The Role of Bauxite and Alumina in Iran’s Primary Aluminium Business

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Abstract: Aluminium industry has found its place in Iran, a country with huge reserves of natural gas, a reliable source for primary aluminium production as the most energy-intensive industry based on per tonne of the production and the big volume produced globally, around 58 million tonnes per year (2015). Nevertheless, the low availability and quality of Iran’s local bauxite reserves as the main mineral ore for primary production of aluminium has always been a cause for concern for this section’s development decision-makers. Iran regional climatic characteristics are not considered appropriate to bear high-quality sufficient bauxite resources for being processed viably and economically into alumina, a white powder extracted from bauxite in refineries and fed into aluminium smelting reduction pots directly. In the current paper, this challenge with bauxite is more explicitly explained to see its real impression on Iranian primary aluminium industry and the future development projects considering the country’s 2025 Vision plan to raise the current 487-ktonne primary metal capacity to 1500 ktonnes, more than three times of augmentation. IMIDRO as Iran’s biggest mining and mineral industries state holding organization and as the body in charge of capital-intensive industries development, like aluminium smelters with more than 1 billion dollars of investment, has defined solutions for the aluminium industry raw materials’ supply. In this paper, it will be discussed why today’s aluminium smelting development is not anymore dependant on proximity to bauxite mines. Furthermore, the change in the aluminium business structure globally since 40 years ago till now has been investigated from bauxite and alumina perspective and the repercussions of such an evolution on Iranian aluminium industry as well as our future development plans are being explained.

Keywords: primary aluminium, bauxite, alumina refinery, IMIDRO

Introduction
Before discussing bauxite and alumina markets as mineral raw materials for aluminium, we take a look at aluminium market itself to obtain a comprehensive perspective of what’s been going on recently in this industry to demonstrate to us at Imidro (Iranian mines and mining industries development and renovation organization) as the main policy maker and developer of Iran’s aluminium upstream business the paths we need to take to better tackle the unpredicted nature of this metal’s market. This is especially critical for an entity like Imidro whose roll and duty are to invest in capital-intensive industries like aluminium demanding us to defuse the risks involved with this industry.

Main concepts in aluminium markets which are illuminating for us to know the recently adopted transformational nature of this industry are: correlation of prices and stocks, market fundamentals and premiums.

Aluminium market: Wonder series!
Aluminium has been a metal whose market has been experiencing a series of wonders defying the logical expectations during the past couple of years especially after the Global Recession. It’s a general law of commodities markets that when a metal’s inventories or stocks rise, we should anticipate fall in the prices due to this being a sign of possible weakness in demand. Despite this common knowledge, the fundamentals of aluminium market have been dismissed in several occasions for miscellaneous reasons:

As could be observed in the chart, before 2008 the generally accepted rule explained above has been mostly maintained where lower stocks sent prices of aluminium higher and likewise the higher levels of stocks brought them down. Contrary to the perception of those days based on the trend of the previous years, after 2008 aluminium prices’ mischievous behaviour started in a
conspicuous manner. Since then, the prices haven’t necessarily followed the rise and fall in the aluminium inventories in LME’s (London Metals Exchange) and other commodity exchanges’ warehouses. We can spot cycles in which inventories rose while prices went up as well (2009-2011) or times witnessing a reverse trend of falling inventories accompanying falling prices, implausible under normal situations.

In the period under study, some turning points happened in aluminium markets globally which changed the conventional practices of trading in this section. The most controversial of all has been the Story of Premiums. Premiums have been primarily defined and given the function as the money or extra fee paid over LME aluminium prices by the buyers to the obtainers of the metal [2]. Or premiums were a tool to cover the logistical costs of moving metal that were not covered in the exchange-discovered LME price [3]. Premiums had been historically low and never rose to more than 5 percent of the aluminium LME price before. Premiums vary according to different locations and they tend to increase where markets are tight and vice-versa. This general concept of premiums have been challenged big-time recently- Figure 2 [4]. Since 2009, there has been a considerable oversupply of the metal in the warehouses of main global exchanges while premiums rising to hit new records never seen before! The first reason for this has been commodity financing where aluminium was used by traders as a financial tool and put into exchanges’ warehouses in place of money rising the apparent demand for aluminium and blocking it away from the real consumers for even more than two years in some cases which resulted in a rising gluttony or rather hunger for aluminium and therefore sent up the premiums.

