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THE PRESSURES OF THE BRAZILIAN PRE-SALT PRODUCTION ON THE NATIONAL REFINING SECTOR

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ABSTRACT

The objective of this article is to analyze the current production capacity of the Brazilian refining sector and evaluate how much it should be increased in order to process the oil from the pre-salt layer. The purpose is to verify if the domestic demand for oil will be met and, therefore, whether refined products imports will decrease. The variables considered were refining capacity, refined volume, utilization factor of national refineries, production profile and domestic demand for petroleum products. We conclude that oil production will exceed domestic consumption. However, the refined volume is short of demand, even considering the conclusion of Petrobras investments. To achieve self-sufficiency in refined products by 2030, two refineries would be necessary with an installed capacity of 350 thousand barrels of oil per day each.

Keywords: Brazil; Pre-Salt; Self-Sufficiency; Refining Sector; Oil Derivatives.

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1. INTRODUCTION

The refining process involves transforming crude oil into derivatives. In other words, the oil is separated into fractions according to molecular weight in order to achieve a final product for consumption (KIMURA, 2005). Currently, the Brazilian national refining complex consists of 17 oil refineries. In 2015 these refineries hit the throughput capacity of 2.35 million oil barrels per day (MMbbl/d) on account of Abreu e Lima Refinery (Rnest) that started production in 2014, adding 115 thousand oil barrels per day (Mbbl/d), according to the National Agency of Petroleum, Natural Gas and Biofuels (ANP). Petrobras owns 13 of the 17 existing refineries and 4 are from the private sector. In 2014, the utilization factor of all refineries in national territory was 95%. This information, linked to the other factors mentioned below, highlights the urgency of expansion projects to the national refining capacity.

Since 2008, the Brazilian pre-salt began its production at an accelerated pace. From the year 2013 to 2014 there was a 63% increase in the volume extracted from these fields (EIA, 2015). There are many blocks in the region waiting to be auctioned, pointing to greater future output. Currently, Brazil produces about 2.3 MMbbl/d and consumes about 3.2 MMbbl/d (ANP, 2015).

The purpose of this paper is to analyze the national refining capacity upon the expanding Brazilian oil production scheduled for the years to come. The specific goal is to verify if the domestic demand for oil will be met and, therefore, whether it will decrease in its imports expenditure, as well as an increase in revenue from the export of high value-added products.

2. REFINING PLANTS IN BRAZIL

An important feature of the Brazilian refining sector is its high spatial concentration. The construction of the refinery network aimed to maximize economies of scale in production and minimize diseconomies of scale in distribution. Figure 1 locates the Brazilian refining park and the pre-salt area.

