroeste Region.** Pemex economic evaluation of hydrocarbons' reserves, January 1st, 2012.
- **South Region.** Pemex economic evaluation of hydrocarbons' reserves, January 1st, 2012.
- **North Region.** Pemex economic evaluation of hydrocarbons' reserves, January 1st, 2012.

Exploratory opportunities data base III 2010.

- **BDOE III 2010**. Pemex Exploration and Production data base used to estimate identified prospective resources by each exploratory opportunity.
- It corresponds to a data base updated at 3rd quarter, 2010. Pemex uses this information to evaluate country's exploratory potential presented at 2011 Portfolio Projects.
- Only exploratory opportunities with economic evaluation were included.

Annex IV. Figures for projects indicators

Exploitation projects

#	Name	Profitability Indicator (IR)	Resources (Mmboe)	Uncertainty Indicator (Θ_i)	Funding
Deep Water					
1	Lakach	-0.0	195	0.22	✓
2	Lalail	0.1	47	0.73	✓
Chicontepec					
1	Agua Fría	1.2	142	0.58	✓
2	Agua Nacida	1.9	123	1.03	✓
3	Ahuatepec	2.1	141	1.32	✗
4	Aragón	2.3	156	1.06	✗
5	Coyol	1.5	467	1.25	✓
6	Coyotes	1.7	149	0.75	✓
7	Escobal	1.6	69	0.71	✓
8	Humapa	1.6	497	1.05	✓
9	Miahuapan	2.0	257	1.42	✓
10	Pastoria	2.3	205	1.41	✗
11	Sábana Grande	1.2	250	1.58	✗
12	Sitio	0.7	155	1.01	✗
13	Tenexcuila	1.8	226	1.59	✗
14	Tlacolula	2.0	199	1.48	✗
15	Horcones	1.6	134	0.85	✓
16	Amatitlán	2.6	269	1.37	✗
17	Cacahuatengo	2.1	134	1.28	✓
18	Coapechaca	1.5	148	0.62	✓
19	Corralillo	1.5	257	0.86	✓
20	Coyula	1.5	144	0.68	✓
21	Furbero	1.4	349	0.78	✓
22	Gallo	1.6	131	1.02	✓
23	Miquetla	2.0	287	1.23	✓
24	Palo Blanco	1.6	303	1.01	✓
25	Presidente Alemán	1.3	361	0.77	✓
26	Remolino	0.8	627	1.00	✓
27	Soledad	1.7	120	0.79	✓
28	Tajín	1.6	178	0.77	✓
Non-asocciated Gas					
1	Arcabuz	0.7	22	0.26	✓
2	Arcos	0.9	14	0.27	✓
3	Cauchy	7.7	54	0.15	✓
4	Cuatro Milpas	0.4	10	0.14	✓
5	Cuervito	1.1	35	0.10	✓
6	Cuitláhuac	1.1	32	0.15	✓
7	Culebra	0.8	24	0.17	✓
8	Fundador	1.5	11	0.13	✓
9	Lizamba	5.6	20	0.01	✓
10	Narváez	3.4	13	0.00	✓
11	Palmito	1.2	15	0.25	✓
12	Papán	7.3	27	0.00	✓
13	Tepetitán	2.3	11	0.59	✓
14	Santa Anita	0.8	21	0.20	✓
15	Géminis	0.8	11	0.15	✓
16	Nejo	2.0	41	0.12	✓
17	Gasifero	5.1	25	0.46	-

