

IP STRATEGY FOR THE O&G SECTOR – PETROBRAS’ CASE STUDY

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ABSTRACT

When investing in innovation one has to ensure that the result of years of research is not simply copied and used by competitors. To secure the benefits of being a pioneer in the development of a new technology, companies build large Intellectual Property (IP) portfolio. The way companies use this portfolio may be taken as their IP strategy. The purpose of this article is to analyze the IP strategy of Petrobras, a leading oil and gas company in the Brazilian market. Like other companies, Petrobras does not disclose its IP strategy but it can be inferred indirectly according to the way it manages its patent portfolio. Even though Petrobras is the leader among other Brazilian companies in patent filing and technology transferring, a comparison of its IP strategy with other companies in the Oil and Gas (O&G) industry points to improvement opportunities mainly in the defensive, cost control and value creation aspects.

Keywords: IP strategy, patent licensing, patent portfolio management, patent abandonment, value creation.

1. INTRODUCTION

When addressing innovation, one must keep in mind the research and development of new technologies that will reach the market. While in some cases innovation can arise naturally within an organization, it must be seen as a process, not at all trivial and with a high degree of uncertainty, but considerably manageable [1].

Before the new technology reaches its dominant design, it can turn into subject of interest by competitors, so that Teece [2] states that adherence to appropriability regimes is essential. Teece [3] believes that it is not always someone who introduces a new technology into the market who makes big profits from it. There are several examples in the history of companies that innovated, but did not perpetuate their success, being overwhelmed by other companies that improved their

inventions. We can cite as an example the success of Fuji, Canon and Sony companies in the field of digital cameras pioneered by Kodak, which began bankruptcy in 2012.

According to this author, the main reason for the failure of innovative organizations lies in the difficulty of protecting their creations. This difficulty is directly linked to the effectiveness of the legal protection mechanism and the nature of technology. We can cite as a form of technology protection the following mechanisms: filing of patent applications, registration of industrial designs, ensuring a business secret, registration of computer programs, among others. Once protected, such technologies become part of the company's portfolio of intangible assets, also called Intellectual Property Rights - IPR.

The role of patents, the most popular form of protection among those cited, changed fundamentally in the 1990s [4]. The number of patent applications has increased notably faster than companies' R&D spending. Patents have gained strategic importance that has surpassed their traditional role of appropriating direct R&D returns.

The increasing competition between companies and the commoditization phenomenon of products and services has elevated the strategic importance of intangible assets as a factor of differentiation between companies, providing competitive advantages to its holders to face the competition and stand out in its markets of performance, since tangible assets such as factories or equipment, for example, are no longer responsible for most of the value creation in a company, since in a competitive environment, they can be quickly reproduced or easily become obsolete. Intangible assets such as technology, manufacturing processes, patents, distribution networks or brands are largely responsible for the generation of value. Consequently, as business value is increasingly determined by its ability to innovate, the protection of intellectual property rights has become absolutely paramount in the current knowledge-based economy [5].

In a simpler approach it is common to find references to intellectual property strategies as defensive and offensive [6]. A company will defensively patent their inventions to prevent other companies from doing so in advance and later processing them for infringement, even though the company does not need a patent on the invention to get a return on their investment in innovation. These approaches mainly refer to the role of patents in preventing other market participants from using patent protected technologies, but not necessarily used in business. Companies patents offensively to prevent other companies from patenting similar but not identical inventions they intend to commercialize. In this case, the firm builds a much wider patent wall - compared to defensive patenting - around its invention. This prevents other companies from marketing competing products, even if the company does not intend to market or license those other products.

This form of strategy combines with the closed innovation model where a research-driven institution does not rely on external partners or partners to develop new technologies. With the open innovation model proposed by Chesbrough [7] the way of dealing with intellectual property

is much broader. Rather than treating IP as a way to prevent third parties from using its technology, you should use IP to leverage your own business model and profit from the use of your technology by a third party. More than this, encouraging the use of its technology by third parties (and vice versa) can generate very useful experiences. Patents have become important assets in R&D collaborations to generate licensing revenue or to set cross-licensing agreements [4]. It is assumed that, alongside the traditional protection role, these additional strategic aspects influence the way companies build their patent portfolios.

Therefore, strategic planning has to understand the dynamics of value creation in the company, that is, map the unique characteristics of value creation of its tangible and intangible assets and the combinations of these assets, since only a deep analysis of these value generators will allow the identification of variables that, in fact, have the greatest impact on the value of the company.

A viable patent strategy that leads to a strong portfolio is generally required to secure the funding needed to move the industry from the R&D to the commercialization stage. When building a IP portfolio, companies should not only keep in mind only the value of their own patent portfolio and the need to protect their core technology, but also the need to identify the IP of others where it may be necessary to acquire a license (or otherwise avoid). Once a strong patent portfolio is built, the company must have a strategy to generate a revenue stream from its IP by licensing or enforcing its IP rights through local law [8].

The objective of this paper is to present a case study analyzing the intellectual property strategy of an oil company. *Petróleo Brasileiro SA - Petrobras* - was chosen as the focus of this study, not only because it is from the Oil and Gas (O&G) sector but also because it is one of the most innovative companies in the Brazilian industry. In one of the latest awards given to O&G companies in Brazil, Petrobras was elected as the most innovative company in the country in the category Base and Metallurgy Industry [9].

As an analysis methodology to conduct this study, we have chosen to refer to the model proposed by Julie Davis and Suzanne Harrison [10]. The authors identify five levels of sophistication in how companies address the management of their IP assets: Defensive Level, Cost Control Level, Value Generation Level, Integrated Level, and Visionary Level.

The study also contains a comparative analysis of Petrobras with other companies in the sector based on public information available, most of it provided by the patent offices in several countries. The second objective is to compare Petrobras' IP strategy with the strategy of other companies in the sector.

2. LITERATURE REVIEW

2.1 Intellectual Property Rights

Intellectual Property Rights are those related to the legal protection that the law assigns to the creation of the human intellect. Included in these rights are the protection of inventions, which

are economic in nature and have industrial applicability.

The protection of a technology can be performed by applying for patents, utility models, industrial designs, software registration, and others. Business secret and defensive publication are also ways of protecting know-how and technologies [11].

Among the forms of protection cited, patents stand out as a form of legal protection that allows the exclusion of third parties from the exploitation of protected technology for a term of 20 years. They are also referred to provide greater clarity and security in the licensing process and in the formation of strategic partnerships for research or industrial operations. It is the ideal form of protection for inventions in products and equipment that will be within the reach of third parties capable of reverse engineering.