The other reason for the unanticipated rise in aluminium premiums has been the idled production and development suspension of aluminium smelters globally bringing serious deficit in the US, Europe and Japan as main customers or final consumers of aluminium.

The reason why commodity financing even started and got great momentum was spreads in aluminium prices or the market which was in a situation called contango about which we won’t give any explanations here due to non-relevance to the title and subject of the current study.

In Table 1 the unusual trend of aluminium prices during the recent years is explained briefly based on Figure 1.

Table 1- The unusual behaviour of aluminium after recession (prices and stock volumes from [1], LME)

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<th>Year</th>
<th>Trend</th>
<th>Prices (3-months)</th>
<th>Stock Volume (millions of tonnes)</th>
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<td>2009-2011</td>
<td>Rising stocks and Rising prices. Prices rose from 1326 $/t to 2739 $/t while stocks rose from 3.2 million t to 4.6 million t.</td>
<td>Reason: Commodity Financing with Al demand increasing</td>
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<td>2014-2016</td>
<td>Falling Stocks and Falling Prices. Prices fell from 1729 $/t to 1500 $/t while stocks fell from 5.3 million t to 2.7 million t.</td>
<td>Reason: The fall in stocks wasn't due to higher demand. It was falling because of general lack of interest in Commodity Financing. Prices were falling because of oversupply (Chinese fake semis entering the market + weaker Chinese and global demand in 2015).</td>
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The wonder series continue for aluminium. Despite the supposed weakness of the market, another almost new phenomenon happened for aluminium when it experienced two consecutive years of deficit after almost a decade of surplus according to WBMS or World Bureau of Metals Statistics [5]. In 2014, the calculated market deficit for primary aluminium had been 850 thousand tonnes which followed a surplus of 570 thousand tonnes recorded for the whole year of 2013. Likewise, in 2015 shortage in the market was 356 thousand tonnes and although the shortage was less than its previous year, still showing the market was negatively balanced. Last year, demand globally rose 7% to 57.71 million tonnes. The reason for the deficit to become less severe in 2015 was higher rate of production increase in aluminium primary industry to 8%. Meanwhile, apparent aluminium demand in China rose by 14% and 9% in the last two years respectively.

Is aluminium back to norms in 2016?

For 2016, aluminium has started to behave normally again with stocks falling from 2.845 to 2.83 at the end of March and prices rising from 1480 $/t to 1537 $/t. But things happening to prices from now on, will to a great extent depend on premiums and spreads (if contango dominates the market again) as well as on the fundamentals of the market i.e. production vs. consumption. As for premiums, they have been on the according to CRU as shown in Figure 3 [6]. Figures 4 and 5 are Metal Bulletin Research’s forecast of the aluminium production and demand for 2016 [7]. As predicted, production rates in both China and ROW (rest of the

Figure 2- Aluminium premiums, Sep2010-Dec2015 [4]
world) is going to decrease which is a good sign for prices. Demand-wise, despite the forecast that the Chinese rate is falling, the demand seems improving in ROW to around 4%, again a good indication for the price. So at least for now, things seem to be promising for aluminium prices.

![Figure 3- Rising US and Japan aluminium premiums](image)

**Figure 3- Rising US and Japan aluminium premiums [6]**

Nevertheless, regarding the 2016 balance there are contradicting projections published by different aluminium producers (Figure 6) implying that unanimity cannot be easily reached for market forecasts and again we should wait and see how the market situation turns out to be [8].

![Figure 4- Aluminium production volumes and rates in China (left) and Rest of the World (RoW) (right) [7]]

**Figure 4- Aluminium production volumes and rates in China (left) and Rest of the World (RoW) (right) [7]**

Having looked at aluminium market above has underpinned not only the unpredictable features of this metal’s pricing but also the implied risks for aluminium producers of not knowing what’s next for aluminium. We can comprehend that controlling the prices considering so many entities involved (producers, consumers, traders, speculators, banks, governments ...) would be impossible. What producers can actually control in order to increase their margins would be the operating costs (opex). Furthermore, this study is evaluating the role of bauxite and alumina in aluminium business so it’s necessary to find out the implications each constituent of aluminium opex may have on viability of this industry.

Aluminium cost structure: electricity is key, where do bauxite and alumina stand?