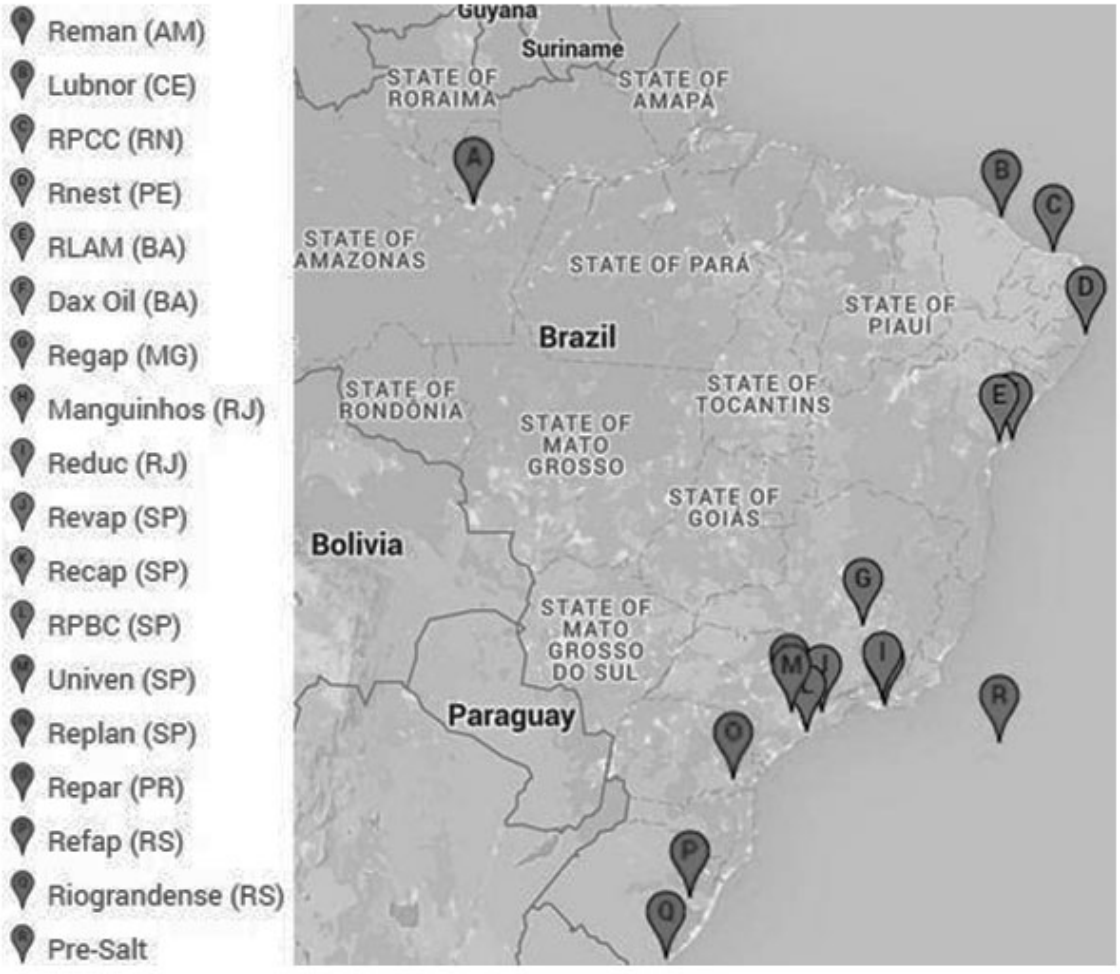

Figure 1. Location of Brazilian refineries and the pre-salt
Source: GoogleMaps (2015)

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Throughout the years, the refineries were built in locations close to the main centers of consumption and production: 8 of the 17 refineries are in the Southeast, the largest consumer base of oil products. Since the Brazilian refining scenario is different between the refineries from the private initiative and Petrobras, we study them separately starting with the refineries of the private sector.

2.1. Private Sector Refineries

The first Brazilian oil refinery was the Oil Refinery Riograndense, opened in Rio Grande do Sul, in 1937. Its refining process is prepared to handle domestic oil, including those from the pre-salt. In 1954, with the beginning of oil exploration in Brazil, the Petroleum Refinery Manguinhos was created in the city of Rio de Janeiro. The raw material used by the refinery ranges from light oil (greater than 30°API) to heavy (less than 22°API), which allows great operational flexibility. The pre-salt brings a window of opportunity to Manguinhos considering its performance on desalting and dehydration (removal of salt and water) of the oil operations to avoid the commonly named 'dead freight' problem, which is the transport of water instead of petroleum during exportation.

Recently, two more refineries began operations. In 2009, Univen Oil Refinery started its activities in the metropolitan region of São Paulo. In 2010, the Dax Oil Refinery began operating in the state of Bahia. Both refineries buy oil from marginal fields producers and use imports, but its facilities can work mostly with national oil grades. The introduction of the pre-salt production in the market will facilitate these private companies to gain access to the national oil supply and improve their operational factor, which was only 34.3%, on average, in 2014 (ANP, 2015).