Taken as another available possibility for protection, business secrets also allow third parties to be excluded from exploitation of the technology, but for an indefinite period of time. Contrasting with this advantage over patents there is the disadvantage of being a form of protection vulnerable to information leakage and greater legal risk. Nevertheless, it is highly indicated in the early stages of development of a new technology and to enjoy the benefits of the newly acquired know-how. Besides it, business secret form of protection is ideal for innovations in processes which have little visibility to external agents hindering or preventing a reverse engineering process. In deciding on this type of protection, it would be obvious to say that a great enterprise effort is needed to keep the secret away from unauthorized persons.

Protection through Defensive Publication, in other words, by disclosing technology in scientific papers and other publications prevents patenting it by third parties. However, it does not present the benefits of licensing and advantages in forming strategic partnerships. It may be the cheapest means of protection, but it does not prevent third parties from developing improvements in technology and such improvements from being patented. This would be the form of protection of greater vulnerability and legal insecurity. Although it appears to have more disadvantages than advantages, it is used in the case of protection of peripheral and low-impact technologies in the company's business.

2.2 Intellectual Property Strategy

In the industrial economy, companies created value from tangible assets, through the transformation of raw materials into finished products. A study from Brookings Institute in 1982, showed that the value of tangible assets represented 62% of the market value of industrial organizations. Ten years later, this percentage fell to 38%. Studies of the end of twentieth century estimate that the value of tangible assets corresponded to only 10 to 15% of the market value of the companies. Based on these data, Kaplan and Norton [12] notes that the opportunities for value creation are shifting from managing tangible assets to managing knowledge-based strategies that exploit the organization's intangible assets: customer relationships, innovative products and services, information technology and database, in addition to skills, and employee

motivation.

A company's strategy is typically defined in terms of its position in the industry or the scenario in which it operates and the company's competitive advantage in that scenario. This competitive advantage, in turn, derives from a combination of assets (what the company has) and capabilities (how the company does what it does). While the image of the oil and gas industry is greatly influenced by its assets, competitive advantage usually results from a combination of tangible assets, capabilities and intangible assets such as reputation and intellectual property [13].

For the hydrocarbon-based industry, there is no single strategy that applies to all organizations or within the same organization in the industry, which can often have diverse interests, e.g. upstream, downstream, chemicals, pipelines and aviation. In addition, the strategic objectives of an international oil company (IOC) may differ from a national oil company (NOC). Depending on the role of a firm within the value chain, different considerations can be applied [14].

The way the company protects its technologies and how it uses its portfolio of IP define their Intellectual Property strategy. In their book, *Edison in the Boardroom: How Leading Companies Realize Value from Their Intellectual Assets*, published in 2002, Julie Davis and Suzanne Harrison identify five levels of sophistication in how companies address the management of their IP assets. This hierarchy, shown in Figure 1, is a useful way of thinking about the company's expectations.

Defensive Level: Companies at this level use their IP only for defensive purposes. Its objectives are to protect their own innovations and to ensure that they don't violate IP of others. In this strategy level the cost of filing fees, enforcement and other legal expenses can be high because there isn't a concern to define the territory boundaries of protection.

Cost Control Level: Companies at this level still have a defensive approach, but also focus on finding ways to get protection while minimizing the costs of creating and maintaining their IP. This means they are more concerned about where they should protect their technologies and also with monitoring their interest in maintaining that protection, which can lead to a good savings in management costs.

Profit Center Level: Companies reach this level when they begin licensing their IP, as well as using it to support the business activity of the company. The value generation occurs directly through financial retributions due by the licensed company, such as royalty payments, or indirectly through economic benefits accruing from the partnership between these companies, as those arising from a cross-licensing agreement.

Integrated Level: Here the business units of the company have already assimilated the power of using IP for a variety of functions in their business. The use of IP for business purposes becomes integrated into all of the company's business activities.

Visionary Level: At this level of sophistication of IP management, companies have a long-term view of the company's role in business and industry. They seek to use IP to create more strategic value for the company.



Figure 1 - Pyramid of IP Strategy Levels

It should not be inferred that the highest level of sophistication of this pyramid equals the best level of IP management. What matters is determining which level best fits the company's needs and capabilities. A thorough understanding of what the company intends with its IP as a whole, taking into consideration its corporate strategy, is an important first step in determining whether the company aspires to obtain business value from its IP, or if it wishes to obtain a value purely defensive [15].

Almost ten years later, Harrison and Sullivan [16] published an updated version of the model shown in Figure 1. In the first edition, the focus for companies was largely inward; what they could and should do to match their IP management activity with what they wanted to accomplish. In the later edition the authors showed how IP-sophisticated companies are focused on using IP to gain strategic position outside of the company.

The levels of maturity have become: Defend Position, Manage Costs, Capture Value, Synthesize Opportunities and Shape the Future. In spite of this the main concepts and the structure of the model remained unchanged. This allowed the IP strategy analysis proposed in this article to be based on any of the versions, the first one being chosen by the authors.

3. DISCUSSION

3.1 The Evolution of the IP Strategy at Petrobras

Petrobras can be considered an integrated oil company, whose operations cover upstream and downstream activities. The company was created in 1953 by the Brazilian federal government and is currently the largest company in Brazil. Currently the company is present in the oil exploration and production, refining, natural gas, electric power, logistics, commercialization, distribution, petrochemicals, fertilizers and biofuels segments.

From a very early stage, Petrobras expressed its concern about the development of its own technologies to achieve its strategic objectives and this desire was materialized in the creation of its Research Center – CENPES – in 1963, one of the most important research complexes in the world. The protection of developed technologies has not been neglected. The register of the first technology patented by Petrobras dates from 1974 and to date more than 1595 patent applications have been filed at the National Institute of Industrial Property (INPI) in Brazil.

The Business and Management Plan of Petrobras' for the years 2018-2022 (also known as PNG 2018-2022) remains based on two main metrics: safety and financial, as had already been defined in its previous version of PNG 2017-2021 and continue guiding the strategic actions of the company. The safety metric was anticipated in two years: the limit of the Recordable Accidents Rate per million man-hours (also known as TAR) was reduced from 1.4 to 1.0 in 2018 and the financial leverage goal was maintained: net debt / adjusted EBITDA of 2.5 in 2018.

Petrobras' Vision includes fundamental principles that define what it wants to be:

"An integrated energy company focused on oil and gas that evolves with society, generates high value and has unique technical capacity."

The company has a Strategic Monitoring process, based on the Strategic Plan released in September 2016, which consists of the permanent evaluation of the business environment and the implementation of the plan, allowing adjustments to be made in a more agile and efficient way.

This monitoring was based on the vision and promoted adjustments in the set of strategies. Three new themes were incorporated: the transition to a low carbon economy; the preparation of the company to capture opportunities created by digital transformation and optimization of the company's financial and risk management, resulting in a total of 20 strategies that can be seen in Figure 2 [17].