#	Name	Profitability Indicator (IR)	Resources (Mmboe)	Uncertainty Indicator (Θ_i)	Funding
Offshore					
1	Abkatún	1.0	240	0.71	✓
2	Akal	5.0	2,884	0.30	✓
3	Akpul	0.8	20	0.69	✓
4	Alak	0.8	42	0.13	✗
5	Alux	3.0	16	0.77	✓
6	Amoca	4.9	34	0.20	✗
7	Arenque	3.0	91	0.05	✓
8	Atún	2.0	13	0.18	✓
9	Ayatsil	2.8	566	0.22	✓
10	Ayín	6.4	111	0.53	✓
11	Bacab	11.4	64	0.43	✓
12	Baksha	5.8	43	0.00	✗
13	Balam	9.5	215	0.54	✓
14	Batab	4.4	11	0.00	✓
15	Bolontikú	7.8	106	0.42	✓
16	Caan	9.4	40	0.00	✓
17	Carpa	5.1	13	0.11	✓
18	Chac	7.0	25	0.00	✓
19	Che	4.0	24	1.18	✓
20	Chuc	7.7	86	0.17	✓
21	Chuhuk	5.1	36	0.53	✓
22	Chukúa	0.5	27	0.42	✓
23	Ek	10.6	212	0.23	✓
24	Etkal	1.2	23	0.05	✓
25	Homol	8.6	90	0.10	✓
26	Ichalkil	2.0	21	0.87	✗
27	Ixtal	14.1	256	0.21	✓
28	Ixtoc	5.9	69	0.29	✓
29	Kab	5.0	141	0.56	✓
30	Kach	1.8	66	0.26	✗
31	Kambesah	4.8	44	0.16	✗
32	Kanaab	6.9	11	0.29	✓
33	Kax	19.9	55	0.00	✓
34	Kayab	4.8	238	0.62	✗
35	Ku	10.2	847	0.16	✓
36	Kuil	4.8	121	0.88	✓
37	Kutz	7.8	58	0.00	✓
38	Lankahuasa	0.6	24	0.40	✓
39	Lum	5.3	46	0.24	✓
40	Makech	7.3	14	0.55	✗
41	Maloob	12.0	1,973	0.16	✓
42	Manik	5.4	15	0.14	✓
43	May	5.2	293	0.27	✓
44	Mejillón	0.5	13	0.00	✗
45	Men	1.8	20	0.41	✗
46	Misón	2.9	11	0.40	✗
47	Nohoch	5.4	19	0.00	✓
48	Och	25.9	32	0.00	✓
49	Onel	5.4	65	0.24	✓
50	Pit	3.6	285	0.43	✓
51	Poctli	0.6	10	0.15	✗
52	Pohp	2.1	36	0.70	✗

#	Name	Profitability Indicator (IR)	Resources (Mmboe)	Uncertainty Indicator (Θ_i)	Funding
Offshore					
53	Pokoch	4.1	46	0.15	✓
54	Pol	7.6	17	0.00	✓
55	Sihil	7.8	326	0.37	✓
56	Sinan	10.4	148	0.21	✓
57	Takín	7.0	27	0.19	✗
58	Taratunich	4.1	44	0.10	✓
59	Tecoalli	4.5	18	0.67	✗
60	Teekit	3.0	12	0.00	✗
61	Toloc	6.0	12	0.00	✗
62	Tsimin	5.8	769	0.35	✓
63	Tson	2.3	25	0.76	✗
64	Tumut	6.7	32	0.44	✓
65	Uech	8.4	31	0.05	✓
66	Wayil	3.0	14	0.19	✗
67	Xanab	9.6	169	0.27	✓
68	Xulum	4.5	18	1.13	✗
69	Yaxche	8.4	169	0.48	✓
70	Yum	9.7	20	0.13	✗
71	Zaap	12.7	1,215	0.07	✓
72	Chapabil	2.3	16	0.88	✗
73	Tekel	6.1	69	0.80	✗
74	Xux	4.3	205	0.69	✓
75	Bagre	0.6	16	0.15	✓
76	Utsil	3.2	48	0.48	-
77	Hokchi	3.5	67	0.52	-
Onshore					
1	Bellota	5.3	68	0.00	✓
2	Blasillo	5.5	28	0.00	✓
3	Bricol	9.0	279	0.45	✓
4	Cacalilao	1.8	21	0.54	✓
5	Cactus	14.2	46	0.23	✓
6	Cárdenas	5.8	97	0.12	✓
7	Chinchorro	11.2	41	0.18	✓
8	Chintul	0.6	13	0.00	✓
9	Cinco Presidentes	6.4	27	0.00	✓
10	Cobra	2.0	14	0.13	✓
11	Costero	5.2	148	0.01	✓
12	Cunduacán	4.8	297	0.13	✓
13	El Golpe	8.2	10	0.00	✓
14	Gaucho	1.4	10	0.27	✓
15	Giraldas	3.4	36	0.05	✓
16	Guaricho	12.7	28	0.02	✓
17	Iride	4.3	516	0.06	✓
18	Jacinto	5.7	30	0.16	✓
19	Juspi	6.7	34	0.48	✓
20	Mora	9.0	65	0.02	✓