2.1.1 Evolution of the Private Refineries

A problem faced by all the refineries in the private sector is obtaining the raw material and maintaining the competitiveness of their products regarding the production of Petrobras refineries. From 2010 onwards, Petrobras controller, the central government restricted oil cost pass through to ensure good prices for final consumers. Thus, in order to overcome this structure of costs and prices of derivatives, private refineries need to have high productivity and produce high value-added products. Table 1 and figure 2 show a sector outlook.

Table 1. Utilization factor (%) of private refineries

2004	2005	2006	2007	2008	2009
87.5%	37.8%	33.7%	51.1%	26.4%	55.2%

2010	2011	2012	2013	2014
73.1%	78.7%	72.3%	43.2%	34.3%

Source: Compiled from ANP (2015)

In figure 2, there are three moments of decreased productivity. The first one is related to the closing of Manguinhos – during the years 2006 to 2009, this refinery left the business due to the lack of competitiveness of its final product compared to Petrobras products, this same problem explains why Univen is closed since April 2014. The second moment corresponds to the oil crisis and the third to the crisis faced by all private refineries to obtain raw materials and produce competitive products. As aforementioned, these refineries present idle capacity and are potential targets for the coming of pre-salt production, which appears promising to the sector.

2.2. Petrobras Refineries

There are four Petrobras refineries installed in the state of São Paulo. The Paulínia Refinery (Replan) is the largest in oil processing capacity: 434 Mbbl/d. Its production is responsible for 20% of all oil refining in Brazil and its feedstock is 80% national, mainly from Campos Basin (ANP, 2014). The Capuava Refinery (Recap) was the first to process the pre-salt oil from Santos Basin, in 2009. The Presidente Bernardes Refinery (RPBC) produces final high value-added derivatives such as premium gasoline, petroleum coke, petrochemical naphtha and fuel for ships (bunker). Most of the raw material used comes from the Santos Basin. The Henrique Lage Refinery (Revap) is the third largest refinery in the country and its feedstock is 80-90% national (Petrobras, 2015).

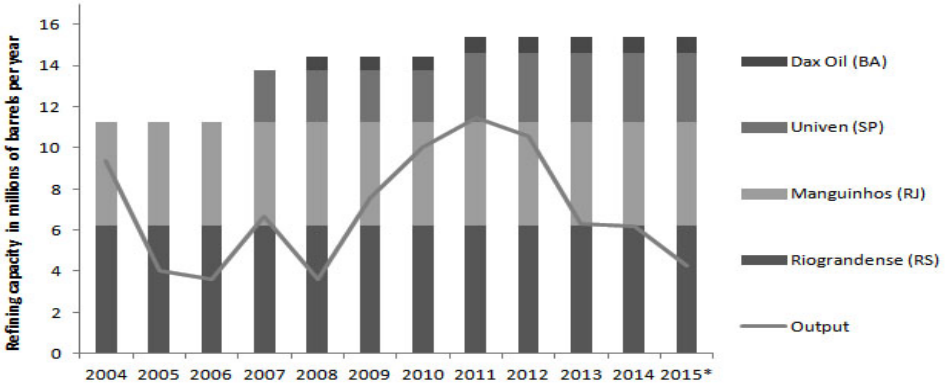

Figure 2. Refining capacity x output of the private refineries (2004-2015)
Source: Compiled from ANP *Preliminary results (2015)

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In the Southeast, there is the Duque de Caxias Refinery (Reduc) in Rio de Janeiro. Currently, this refinery uses about 60% of domestic oil from Campos Basin (ANP, 2014). Located in Minas Gerais, the Gabriel Passos Refinery (Regap) is able to refine 166 Mbbl/d, due to a recent expansion on diesel production. This investment aimed for the pre-salt production, considering that the refinery has already been working with the oil from Campos Basin.

In the South, there are two refineries: the Alberto Pasqualini Refinery (Refap) and the Presidente Getúlio Vargas Refinery (Repar). Both utilize a mixture of domestic oil and imported as a feedstock, with greater participation of Brazilian oil.