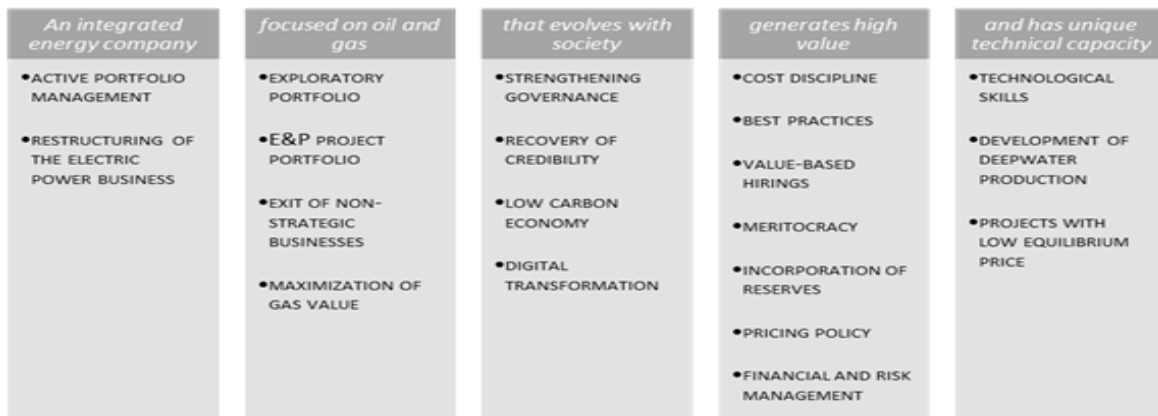


Figure 2 - Petrobras Business Strategies

From the business strategies presented, those that depend directly on a strong Intellectual Property Policy are those related to the development of technological skills and the development of deepwater production. Despite detailing its main strategic objectives, Petrobras does not make public its IP Policy. But its IP strategy can be inferred indirectly according to the patent-based searches that will be presented in this article.

According to the proposed methodology, it is intended to evaluate how Petrobras is framed in the IP Strategy model of Julie Davis and Suzanne Harrison [10]. Using the information obtained in the same patent bases, it is intended to compare Petrobras' IP strategy with the strategy of other companies of this sector based on the same methodology. Harrison and Sullivan [16] state in the later edition of their book that companies can benefit by candidly assessing where they stack up compared to others.

3.2 Defensive Strategy

According to Khan [14], in defense strategy the most appropriate means of protection is the filing of patents, which may enable the applicant to:

- Ensure freedom-to-operate;
- Reduce the chance of infringements by third parties;
- Maintain advantage as a technology pioneer;
- Promote the image of an innovative company;
- To grant tax benefits; and
- Allow greater legal certainty in business and partnerships.

The filing of a patent application can guarantee the freedom-to-operate (FTO) of a company because it makes impossible for third parties to file patent applications for the same technology. In other words, guaranteeing FTO means ensuring that others do not prevent the company from using the technology it has invested time and money to develop in the event that another company comes to seek protection by filing patents for the same technology. Competitors can achieve the same result of a company by lawful means for researching and developing within the same technology area or by illicit means when there is the so-called industrial espionage.

Patent filing also matches the defensive strategy if the company depends on not only ensuring that it will not be prevented or required to pay royalties for the use of a technology that it has invested to develop, but also to exclude third parties from the use of that technology and thereby gain competitive advantage in the market. Patent filing reduces the risk of infringements by third parties but does not completely eliminate them. In the case of process inventions, a patent may not be fully effective in its protection because it is a type of invention difficult to trace. The infringement may occur behind the walls of the competitor and no one would know.

When a company is a pioneer in developing a technology, it seeks to maintain that advantage for

as long as possible. Although a patent grants 20 years of market exclusivity it is not always what happens. The disclosure of how the technology works, exposed by the patent, drives the competitors to develop improvements of the same. This should not discourage the patenting of inventions, but rather the continuous evolution and filing of more patents by the original developer. That way it can continue being the leader developer and exclude third parties from exploiting its technology.

An indirect advantage of patent filing as a business strategy is to promote the image of an innovative company. Patents are also considered valid economic indicators to measure technological progress [18, 19]. Therefore, the company within its intellectual property strategy, should consider whenever appropriate, the filing of as many patents as possible.

In Brazil, there is still the possibility of receiving tax benefits for the filing and granting of patent applications. Law No. 11,196, from 2005, includes a series of fiscal incentive benefits and, among its main items, the deduction of 160% of the expenditures made on R&D activities (only for companies under real profit taxation) for determination of the net income of the company, positively impacting on the amount due on its Income Tax (IRPJ) and Social Contribution (CSLL). This value can reach 170% if the company increases the number of researchers in 5%, and 180% if they increase that number above 5%. In addition, if the company has a patent granted or cultivar registered related to the specific R&D expenditure, it may exclude more 20% of the calculation basis for IRPJ and CSLL [20].

The advantages cited also include a greater legal certainty in business and partnerships that a patent can provide. The greater the number of patents on a given technology, the greater the bargaining power that a company will have in a cross-licensing negotiation or in the formation of a partnership for technological development.

Petrobras has as main objective in its Intellectual Property Policy the guarantee of freedom-to-operate in addition to the other advantages mentioned above. This can be evidenced by the number of patents filed throughout its trajectory as a company that develops solutions to its technological challenges. Using Questel's world patent database called Orbit, it is possible to find at least 1835 "patent families" filed from the 1970s to the present day having Petrobras as applicant. Where there are several applications or publications for an individual invention (in other countries) claiming the same priority or priorities, it is usual to refer to a "patent family". All of these "family members" have priority numbers with associated priority dates in common, in other words, they are related to one another by one or more priority applications. It is common to use patent families in surveys of this kind not to count twice patents filed in two different countries which refer to the same technology.