#	Name	Profitability Indicator (IR)	Resources (Mmboe)	Uncertainty Indicator (Θ_i)	Funding
Onshore					
18	Jacinto	5.7	30	0.16	✓
19	Juspi	6.7	34	0.48	✓
20	Mora	9.0	65	0.02	✓
21	Muspac	6.1	14	0.00	✓
22	Nelash	7.1	11	0.34	✓
23	Níspero	13.2	15	0.00	✓
24	Oxiacaque	6.3	270	0.09	✓
25	Paché	5.5	22	0.46	✓
26	Pánuco	1.8	17	0.62	✓
27	Paraíso	8.4	14	0.09	✗
28	Paredón	6.0	41	0.28	✓
29	Puerto Ceiba	9.6	65	0.06	✓
30	Rabasa	7.4	18	0.05	✓
31	Ribereño	2.2	35	0.64	✓
32	Rodador	9.8	24	0.07	✓
33	Samaria	4.0	631	0.01	✓
34	San Ramón	6.7	42	0.00	✓
35	Santuario	10.7	25	0.00	✓
36	Sen	28.5	159	0.03	✓
37	Sunuapa	2.7	60	0.27	✓
38	Teotleco	10.4	76	0.22	✓
39	Tepeyil	3.7	26	0.76	✓
40	Terra	7.1	64	0.36	✓
41	Tintal	5.3	15	0.00	✓
42	Tizón	12.3	56	0.26	✓
43	Tres Hermanos	2.9	12	0.17	✓
44	Tupilco	9.4	22	0.05	✓
45	Yagual	7.1	34	0.15	✓
46	Madrefil	10.6	80	0.51	✓
47	Brillante	8.3	11	0.07	-
48	Poza Rica	2.9	86	0.60	✓
49	Caparroso-Pijije-Escuintle	23.9	180	0.02	✓
50	Chiapas-Copanó	8.2	42	0.00	✓
51	Ébano-Chapacao	2.1	29	0.21	✓
52	Edén-Jolote	8.0	50	0.09	✓
53	Jujo-Tecominoacán	3.3	652	0.00	✓
54	Luna-Palapa	13.5	29	0.08	✓
55	Magallanes-Tucán-Pajonal	4.2	27	0.56	✓
56	Tamaulipas-Constituciones	2.3	80	0.14	✓
57	Ogarrio	4.2	84	0.05	✓
58	San Andrés	1.2	11	0.44	✓
59	Pareto	9.7	70	0.49	-
60	Cráter	27.3	21	0.00	✓

Exploration projects

#	Name	Profitability Indicator (IR)	Resources (Mmboe)	Uncertainty Indicator (Θ_i)	Funding
Deep Water					
1	Pep-1	1.2	878	1.10	✓
2	Chelan-1	-0.3	68	1.63	✗
3	Tabscoob-201	-0.3	96	1.51	-
4	Nen-1	-0.3	154	1.41	✓
5	Nox-1	0.9	211	1.48	✗
6	Bisba-1	0.5	172	2.10	✗
7	Maximino-1	1.8	1,052	0.86	✓
8	Macalican-1	-0.8	118	2.22	✗
9	Magnanimo-1	0.3	401	1.40	✗
10	Chat-1	-0.5	237	2.08	✗
11	Eslipua-1	-0.5	253	2.13	✗
12	Tumtah-1	-0.5	416	1.77	-
13	Ahawbil-1	-0.5	157	1.42	-
14	Makkab-1	-0.3	165	1.38	✓
15	Naajal-1	-0.2	514	1.37	✗
16	Kajkunaj-1	-0.2	273	1.50	✓
17	Atal-1	-0.2	324	1.21	-
18	Lakach-1001	-0.7	210	1.80	-
19	Alaw-1	-0.5	258	1.29	-
20	Lakach-2001	-0.5	125	1.50	-
Non-asocciated Gas					
1	Organdi-1	0.7	17	1.73	✗
2	Cazadero-1	1.3	17	1.53	-
3	Chiltepec-1	2.7	35	2.09	✗
4	Titanico-1	0.3	16	1.87	✗
5	Corcel-1	0.3	11	1.72	✗
6	Lluvia-1	0.2	13	1.53	-
7	Saltarin-1	0.4	23	1.58	✗
8	Marmol-1	0.0	20	1.87	-
9	Pachache-1	0.5	11	1.63	✗
10	Clonado-1	0.4	27	1.65	✓
11	Cobrizo-1	0.4	13	2.23	✗
12	Burbuja-1	0.7	20	1.87	✗
13	Bombin-1	0.5	22	1.56	✗
14	Arroyan-1	0.4	20	1.74	✗
15	Campeon-1	0.7	18	1.99	✗
16	Rodrigueno-1	0.8	16	1.86	✗
17	Virtuoso-1	0.5	13	1.93	✗
18	Siroco-1	0.8	16	1.47	-
19	Oroval-1	0.8	13	1.28	✓
20	Galocha-1	0.4	15	1.63	✓
21	Tomahua-1	0.4	17	1.66	✗
22	Caudillo-1	0.5	11	1.75	✓
23	Tlamaya-1	0.6	13	1.40	✗
24	Clausico-1	0.9	13	1.64	-
25	Pampas-1	2.0	10	1.40	-
26	Feliz-1	0.6	14	1.51	✓
27	Rapel-1	0.4	10	1.67	✗
28	Picota-1	0.6	18	1.44	✗