In Figure 7, aluminium opex ingredients are shown [9]. As obvious, more than one-third of the costs are for electricity and alumina, each with equal 38% share comprising around 75% of the opex. Nevertheless, the most critical element for aluminium production and cost of production is electricity rather than alumina. Aluminium smelters consume huge amounts of electricity as aluminium is the most energy-intensive metal produced industrially. Besides the significant quantity of power needed, having access to close big sources of electricity is essential for smelters due to the fact that this kind of energy cannot be transferred economically to faraway distances. In case of alumina, this is not the case. Yearly, million tonnes of alumina are being sent from refineries to those who need it to produce aluminium. Alumina powder is extracted from bauxite mineral ore. As a result, not having direct and long-term access to high amounts of cheap electricity means no sustainable aluminium production however if you as an aluminium smelter don’t have rich bauxite mines in your country, you can easily bring alumina in by importing from international markets.
In this study, the global primary aluminium producers have been categorized into three groups of members in World Aluminium VIP Club: 1- Producers with access to cheap abundant energy as a natural privilege like the smelters of Middle East and Russia. These members are in group of the Privileged, 2- Smelters receiving electricity subsidies from their governments like those in China who are being kept safe from exposure to fluctuating market conditions through political measures. This member group is called the Protected and finally 3- Those who through constant research and development try to take the initiative in technology to control and decrease cost at their plants like Hydro, Alcoa and UC Rusal called the Pioneers.

Looking at the VIP players above, we can see electricity is a serious determinant in where global major producers stand. Even if access to cheap abundant power is vital, the other one-third of opex is alumina. Alumina and bauxite also play an indispensable role in aluminium production since without them it’s not possible to produce aluminium. Although recently some new methods to get alumina from minerals other than bauxite have been being developed, still bauxite is the main material from which alumina is produced. As a big portion of aluminium cost structure, we need to learn the fundamentals of bauxite and alumina markets.

For Imidro who is going to invest hugely in aluminium business, apprehension of the market mechanisms of these two materials, bauxite and alumina, is necessary to decide for the future of this industry. Imidro is developing aluminium industry based on Iran’s number one global natural gas reserves which guarantees direct access to available cheap energy for primary metal production [10]. Yet, Iran is underprivileged in bauxite resources due to not having favourable climatic conditions to bear bauxite. Here, we need to explore the supposable bottle-necks for Imidro and Iran’s aluminium industry with regards to bauxite and alumina and the options Iranian aluminium business shall choose to assure a sustainable growth.

**Evolution in aluminium industry since 1970’s and its implications on bauxite and alumina**

Alumina trade has always been quite popular between customers (aluminium smelters) and refinery owners. Before, it was preferred to have alumina refineries attached closely to bauxite mines when many bauxite-alumina-aluminium integrated complexes were placed in one location. However, during the past 40 years especially in recent decade, the structure of aluminium industry and its raw materials has evolved considerably where the integrated development model of the bauxite-alumina-aluminium has become outdated and the location allocation of every entity of the supply chain is being decided independently. In today’s aluminium business model, the decision where to build a bauxite mine, an alumina refinery and an aluminium smelter is taken based on the benefits and advantages each geographic location offers with regards to: a) For bauxite, the availability of economic reserves and access to infrastructures (rail, power, port), b) For alumina, market proximity, infrastructure (water, energy, port) and c) For aluminium, cheap abundant electricity, market.

A report has been prepared by International Aluminium Institute or IAI demonstrating the evolving nature of aluminium industry in almost half a century since 1970’s. The report’s data are till 2010 and have been updated and analysed by Imidro’s Mineral Industries department to 2015 [11]. In the report, the market structure has been studied based on countries and also companies. We compared the data provided in the report with other sources like USGS and by our technical knowledge of the market, we produced some critical conclusions. Here are our main takings from the report:

**Focus on Countries:**

1- During the past 45 years, bigger and new bauxite producers have joint the market which are net exporters of bauxite like Guinea, Malaysia and Indonesia. Today, bauxite is produced in 8 countries mainly who except for Russia and China, the others are exporters of this mineral. This confirms that today less bauxite is converted to alumina in integrated refineries and that the access of third-party or free-market customers (refineries who don’t have mines or have shortage of bauxite) has become facilitated. Simply, the bauxite market has expanded. Today we have countries like Indonesia and Malaysia who exported 56 and 21 million tonnes of bauxite in 2013 and 2015 respectively. On the other side, we have China who imports 56 million tonnes yearly (2015) while producing half of the world’s bauxite too with only 3% of total global bauxite reserves [12, 13]. Figure 8.
2- The biggest bauxite reserve owners and producers don’t produce alumina and aluminium like Guinea with 26% of global reserves and 6% of production, Malaysia with 8% of the supply, Jamaica with 7% of reserves and 4% of supply. The 6 top bauxite owners have 76% of reserves and produced only 5% of aluminium in 2015. So having big reserves of bauxite cannot be an advantage for aluminium industry. Figure 9.