Located in the Recôncavo Baiano, Landulpho Alves Refinery (RLAM) is the second largest in the country with an installed capacity of 377 Mbbl/d. Also in the Northeast, the Potiguar Clara Camarão Refinery (RPCC) is located in Rio Grande do Norte. This state became the only in the country to be self-sufficient in the production of all types of oil products (ANP, 2014). Both of them work with heavy crude oil from the post-salt and the light crude oil from the pre-salt layer, originated in the Campos Basin.

All the aforementioned refineries are able to process the oil from the pre-salt. The Isaac Sabbá Refinery (Reman) is located in the Amazonas state, deep in the Amazon forest. The oil used in the refinery presents high API gravity (about 30 ºAPI), different from the pre-salt oil. Furthermore, there would be an insurmountable logistical problem in the transportation of raw material from the pre-salt. On the other hand, the Lubrificantes e Derivados do Nordeste Refinery (Lubnor), in the Ceará state, works with extra heavy oil from the state itself and Espírito Santo. Thus, the oil coming from the pre-salt is not a priority for this refinery, because the properties of this oil hinder the production of certain derivatives, including high value-added lubricants for noble use. In the same operation line, the Abreu e Lima Refinery (Rnest), located in Pernambuco, began operations in December 2014, with the main objective to produce diesel using as raw material a heavy crude oil (around 16º API) from Rio Grande do Norte.

2.2.1. Evolution of the Petrobras Refineries

The problem faced by Petrobras in the refining business is the high utilization factor of its refineries, which is explained by an easy access of raw material, given the company also acts in the exploration and production sector (E&P) and utilizes economies of scale inherent of the sector. Table 2 and figure 3 demonstrate this scenario.

Table 2. Utilization factor (%) of Petrobras refineries

2004	2005	2006	2007	2008	2009
85.7%	83.6%	86.4%	87.2%	86.9%	88.2%

2010	2011	2012	2013	2014
94.9%	92.9%	97.2%	99.3%	98.0%

Source: Compiled from ANP (2015)

Since 2008, the utilization factor of refineries has been growing until last year, when the country began facing a severe economic crisis that affected the domestic demand for petroleum products, as shown in table 2. On the other hand, according to figure 3, even with the global and domestic economic crises, the refined volume did not show a significant fall. The production of Petrobras refineries reached 2.17 MMbbl/d in 2014, which represents a growth of 2.6% compared to 2013. This record is due to the Medium and Gasoline Production Program (Promega), implemented by the company to maximize the volume of petroleum derivatives produced from medium fractions of oil, through the updating and improvement of the refineries (PORTAL BRASIL, 2014).

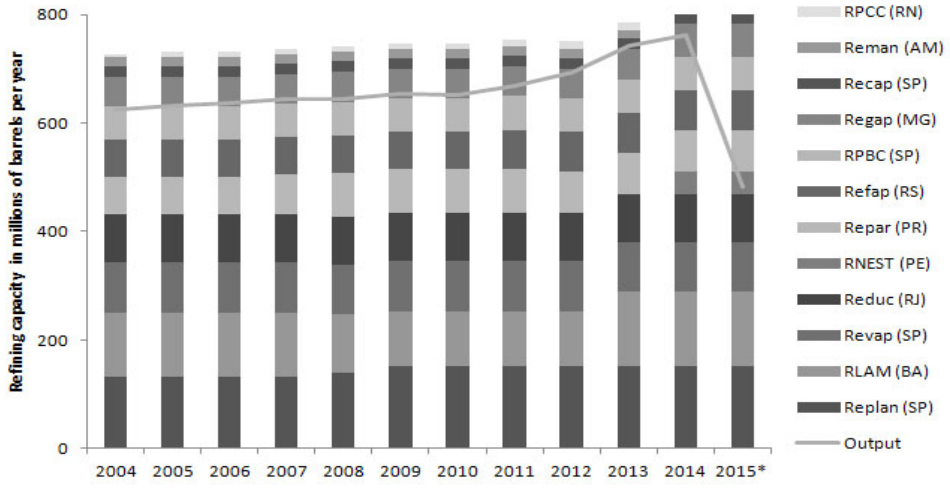

Figure 3. Refining capacity x output of the Petrobras refineries (2004-2015)
Source: Compiled from ANP *Preliminary results (2015)