Classification of hydrocarbons' exploration and exploitation projects

#	Name	Profitability Indicator (IR)	Resources (Mmboe)	Uncertainty Indicator (Θ_i)	Funding
Non-asocciated Gas					
29	Corsario-1	0.6	10	1.65	-
30	Atacama-1	0.5	11	1.45	-
31	Mercalli-1	0.7	11	1.52	✗
32	Era-1	0.4	21	1.59	✗
33	Ventisca-1	0.5	15	1.66	✗
34	Garson-1	0.2	11	1.49	✓
35	Capitolio-1	0.4	17	1.52	✗
36	Catavina-1	0.1	11	1.73	✓
37	Kanon-1	0.2	21	1.46	✗
38	Jejen-1	1.1	52	1.60	✗
39	Lucido-1	0.9	12	1.77	✗
40	Ejemplar-1	0.9	12	1.62	✗
41	Saguaro-1	0.7	19	1.46	✗
42	Bedel-1	1.1	15	1.43	✗
43	Gasifero-1	0.6	11	1.93	✗
44	Ramie-1	1.8	20	1.38	-
45	Nuevaera-1	0.6	14	1.65	✗
46	Quixote-1	1.1	17	1.31	✓
47	Organico-1	1.4	10	1.32	-
48	Progreso-101	0.9	16	1.43	-
49	Gato-1001	0.7	11	1.23	-
50	Cuatrocienegas-1001	0.6	13	1.70	-
Offshore					
1	Lum-201	2.2	49	1.27	✓
2	Alak-101	1.6	142	0.96	✗
3	Lum-101	4.5	58	0.90	✓
4	Picon-1	2.0	57	1.61	✗
5	Camaron-1	2.9	41	1.20	✗
6	Jurel-101	3.4	59	1.58	✗
7	Molusco-1	1.8	38	1.76	✗
8	Ostracodo-1	3.5	69	1.75	✗
9	Mekpal-1	4.0	139	1.08	✗
10	Xupal-1	3.3	88	1.23	✗
11	Xipal-1	2.2	39	1.36	✗
12	Cheek-1	8.0	63	0.85	✗
13	Bisik-1	3.4	165	2.24	✗
14	Kaxanbil-1	2.0	73	1.82	-
15	Nohoch-101	3.3	82	1.96	✗
16	Tomba-1	3.4	132	2.39	✗
17	Tomon-1	5.2	96	2.17	✗
18	Chapabil-301	2.0	100	1.01	-
19	Akal-301	1.9	42	1.31	-
20	Suuk-1	2.9	88	1.12	✗
21	Hermes-1	2.0	115	2.14	✗
22	Kama-1	2.0	132	2.07	✗
23	Tson-101	3.5	148	0.91	✓
24	Zarpador-1	2.8	100	2.16	✗
25	Tatziquim-1	0.2	43	1.66	✗
26	Taratunich-3001	3.2	31	1.53	-
27	Bentonico-1	2.8	67	1.88	✗
28	Necora-1	2.5	90	1.78	✗
29	Och-301	6.1	84	0.74	-