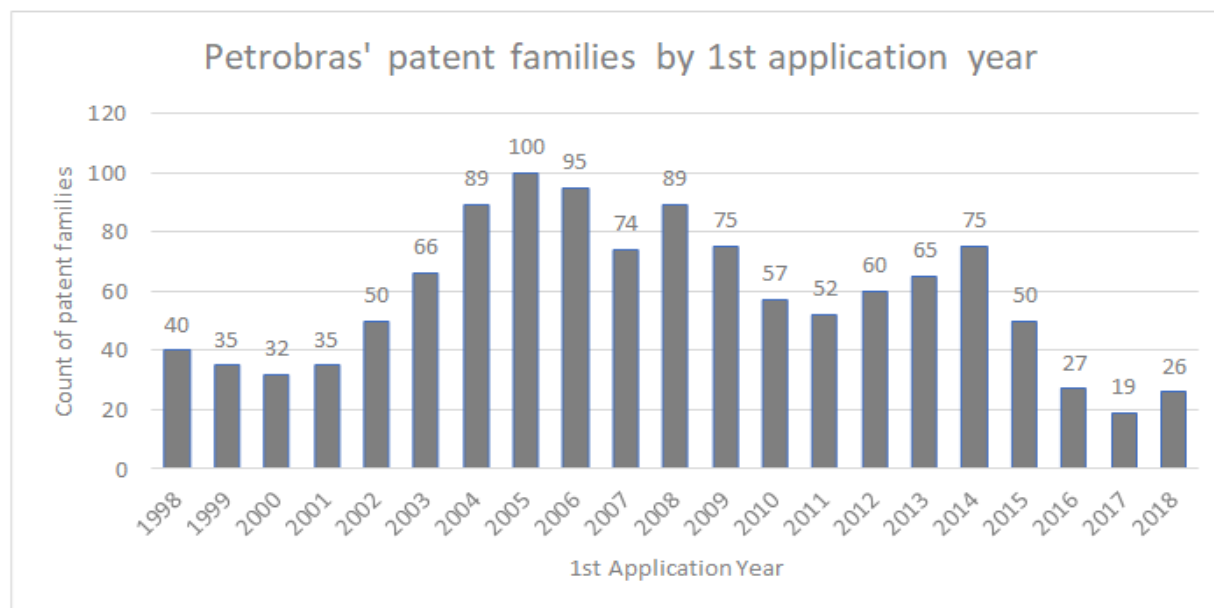


Figure 3 - Evolution of the patent filings made by Petrobras between 1998 and 2018

The graph of Figure 3 illustrates the evolution of filings over the last 20 years, indicating the dynamics of the studied portfolio. Different profiles can be observed depending on the patenting strategy implemented by the applicant. Thus, a growing portfolio (linear or exponential) indicates that the depositor is in the construction phase of his portfolio (more or less rapidly). When a stabilization of the number of deposits is observed, this can be explained by:

- a stabilization of R&D budgets, which leads to a flow of patent applications that is more or less constant without much selectivity for patent applications; or
- a desire to stabilize the costs of patents, which leads to a significant selectivity in the filings and their maintenance.

In Petrobras' case, the sudden increase in the number of deposits from the year 2000 can be attributed to a change in its IP Policy. This year the "Inventor Award" was created, a type of stimulus to the patenting given to the inventors who have patents filed or licensed by the company. Petrobras, in addition to recognizing its workforce through a public ceremony, also contemplates its inventors with a sum of money that, according to an internal standard, varies according to the inventiveness and impact of the technology developed in the company's operational activities.

A decline in the number of patents filed is generally symptomatic of a substantial decline in R&D or intellectual property management budgets. It is worth noting that there will always be a gap in current patent information due to the 18-month delay between filing an application and its publication. In Petrobras, the decline evidenced after 2015 is directly linked to the change in the

company's strategic business objective that set bold targets for the reduction of its financial leverage, previously mentioned.

A survey comprising data on patent filing in the period between 2000 and 2012 places Petrobras as the leader in the ranking of applicants resident in Brazil as can be seen in Table 1 [21].

Table 1 – Main patent applicants in Brazil (2000-2012)

| Rank | Applicant | Number of Patents |
|------|---|-------------------|
| 1 | Petróleo Brasileiro S.A. - Petrobras | 730 |
| 2 | Whirlpool S.A. | 659 |
| 3 | Universidade Estadual de Campinas - Unicamp | 620 |
| 4 | Universidade de São Paulo - USP | 468 |
| 5 | Universidade Federal de Minas Gerais - UFMG | 425 |
| 6 | Universidade Federal do Rio de Janeiro - UFRJ | 235 |
| 7 | Universidade Federal do Paraná - UFPR | 208 |
| 8 | Vale S.A. | 173 |
| 9 | Universidade Federal do Rio Grande do Sul - UFRGS | 163 |
| 10 | Empresa Brasileira de Pesquisa Agropecuária - Embrapa | 133 |

This number of patent owned by Petrobras may be significant in comparison with national companies in other sectors and even with Brazilian universities, but when compared to other foreign companies in the O&G sector, there is a big difference.

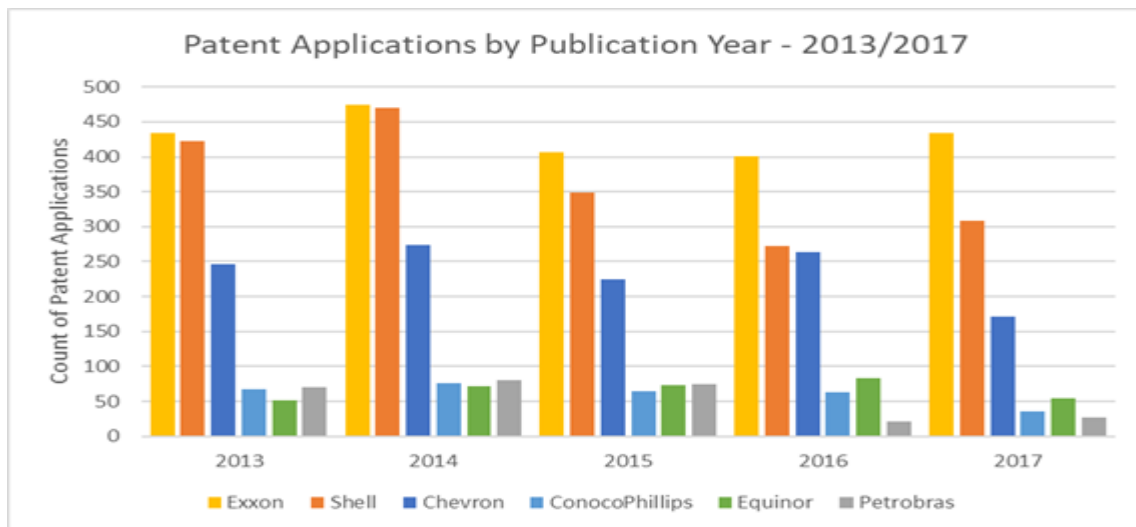


Figure 4 - Patent Applications by Publication Year for a selection of O&G companies

The chart of Figure 4 compares the number of patents published by Petrobras and some of its foreign peers. These numbers encompass patents filed in many patent offices around the globe, not only in Brazil. This selection of O&G companies could be divided into two subgroups. The first subgroup with the largest number of patents, comprising companies Exxon, Shell and Chevron and a second subgroup with companies ConocoPhillips, Equinor (formerly Statoil) and Petrobras. Comparing Petrobras with the companies in its subgroup, in the first three years it presented a higher number of published patents and a growing trend in its deposits. Analyzing only these numbers could lead to the conclusion that Petrobras has a similar patent filing strategy compared to the companies of its subgroup. However other factors such as company size and amount invested in R&D should also be taken into account before making this kind of statement.