3- Alumina production decreased in countries with bauxite reserves that don’t produce aluminium or their metal production has declined, like in Suriname, Jamaica and Venezuela, Figure 10. More importantly, Australia as the biggest producer of alumina in the world has decided to shut down a considerable part of its alumina refineries to export raw bauxite. The US, Canada and Russia whose share in global ingot production decreased have experienced decrease in alumina production too. This implies that countries with rising aluminium smelting capacity raised their alumina production too like China, India and Brazil. From now on, it could be anticipated that this trend will go on in new hubs of aluminium growth like the Middle East with alumina refinery projects defined in Emirates, Iran and Bahrain. Nevertheless, there are still exceptions like EGA’s (Dubal) probable refinery in Guinea to be built till 2022 next to a mine owned by EGA [14].
RioTinto, Hydro, Rusal) still dominate aluminium’s raw material market. Even if the share of those companies has decreased from around 90% in both bauxite and alumina in 1955 to 54% in 2010, they continue to own half of the market in their hands controlling the flow of the raw materials in aluminium industry.

Focus on Companies:

4- In Figure 11, the production share of bauxite and alumina in big aluminium companies since 1955 to 2010 is shown [11]. Before, fewer companies had greater share of the market or market had been highly intensified but now intensity has become replaced by more diversity as more companies have marked shares of today’s bauxite and alumina supply. Besides, the share of others is around 40% in 2010 for both materials showing that the market has become more expanded and diversified with higher number of third-party (non-integrated) players.

5- We can see some Chinese alumina producers with no bauxite production in 2010. These refineries produce alumina from imported bauxite. We can also see some bauxite producers with no alumina production like Vale and BHP. This emphasizes the fact that bauxite trade has become more widespread and that companies have emerged who are sole exporter of bauxite.

6- All big alumina producers have been always big aluminium producers too (except for Vale). Today, this is still prevailing. Big aluminium companies don’t risk being dependent on free-market and they have preferred to own their alumina and use it for their smelters. Like in China, alumina refining capacity has increased in tandem with smelting. That’s another reason we predict refineries are going to expand close to smelters.

7- The unchangeable fact of yesterday and today is that for both bauxite and alumina, big players (Alcoa, BHP,
their bauxite. However, they should be worried if they want to depend on spot market to provide their bauxite and alumina since this is a market controlled by few participants. Companies like Imidro who are going to increase aluminium production to more than one million tonnes based on energy advantage, have to guarantee their continuous access to raw materials and cannot jeopardize their aluminium production and plans being exposed to the free bauxite and alumina market. Later in this study, we will discuss Imidro’s strategies to safeguard Iran’s aluminium industry with regards to raw materials.

Here are the overall transitions of bauxite, alumina and aluminium market conformation chronologically:

70’s and 80’s: Focus on aluminium production in or near consumption centres, location of smelters followed the market, many aluminium producers were alumina producers too with refineries close to the smelter, bauxite trade started to get momentum.

90’s: Refineries moved to be close to bauxite mines, bauxite trade in long distances (basin to basin) was implausible and uneconomical, companies inclined to supply their own bauxite for owned refineries, market still dominated and new smelting capacity was built in China, India and Brazil.

2000’s: Energy prices rose, aluminium capacity increase becomes viable in places with cheap energy like ME where Dubal and Alba appeared which caused independency of refineries from smelters, new smelting capacity kept on rising in demand intensive areas like China.

2010’s H1: Refineries’ independency from bauxite mines, less refineries close to mines, lower freight costs and more economical trade of bauxite, bauxite is ubiquitous, new smelting capacities are estimated to grow only in China and the ME, refineries may most probably follow smelters, the localized structure of aluminium industry from mine to the smelter has revolutionized to become truly globalized in a way that entities cover each others’ insufficiencies.