#	Name	Profitability Indicator (IR)	Resources (Mmboe)	Uncertainty Indicator (Θ_i)	Funding
Offshore					
30	Tach-1	2.5	49	0.82	✓
31	Hayabil-101	1.9	42	0.81	✗
32	Mizton-1	6.5	73	1.32	✗
33	Canin-1	7.2	95	1.38	✗
34	Tlacame-1	3.2	39	1.16	-
35	Talan-1	0.8	143	1.27	-
36	Ichal-1	2.8	134	1.16	-
37	Xikin-1	4.0	117	0.97	✗
38	Chac-301	2.6	35	1.45	✗
39	Ek-301	3.5	91	1.09	✓
40	Abkatun-2001	3.9	50	1.19	✗
41	Tonalli-1	6.7	56	1.07	✗
42	Charales-1	3.9	85	1.76	✗
43	Ek-201	2.8	44	1.10	✗
44	Sihil-101	3.9	95	1.14	✗
45	Tson-1001	2.6	104	1.47	✗
46	Nohoch-201	5.3	90	1.98	-
47	Ek-1001	4.5	115	1.72	✗
48	Yut-1	1.9	23	1.10	✗
49	Ayin-3dl	3.2	93	0.97	✓
50	Tson-201	3.6	177	0.92	✓
51	Gema-1	2.8	120	1.61	✗
52	Ken-1	3.7	205	1.00	✗
53	Beluga-1	1.6	24	1.44	✗
54	Isurus-1	2.2	46	1.54	✓
55	Myliobatis-1	2.2	56	1.89	✗
56	Pit-2001	2.3	99	1.60	✗
57	Zazilha-101	3.7	77	0.95	-
58	Chapabil-201	3.0	64	1.04	-
59	Maloob-201	3.9	66	1.00	✓
60	Ku-301	4.6	117	0.87	-
61	Chapabil-401	4.3	93	1.09	-
62	Lum-301	2.2	57	1.21	✗
63	Uech-201	2.9	44	0.91	✗
64	Salmon-1a	3.7	77	1.61	✗
65	Uchbal-1	3.3	102	1.62	✗
66	Yaxche-201	2.7	115	1.51	✗
67	Ku-3001	3.2	82	1.32	✗
68	Ku-2001	1.5	37	1.36	-
69	Ku-5001	4.1	55	1.20	-
70	Esah-1	3.2	60	0.84	-
71	Yum-1001	3.0	95	0.88	✓
72	Tsanlah-1	4.1	117	1.40	✗
73	Balam-1001	3.9	45	1.49	-
74	Ayatsil-1001	2.1	87	1.45	✗
75	Zaap-3001	3.1	82	1.46	✗

#	Name	Profitability Indicator (IR)	Resources (Mmboe)	Uncertainty Indicator (Θ_i)	Funding
Offshore					
76	Xulum-1001	2.0	55	1.14	✗
77	Ku-201	3.6	49	0.94	-
78	Utsil-101	4.0	71	0.86	-
79	Pit-1001	3.1	214	1.10	✗
80	Tsimin-3dl	2.4	126	1.56	-
81	Bacab-501	2.4	38	1.02	-
82	Numan-101	2.0	33	0.88	-
83	Kay-1001	2.6	69	1.02	-
84	Chapabil-1001	0.9	76	1.33	-
Onshore					
1	Sitala-1	1.3	19	1.18	✗
2	Xumapa-1	2.9	24	1.19	✗
3	Puan-1	3.3	42	1.32	✗
4	Chichicaxtle-1	2.7	55	1.99	✗
5	Mexhu-1	7.0	24	1.20	-
6	Robusto-1	6.2	89	1.39	✗
7	Navegante-1	6.5	256	1.77	-
8	Jaule-1	2.8	18	1.53	-
9	Jachim-1	4.9	182	1.90	✗
10	Zanate-1	6.5	192	1.76	✓
11	Nicapa-201	3.1	70	1.36	✓
12	Terra-2DL	5.3	72	1.03	-
13	Laventa-1001	7.1	32	1.32	✓
14	Bombo-1	4.7	24	1.68	✗
15	Altamonti-1	3.7	107	1.18	✓
16	Muyil-1	2.4	24	1.63	✗
17	Lumija-1	3.9	118	2.79	✗
18	Tembac-1	2.9	41	2.29	-
19	Epico-1	1.5	57	2.35	✗
20	Longo-1	2.8	67	2.29	✗
21	Choco-1	1.8	43	2.28	✗
22	Gaia-1	2.8	213	2.50	✓
23	Tilico-1	2.2	52	2.08	✗
24	Jujo-1001	4.4	98	1.21	-
25	Pepino-1	5.2	52	1.15	✗
26	Triunfo-201	2.2	58	1.71	✗
27	Vanguardia-1	2.6	67	2.07	✗
28	Achote-1	6.0	21	1.23	✓
29	Enebro-101	4.7	58	1.24	✓
30	Giraldas-201	2.8	68	1.44	✓
31	Saraguato-101	3.1	62	2.26	✗
32	Alebrije-1	2.9	44	2.14	✓
33	Maceral-1	2.2	23	1.45	✗
34	Lagar-1	4.4	34	1.75	✗
35	Azti-1	6.1	87	2.14	✓
36	Multi-1	1.7	16	1.83	✗
37	Pacoco-1	1.6	58	1.89	✗
38	Alir-1	4.8	19	1.68	✗
39	Tijib-1	4.4	73	1.49	✗
40	Cheej-1	2.6	85	1.89	✓
41	Kanemi-1	5.4	127	1.43	-
42	Pache-1001	2.6	16	1.19	✗
43	Sanramon-1001	3.8	25	1.63	✓
44	Genes-1	4.9	69	1.97	✗
45	Arroyozanapa-201	4.4	37	1.10	-