It is possible to create an R&D efficiency indicator that measures the ratio between the output of the process - number of patents filed - and the input of the process - amount invested in R&D [22]. The proposed indicator leads us to the graph of Figure 5.

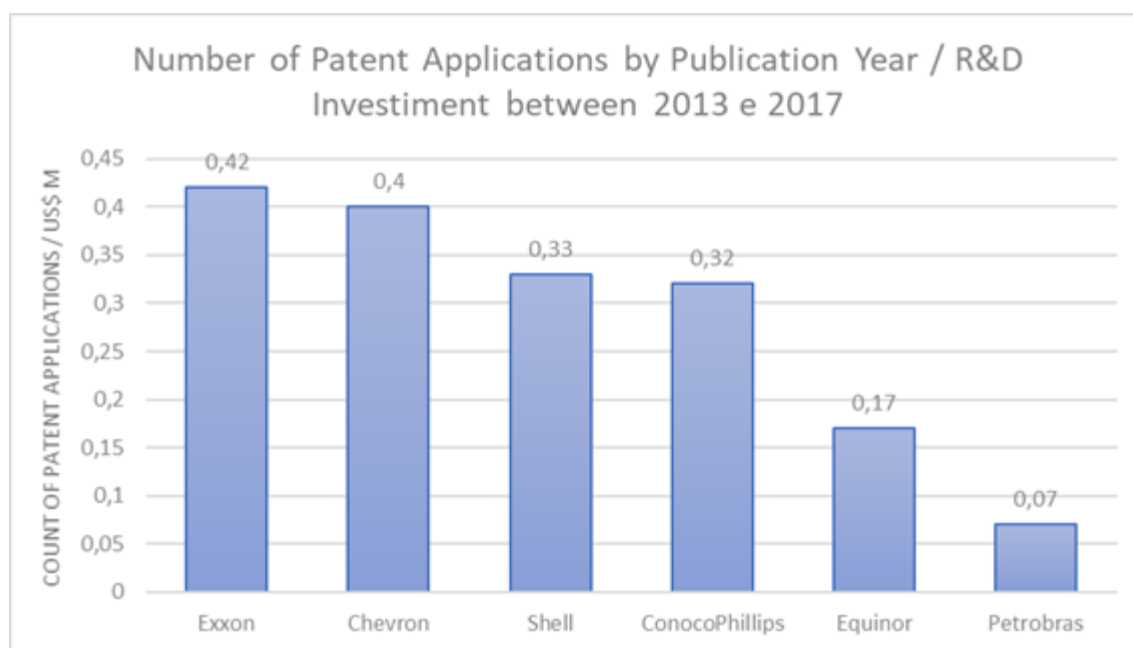


Figure 5 – R&D efficiency indicator

The comparison proposed in this chart places Petrobras as the last one position in terms of patent protection of its inventions. The option for the Business Secret could justify the low number of patents held by Petrobras in comparison with other companies. But the truth is that the patent protection culture is less widespread not only in Petrobras but also in most Brazilian companies.

3.3 Cost Control Strategy

The IP strategy based on cost control is the next step in the methodology chosen to analyze patent data collected in this article. It complements the defensive strategy seen in the previous

topic. In addition to the goal of building a patent portfolio to achieve its strategic objectives, companies that are at this level of refinement are also concerned about the costs that this portfolio can present.

Patenting costs can vary greatly from country to country. In Brazil maintaining a patent during its lifetime can cost more than R\$ 25,000 (local currency) or approximately US\$ 6,000, while in the United States this cost jumps to more than US\$ 12,000. This is not to mention the fees that are charged for filing, examining the applications, office actions and other events that occur until the grant of the patent and other costs with agents to represent the company at the patent offices of those countries. Therefore, it is important to be aware of the territory where you want to protect an invention. Since the protection granted by a patent is restricted to the territory where it was filed, it may not make sense to protect the technology where the company has no commercial interest. Less sense still exists in maintaining a patent for a technology that has become obsolete in less than 20 years.

The concern with cost control with IP Management can then be translated into two types of practices:

- Diligence in the choice of countries for overseas patent filing; and
- Abandonment of patents from obsolete technologies and/or abandonment of patents filed in countries where company have lost business interest, saving legal maintenance costs.

Petrobras has a structured process to choose the countries for overseas applications based on its strategic business plan and on technology monitoring methodology that aims to predict the directions that technologies related to the oil, gas and energy business can take. Details about this methodology are not available to be presented in this article, however it is possible to analyze the other practice of the cost control strategy related to patent maintenance.

If we compare the portfolio of patent families of the O&G companies selected for this study it can be observed a very interesting pattern. It is common for companies to have their portfolio divided into the following categories:

- Granted: if the family had at least one member granted (associated with a living status).
- Pending: if the family had at least one current application in process, but the patent has not yet been granted and published (associated with the living status).
- Revoked: If the family has had at least one member that has been revoked, but no application currently processed and no issued patent (associated with dead status).
- Expired: if the family has had at least one member expired (which has reached the end of its protection period), but no member has been revoked, no application is being processed and no granted patent (associated with dead status).
- Abandoned: if the family had at least one member who was abandoned (who did not reach the end of their term of protection), but no member was revoked, no member expired, no applications were processed and no published patents (associated with dead status).

As can be seen in Figure 6, all analyzed companies with the exception of Petrobras have a considerable portion of their portfolio classified as abandoned. This shows that these companies have the habit of reassessing their portfolio periodically to identify patents that are protecting obsolete technologies or that have no commercial interest in certain countries.

The highest percentage of patents pending in comparison with their peers is related to the speed that the industrial property office in Brazil takes to analyze the patent applications filed there. For patent applications in the area of Petroleum and Chemical Engineering the examination time is around 10.26 years [23]. As Petrobras has the majority of its deposits made only in Brazil, it is impaired in this comparison.