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3. DOMESTIC DEMANDS AND PRODUCTION OF OIL AND DERIVATIVES

Demand has exceeded domestic production capacity, particularly since 2010. This can be seen in Figure 4 below, that presents imported and exported refined products from 2005-2014. After the 2008-2009 crisis, the government started a strong tax incentive program reducing automobiles sales taxes and freezing gasoline and diesel oil prices. The surge in demand led to a significant trade deficit in refined goods.

Figure 5 below indicates that the specifically refined goods were in short domestic supply. The refineries profile reveals in which products they are specialized and which are more demanded by the domestic market. The graphs (figure 5) below display the quantity produced for a set of refined goods, chosen according to their relevance, and the consumption of each one.

According to figure 5, among the important group of oil products, Brazil exports only fuel oil. In addition, based on data provided by the ANP, in 2014, the country had an

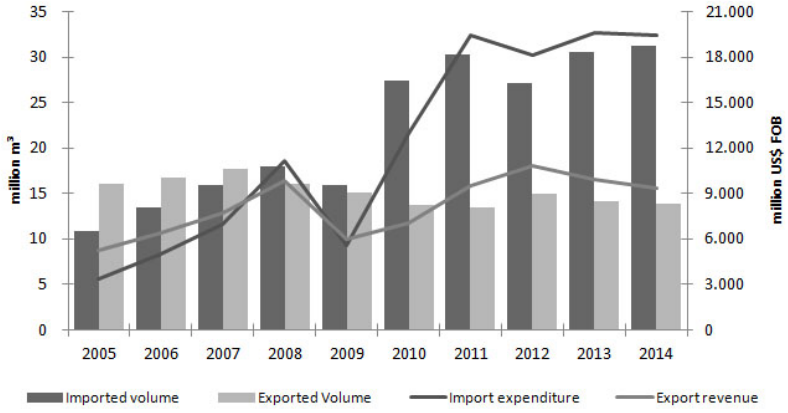

Figure 4. Trade balance in refined goods (2005-2014)
Source: ANP (2015)