Market determinants of bauxite and alumina: trade of bauxite getting momentum to faraway destinations.

Global alumina market was oversupplied last year and prices fell from 355 $/t to 200-355 $/t and ended the year at 201 $/t. The average prices for 2015 was 301 $/t with 9% decrease y-o-y. The percentage in which alumina is priced based on LME aluminium rose to 17.8%. This percentage was lower a few years ago however due to lower aluminium prices, alumina being priced as a percentage of the metal’s price is not able to cover production costs and instead the percentage has risen, Figure 12. Also, today less alumina is available to be sold to third-party buyers on long-term basis and the market has become more short and medium-term showing that the risk for third-party buyers who are dependent on alumina import has increased, Figure 13 [15].

Last year, China imported 5 million tonnes of alumina with 12% yearly decrease. The reason of this fall was that China imported 56 million tonnes of bauxite with 54% increase, Figure 14 [16]. Malaysia alone sent 24 million tonnes to China, Table 2 [13]. Before 2014, Indonesia was China’s main supplier of bauxite however that country put a ban on raw materials’ export including bauxite. This changed the structure of bauxite trade in a meaningful way. Prior to this event, bauxite was mostly transported within its traditional basins: Atlantic, Pacific and Inland and the transactions outside those basins were really negligible [17]. This changed in 2012 by Indonesia putting a ban on its bauxite.

Because of the ban, China suddenly lost the main source of its bauxite and had to import from diverse countries.
That was when bauxite transaction between the two basins officially started and first cargos of bauxite were sent from Guinea in Atlantic to China in Pacific basin, Figure 15 [18]. Figure 16 depicts virtual trade paths of bauxite in the basins. Data to draw the table is from sources mixed together by our own knowledge at Imidro however they are mainly calculated based on [12, 17].

Tables 3 and 4 are the bauxite and alumina trade data calculated by Imidro by considering the bauxite and alumina productions and surplus in bauxite producing countries. It’s assumed that for each tonne of alumina 2-2.5 tonne of bauxite is needed. Production data are from [12, 17].

Table 3- Global trade of bauxite, imports and exports [12, 17, Imidro calculations and adjustments]

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Table 4- Global trade of alumina, imports and exports [12, 17, Imidro calculations and adjustments]

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Production versus consumption: bauxite apparent shortage because of China’s imports. Is alumina refining in China going to be sustainable in the future?

Tables 5 and 6 show global bauxite and alumina supply vs. demand [12, Imidro calculations]. In 2015, alumina market had oversupply but bauxite showed apparent shortage. This shortage was not real because China had been stocking bauxite since Indonesian ban and had enough ore in warehouses to continue alumina refining. By the way, as shown in Figure 14, China is going to be more and more dependent on imported bauxite and alumina produced from imported bauxite is more expensive in China making the long-term continuation of this trend unsustainable. China doesn’t have enough and high-quality bauxite too. Figure 17 shows alumina production costs in Chinese refineries with highest in Shandong.

Table 5- Bauxite supply vs. demand [12, Imidro calculations]

Table 6- Alumina supply vs. demand [12, Imidro calculations]

Figure 17- Chinese refineries’ opex, highest in Shandong with imported bauxite [19]

So if alumina development might stop in China finally, where are the places most susceptible for future growth?

Alumina projects: Middle East a new growth centre for refineries, Iran included.

Tables 7 lists alumina projects recently defined or commissioned in countries which import bauxite [12, 14]. As could be seen, new refineries are being defined closer to aluminium smelting centres like China, Emirates and Iran.

Table 7- New refineries in places with bauxite shortage [12, 14]

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Table 7- New refineries in places with bauxite shortage [12, 14]

Table 8 lists refinery projects near bauxite mines. The projects have been mostly postponed (in Brazil and Australia), delayed probably for good due to local conflicts about acquiring bauxite (India) and those in Guinea may never happen because they are planned for the next 8 years and many things can happen and corporate strategies could change which may prevent those projects from becoming materialized.