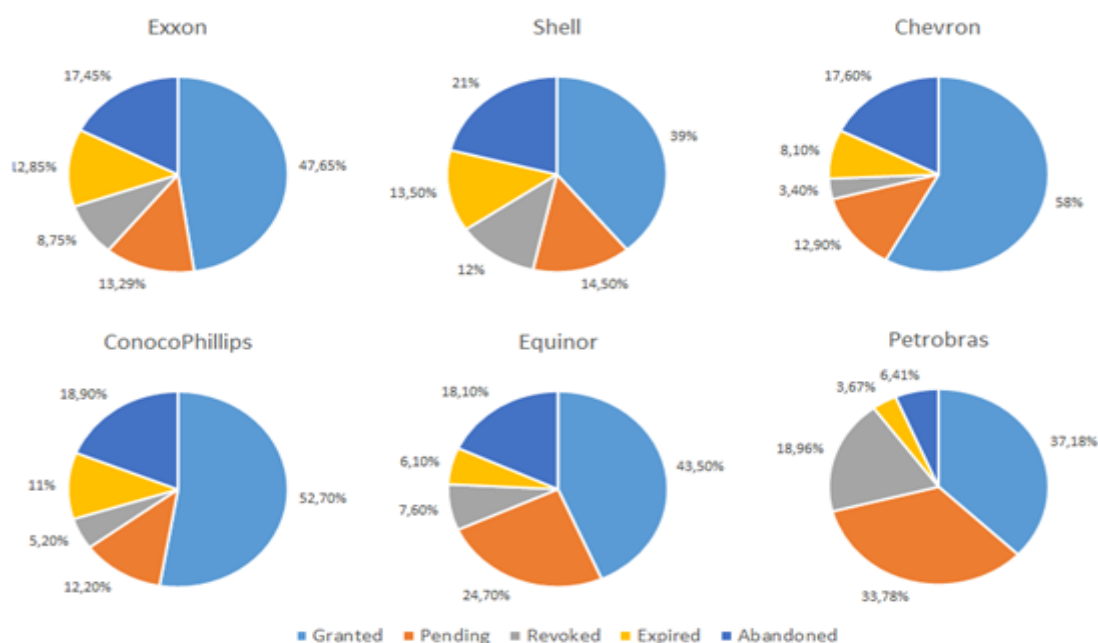


Figure 6 - Legal status of patent families published between 1998 and 2018.

3.4 Profit Center Strategy

Companies reach this level when they start licensing their IP, and use it to support the business activity of the company. Most large companies have a large IP portfolio that is not always used to their full potential. Generate value from an active IP can be achieved in several ways such as selling, licensing (up to competitors), cross-licensing to increase the profit margin (with competitors, suppliers, customers or developers) and even donation to result in other benefits [14]. In Brazil, the applicant may request the INPI to disclose that his patent is available to be licensed to whom it may concern, resulting in an annuity rate halved in the period between the offer and the grant of the first license.

It was evidenced by Questel's Orbit search tool, which includes information published by the

Securities and Exchange Commission (SEC), the United States Patent and Trademark Office (USPTO) and other public data, that nearly all O&G companies cited in this article have a history of patent licensing. It is important to keep in mind that this type of data is inherently incomplete because most of the licensing agreements are not publicly disclosed. Even so, the survey showed that these companies have at least one licensed patent application, highlighting Shell and Chevron with 101 and 44 licensed patent families respectively.

Shell may be one of the companies that most invests in licensing its technologies. In its webpage it provides a contact with possible interested in licensing its technologies. Shell Global Solutions offers a range of technologies for the treatment of contaminants in loads still to be processed to help meet the most stringent environmental requirements and product specifications, even under the most severe and fluctuating operating conditions, as they say [24].

On surveyed database it was not possible to identify any patent or application licensed by Petrobras. But from Brazilian PTO database [25] it is noted that Petrobras is a leading company among other companies in technology contracts registered. The Table 2 shows the main technology licensors in Brazil for the year 2016.

Table 2 – Main technology licensors in Brazil (2016)

| Rank | Company | Number of Contracts |
|------|--------------------------------------|---------------------|
| 1 | Petróleo Brasileiro S.A. - Petrobras | 32 |
| 2 | Embraer | 31 |
| 3 | Volkswagen do Brasil | 22 |
| 4 | Vale | 16 |
| 5 | Mahlemetal Leve | 16 |
| 6 | Moto Honda da Amazônia | 13 |
| 7 | Robert Bosch | 11 |
| 8 | Arcelormittal Brasil | 9 |
| 9 | Braskem | 9 |
| 10 | Komatsu do Brasil | 8 |

Very often, revenue from royalties is not the main reason for the licensing of patents by O&G companies. Licensing is important for Petrobras because:

- allows the entry of a new technology in the market with the possibility of consolidating it as an industry standard;
- allows improvements of Petrobras's interest to be develop and implemented in the technology without additional investments by the company;
- transfers the business risk related to the effectiveness and acceptance of the technology by the market to the licensed company;
- develops the supply chain of Petrobras enabling new companies to meet the company's demands, thereby increasing market competition;
- allows partner companies in an exploratory field to use Petrobras technologies with advantages for both;
- in the case of licensing for academic purposes, generate studies and form human resources of

interest for Petrobras.

3.5 Integrated and Visionary Strategy

These two types of strategy can be studied together. At this level of sophistication, the company's business units have already assimilated the power to use IP for a variety of functions in their business. In addition, companies have a long-term vision of the company's role in business and in its industry. They seek to use IP to create more strategic value to the company.

It's possible to identify that companies also focus on this type of strategy when they present growing or steady volume of patent filing on technologies that are not necessarily their primary goal but which have potential to change their business dramatically. When it comes to oil and gas companies, we can verify that their IP strategy is integrated or visionary if we find many filings on alternative energy technologies such as solar, wind or other renewable sources.

The graph of Figure 7 shows the result of a search on patents from each of the companies cited in this study that have at least one international patent classification code - IPC code - relating to solar, wind or biomass energy and which have been published in the last 20 years.

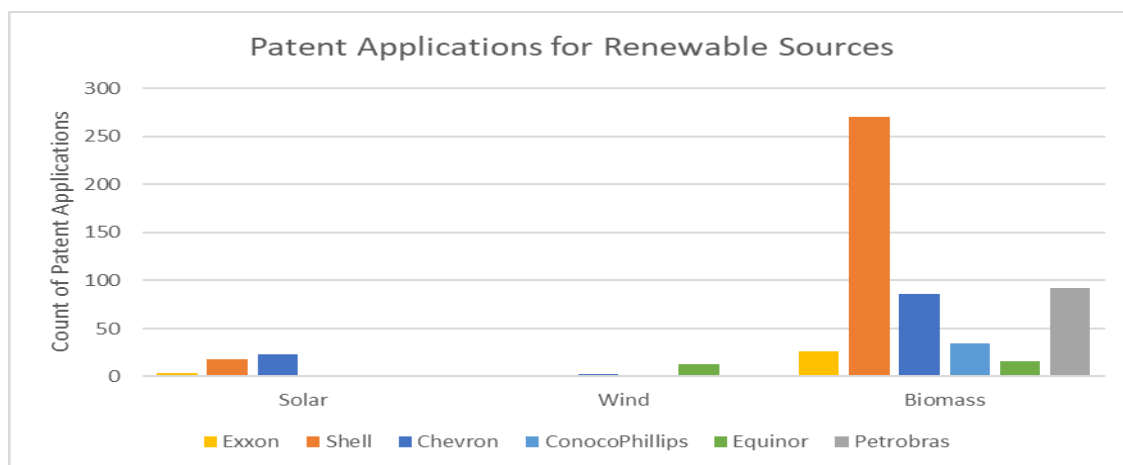


Figure 7 – Patent Applications for Renewable Sources published between 1998-2018

The focus of companies on the development of technologies for the production of energy based on biomass is evident. Shell, Petrobras and Chevron are noteworthy in this technology segment.