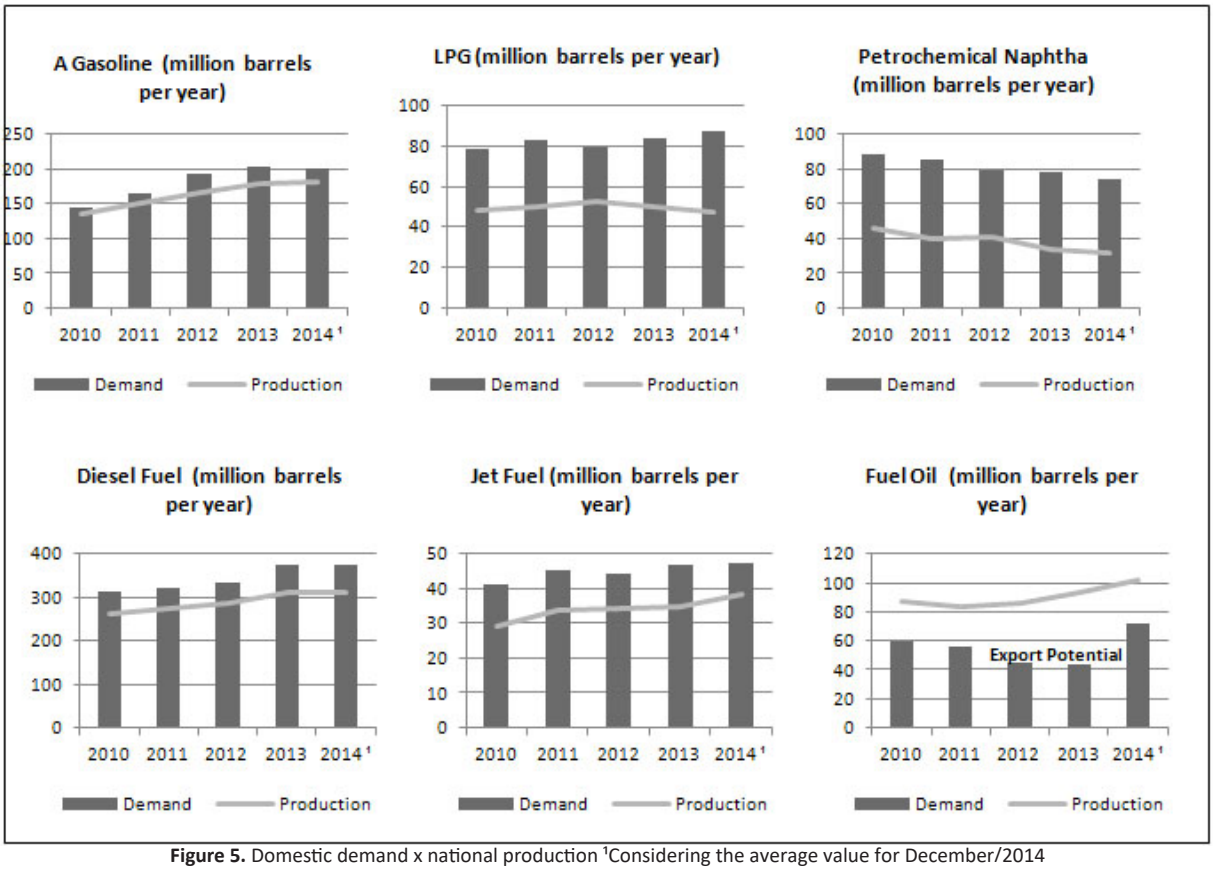

Figure 5. Domestic demand x national production ¹Considering the average value for December/2014
Source: Compiled from Ministry of Mines and Energy - MME (2014)

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expenditure of 15.9 billion dollars with crude oil imports and revenue of 16.4 billion dollars with export, leading to a surplus of 500 million dollars, but the average price per imported barrel is more expensive than the Brazil's exported barrel.

In contrast to this role of great importer, Brazil has the potential to be self-sufficient in derivatives in the years to come. According to U.S. Energy Information Administration (EIA, 2015), petroleum production in Brazil will exceed consumption next year. In addition, BP Energy Outlook 2035 affirms that volume extracted oil from Brazilian basins will continue to grow, reaching 4.3 MMbbl/d in 2035.

In consonance with this information, it follows that the greatest obstacle to the Brazilian self-sufficiency in relation to petroleum products is the total capacity of the national refineries. Some measures to solve this issue are already being provided, such as: (a) investments in new refineries and (b) expansion of the existing ones.

4. BRAZILIAN REFINING SECTOR INVESTMENTS

By 2020, Petrobras planned to supply the totality of the Brazilian market for petroleum products, achieving self-sufficiency in relation to oil derivatives. To fulfill this goal, two investments were taking course. The first was finishing the construction of the Abreu e Lima Refinery (Rnest) first refining train, so the refinery can operate at 95% of its capacity – currently the maximum is 64%, due to complication with the Environmental Agency of the State of Pernambuco. Moreover, the second was building the Petrochemical Complex of Rio de Janeiro (Comperj), which would have as final products diesel fuel, naphtha, jet fuel, coke and LPG. The forecast for starting operation of the first refining train was in August 2016, with an installed refining capacity of 165 Mbbl/d. Unfortunately, the company completely canceled the construction of the petrochemical complex and will only complete the refinery with the support of a partner. Petrobras also intended to continue the Promega, which has already shown results by increasing the refineries efficiency, but with the decline in consumption and the financial crisis of the company, investments like this were postponed. Another setback was the withdrawal of two more Petrobras investments, the Premium I and Premium II Refineries, which would have had the capacity to process 600 and 300 Mbbl/d respectively.

However, considering the perspective of growth for the internal demand, even with the possible retraction of the Brazilian economy, which in 2020 it will arrive at 3.5 MMbbl/d. Assuming that Rnest and Comperj will be fully operating until 2030, Brazil will need to add more 695 Mbbl/d to its existing refining capacity, which would correspond to an implementation of two more refineries in the same technical scheme of Landulpho Alves Refinery – with main final products the derivatives at the top of the Brazilian import list: gasoline, diesel, naphtha and jet fuel – and installed capacity of approximately 350 Mbbl/d to achieve the expected self-sufficiency.

As for the private refineries, there are still no concrete investments plans. However, the best way to increase the refined volume will be the full use of its installed capacity, which can reach up to about 40 Mbbl/d, meaning more than twice the volume of the year 2013.

5. CONCLUSION

The pre-salt production expands at an accelerate pace, as well as consumption. According to ANP, domestic demand grew by 5.6% in 2014 and it is expected to increase between 3 and 5% in 2015, despite the possible downturn in the national economy, since the growth of demand is linked to the performance of the Gross Domestic Product (GDP). This setting is ideal for Brazil to avoid what happens to countries like Mexico and Iran, which are crude oil exporters and petroleum derivatives importers. Nevertheless, investments in the refining sector have being encountering many obstacles along the way.

The 2030 Strategic Plan by Petrobras announced a self-sufficient Brazil in gasoline and diesel by 2020, when the country's refining capacity would reach 3 MMbbl/d. However, with the annulment of the Premium I and Premium II, this optimistic scenario is distant. In the current scenario, the inauguration of the Petrochemical Complex of Rio de Janeiro (Comperj), the completion of works in Abreu e Lima Refinery (Rnest) and the increase of the utilization factor of private refineries will not be enough for the country to achieve its self-sufficiency in relation to oil products. Investments such as the construction of new refineries, expanding the existing ones and the efficient use of private refineries will be necessary.

REFERENCES

BP (2015) "Relatório Estatístico BP 2015, *O mercado energético no Brasil em 2014".* (Portuguese) Available at: <www.bp.com/pt_br/brazil/sala-de-imprensa/relatorio-estatistico-2015.html>. (Accessed on 09 Out 2015)

EIA (2015) "Brazil - International energy data and analysis". Available at: <www.eia.gov/beta/international/analysis.cfm?iso=BRA>. (Accessed on 09 Out 2015)

Kimura RM (2005) "Indústria Brasileira de Petróleo: Uma Análise da Cadeia de Valor Agregado". (portuguese) IE/UFRJ, Rio de Janeiro, RJ.

Ministry of Mines and Energy (2014) "Relatório do Mercado de Derivados de Petróleo N 108". (Portuguese)

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DOI: 10.14488/BJOPM.2016.v13.n3.a11

Brasilia: Secretary of Petroleum, Natural Gas and Renewable Fuels, Petroleum Fuels Department. Available in PDF

National Agency of Petroleum, Natural Gas and Biofuels (2015) ANP. Available at: <www.anp.gov.br>. (Accessed on 20 Jan 2015)

Petrobras (2015) Refineries. Available at: <www.petrobras.com.br/pt/nossas-atividades/principais-operacoes/refinarias>. (Accessed on 03 Sep 2014)

Portal Brasil (2014) "Promega contribui para os recordes de refine". (Portuguese) Available at: <www.brasil.gov.br/economia-e-emprego/2014/04/promega-contribui-para-os-recordes-de-refino>. (Accessed on 30 Nov 2014)