If we want to cite an example of technology that is of great interest in the patenting by large oil companies, we can mention biofuels. Any company interested in commercializing these emerging biofuel technologies is advised to make an effort to understand the general trends in biofuel research and to use this knowledge to build a strong intellectual property strategy [8].

But to be sure about whether one of these companies actually adopts an integrated and visionary

IP strategy, we can look at the number of patent applications published in these areas over the last five years and observe their growth or stabilization trend. This can be analyzed in the graph of Figure 8.

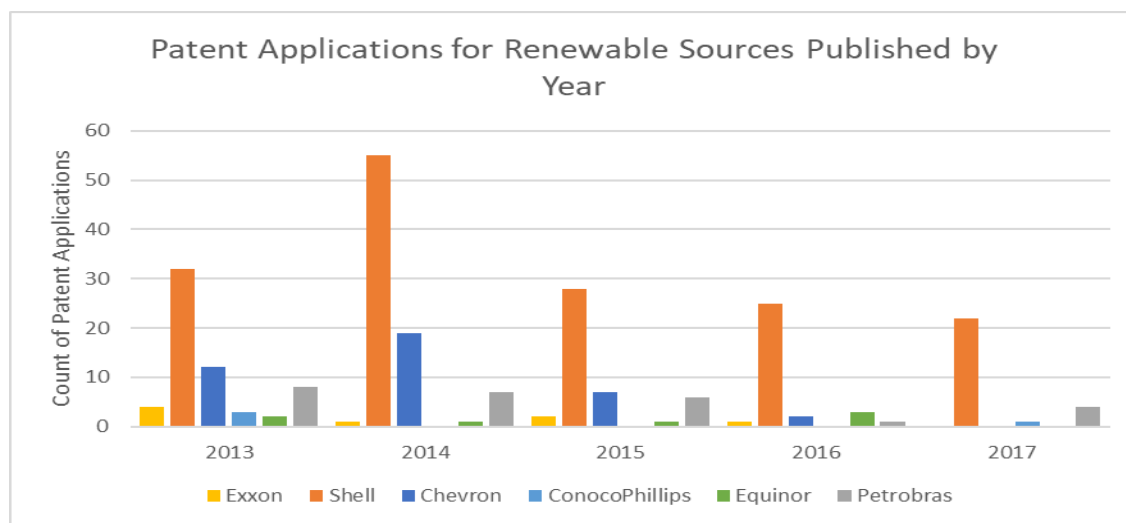


Figure 8 - Evolution of the Renewable Sources Patent Applications between 2013-2017.

Analyzing the graph, it can be inferred that Shell and Petrobras tend to maintain their average filing of patent applications in technologies related to renewable sources. Although Chevron has a volume of deposits that deserves prominence in this period, it has a downward trend in recent years. Investment in this type of technology is extremely dependent on the international price of oil. A prolonged decline in this price may justify the small decrease in the number of filings of these companies for these technologies.

3.6 Final IP Strategy Comparison

The proposal of this paper, which is to use the model of Julie Davis and Suzanne Harrison [10] to categorize the types of IP strategy that a company can adopt and analyze the IP strategy of Petrobras and other companies in the oil and gas sector can be summarized in the infographic of Figure 9, which relates each company and its intensity (strong, medium and weak) in each of the strategies. This infographic considers only information retrieved from the survey made in Questel Orbit patent database. Harrison and Sullivan [16] also stated in the later edition of their book that companies can benefit by candidly assessing where they stack up compared to others, which validates our proposal.

The criterion used to judge the intensity in each of these strategies was arbitrated so that the company that obtained the largest number of deposits within each evaluated item would receive maximum score and therefore would be classified as strong in that strategy. Companies that had

at least 60% of the number of deposits of the best placed company would also be classified as strong in the same strategy. Companies that stayed between 20 % and 60% of the value of reference were classified as medium intensity; and those that stayed below 20% of the reference value were classified as weak in this type of strategy.

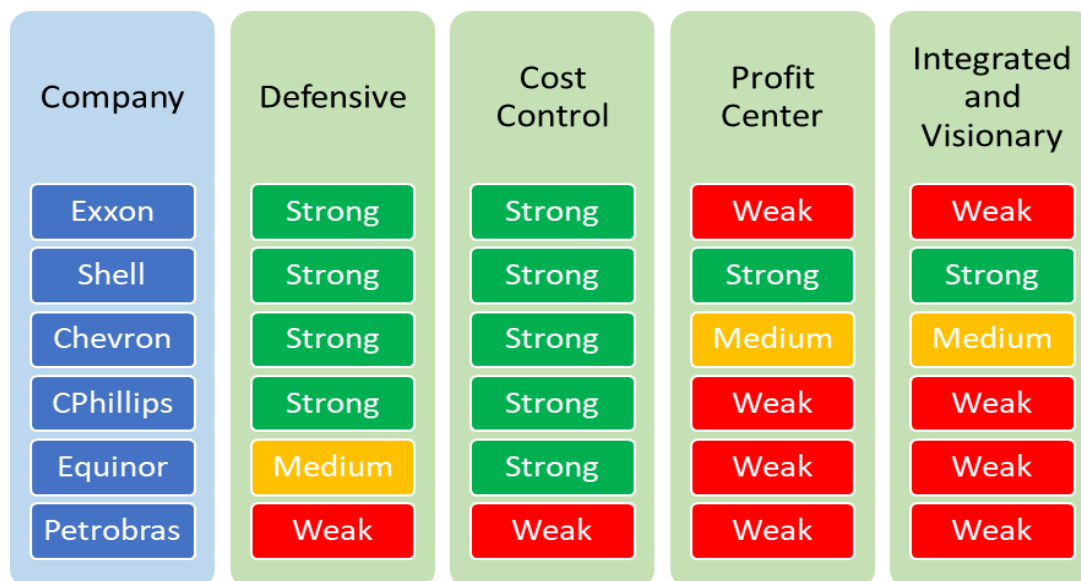


Figure 9 - Strength of O&G companies in each type of IP strategy

As stated before, it should not be inferred that the highest level of sophistication proposed by the methodology equals the best level of IP management. What matters is to define which level best fits the needs and capabilities of the company. The important thing is to match the IP strategy with its corporate strategy. That is, whether the company aspires to obtain business value from its IP or whether it wants to obtain a purely defensive value, provided that it is employing the type of strategy at the appropriate intensity.

4. Conclusion

One way of assessing whether the company is employing the right intensity in its IP strategy is by comparing it with its peers in the industry. We already know that Petrobras is the leader in patent deposits in Brazil when compared to other companies in any sector and Brazilian universities [21]. It was also verified that Petrobras has a leading position in technology transferring in Brazil when compared to other Brazilian companies [25]. However, when compared to other O&G companies abroad it is noted that its potential is not fully explored.

Therefore, if Petrobras' focus is on a defensive strategy, it is recommended that the company stimulate increased patenting of their technologies not only to ensure their freedom-to-operate but also to gain more advantages in strategic partnerships. One of the barriers to patenting more lies in the culture of intellectual property protection that is not widespread among Brazilian

companies. To reverse this scenario, Petrobras' IP department must seek support from senior management to obtain the necessary sponsorship to promote its IP Policy. Actions should be implemented and maintained to train and raise awareness of the workforce on IP issues constantly.

If Petrobras wants to improve their IP management it should additionally take actions to reduce costs (e.g. abandonment of obsolete patents) and to generate value (e.g. licensing its technologies). These non-trivial activities should be implemented by the company's IP department, which should adopt the best practices in this area. It is also advisable to make partnerships with companies that have in the commercialization of technologies their core business.

Finally, if Petrobras wants a better positioning in an integrated and visionary IP strategy, the company must invest in the patenting of alternative energy technologies and be alert to changes in the world energy market to ensure that its strategic direction is predicting the changes in environmental laws, increasingly stricter, that may end up putting its business at risk.

5. References

- Tidd, J., & Bessant, J. R. (2018). *Managing innovation: integrating technological, market and organizational change*. John Wiley & Sons.
- Teece, David J. (1986) "Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy." *Research policy* 15.6: 285-305.
- Teece, D. J. (1992). Strategies for capturing the financial benefits from technological innovation. *Technology and the Wealth of Nations*, 509-533.
- Blind, K., Cremers, K., & Mueller, E. (2009). The influence of strategic patenting on companies' patent portfolios. *Research Policy*, 38(2), 428-436.
- do Canto Cavalheiro, G. M., Joia, L. A., & Gonçalves, A. C. (2014). Strategic patenting in the upstream oil and gas industry: Assessing the impact of the pre-salt discovery on patent applications in Brazil. *World Patent Information*, 39, 58-68.
- Arundel, A., & Patel, P. (2003). Strategic patenting, background report for the trend chart policy benchmarking workshop. *New trends in IPR Policy*.
- Chesbrough, H. W. (2006). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business Press.
- Mannan, R. (2010). Intellectual property landscape and patenting opportunity in biofuels. *Journal of Commercial Biotechnology*, 16(1), 33-46.

- PETROBRAS Fatos e Dados Estamos entre as empresas mais inovadoras do Brasil. (2016). Retrieved from: <http://www.petrobras.com.br/fatos-e-dados/estamos-entre-as-empresas-mais-inovadoras-do-brasil.htm>
- Davis, J. L., & Harrison, S. S. (2002). Edison in the boardroom: How leading companies realize value from their intellectual assets (Vol. 28). John Wiley & Sons.
- Stern, A. (2005). Leveraging intellectual property for strategic advantage in product development. *South African Journal of Information Management*, 7(4), 1-1.
- Kaplan, R. S., & Norton, D. P. (2000). Organização orientada para a estratégia: como as empresas que adotam o balanced scorecard prosperam no novo ambiente de negócios. Gulf Professional Publishing.
- Garcia, R., Lessard, D., & Singh, A. (2014). Strategic partnering in oil and gas: A capabilities perspective. *Energy Strategy Reviews*, 3, 21-29.
- Khan, R. (2017). What is an Intellectual Property Strategy for Oil and Gas Industry?. *les Nouvelles-Journal of the Licensing Executives Society*, 52(1).
- Sullivan, P., & Harrison, S. (2008). IP and business: managing IP as a set of business assets. *WIPO Magazine*, 1(1), 1-4.
- Harrison, S. S., & Sullivan, P. H. (2011). Edison in the boardroom revisited: how leading companies realize value from their intellectual property (Vol. 37). John Wiley & Sons.
- Petróleo Brasileiro S.A. (2019) - Quem somos - Estratégia. Retrieved from: <http://www.petrobras.com.br/pt/quem-somos/estrategia/>
- OECD (2009), OECD Patent Statistics Manual, OECD Publishing, Paris, Retrieved from: <https://doi.org/10.1787/9789264056442-en>.
- Danguy, J., De Rassenfosse, G., & van Pottelsberghe de la Potterie, B. (2013). On the origins of the worldwide surge in patenting: an industry perspective on the R&D–patent relationship. *Industrial and corporate change*, 23(2), 535-572.
- Kannebley Júnior, S., Shimada, E., & De Negri, F. (2016). Efetividade da Lei do Bem no estímulo aos dispêndios em P&D: uma análise com dados em painel.
- Carvalho, S. M. P., Jorge, M. F., Barcelos, V. I., Lopes, F. V., & Pinheiro, V. L. S. (2015). Indicadores de Propriedade Industrial (2000-2012): o uso do sistema de Propriedade

Industrial no Brasil. Rio de Janeiro: Instituto Nacional da Propriedade Industrial–INPI.

Retrieved from: http://www.inpi.gov.br/sobre/estatisticas/arquivos/publicacoes/indicadores-de-propriedade-industrial-2000_2012.pdf/view.

DISPÊNDIOS em P&D. In: All financial data in US dollars. London: Evaluate Energy (2018)

Retrieved from: <http://www.evaluateenergy.com/webreport/welcome.aspx>.

INPI. "Relatório de Atividades INPI 2017" Rio de Janeiro: Instituto Nacional da Propriedade Industrial–INPI (2017) Retrieved from: <http://www.inpi.gov.br/sobre/arquivos/relatorio-de-atividades-inpi-2017-english-version.pdf/view>

Licensed Technologies – Shell (2019) Retrieved from: <https://www.shell.com/business-customers/global-solutions/gas-processing-licensing/licensed-technologies.html>

INPI. "Indicadores de Propriedade Industrial 2017" Rio de Janeiro: Instituto Nacional da Propriedade Industrial–INPI (2017) Retrieved from: http://www.inpi.gov.br/sobre/estatisticas/arquivos/indicadores_pi/indicadores-de-propriedade-industrial-2017.pdf/view

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