Table 8- New refineries in places with bauxite surplus [12, 14, company websites, news websites like metalbulletin.com and alcircle.com]

The postponement of the projects near mines could be another sign that the trend of having bauxite- alumina complexes is losing pace. Yet, countries like Iran and Emirates are following up their projects seriously. Al Taweelah is supposedly producing its first alumina in December 2017. In Iran, Imidro’s Persian Gulf Alumina project has been studied a few years ago and once being put for EPC tender, was stopped due to Imidro’s preference to retender the project in EPCF or to co-invest with a partner. Furthermore, Imidro owns a bauxite mine in Guinea called SBDT with plans to be developed in the future when challenges with immature infrastructure becomes facilitated. We are going to discuss Imidro’s bauxite and alumina strategies later in the article.
Bauxite shortage: will it really happen? What’re the implications for Iran who doesn’t have enough bauxite?

Up until now, we have shown that bauxite and alumina have started to grow separately and there are pure bauxite producers ready to sell their bauxite to third-party refineries. They also say that bauxite reserves are enough for 300 years of economical production (IAI). We also understand that new refining capacities are being defined who will import bauxite like in China and the ME. So will accessing bauxite seem comfortable to those who don’t have it?

On the other hand, CRU market study institute has forecasted that there might be a considerable shortage of bauxite in years to come. So it won’t be unthinkable to predict higher prices of bauxite, Figure 18 [16].

With Indonesian ban, prices have already jumped once from 30-40 $/t cash to 50-60 $/t cash or even higher, Figure 19, [19].

So even if Iran has great quantities of energy which makes it a suitable country to invest in aluminium, aluminium smelters will need to import alumina or bauxite taken into account the low availability of bauxite locally. Considering the unpredictability of aluminium’s raw materials market, the risk of relying on spot markets or not having guaranteed/owned sources of bauxite/alumina could become really challenging endangering the viability of huge investments which Iran/Imidro has planned for the future. For a big player in aluminium business, securing raw materials has become key point these days. As shown in Table 9, all main aluminium companies in the world have secured and owned bauxite mines [17, company websites].

Imidro’s strategies to secure bauxite and alumina for Iran’s growing aluminium industry: where to focus?

Iran has 487 thousand tonnes of primary aluminium capacity from which around 350 thousand tonnes is operational. Imidro, as Iran’s main mineral industries holding company responsible for capital-intensive industries’ development especially aluminium, has defined plans to reach 1.5 million tonnes of capacity in 2025. Right now, Salco project with 300 thousand tonnes of primary capacity has just started construction and there are plans to add two more new smelters with negotiations going on with foreign potential partners.

Iran’s only major bauxite mine is Jajarm owned by Iran Alumina Company (owned by Imidro currently) located in North Khorasan Province. Total (proved, probable and possible) bauxite reserves of Iran are 30 million tonnes from which 20 million tonnes are in Jajarm and 10 million tonnes owned by private sector. Jajarm has 7 million tonnes proved reserves. Iran Alumina Co. has explored and owned 19 bauxite zones in different places around Iran which are not by themselves economical and are used as extra feed for Jajarm alumina refinery. This refinery is Iran’s only alumina refinery with 280 thousand tonnes of capacity and around 250 thousand tonnes of production.

Table 9- Ownership of big aluminium companies in bauxite mines [17]
The zones include Golbini, Zou, Tagoni, Sangtarash, Gano, Tash, Mandoon, Dashtedeh (east and west), Shahmirzad, Bolbolooogh, Darsinoheh and some minor mines in Provinces Semnan, Khorasan, Kerman, Yazd, Kohkilooyeh.

Current annual consumption of alumina by local smelters is 700 thousand tonnes from which 250 thousand tonnes is supplied by Jajarm and the rest is imported.

Table 10 is giving general information about Iran’s only refinery. The captive mine of the plant produces around 700-800 thousand tonnes of bauxite annually.

<table>
<thead>
<tr>
<th>Plant Features</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>280,000 tonnes</td>
</tr>
<tr>
<td>Contractor(s)</td>
<td>Built by Technocrop of Czech Republic and finished in 2001, unable to operate the plant due to technical issues</td>
</tr>
<tr>
<td>Commissioned by NIC of China in 2003 by imported bauxite</td>
<td></td>
</tr>
<tr>
<td>Total Capex</td>
<td>348 million US$ (2002-2003 constant dollars)</td>
</tr>
<tr>
<td>Water Usage (m^3)</td>
<td>1.5 million m^3</td>
</tr>
<tr>
<td>Power Demand</td>
<td>20 MW</td>
</tr>
</tbody>
</table>

Table 10 - Iran Alumina Company (Jajarm) overview

Close to the refinery, a smelter is being built with around 50% of progress and 36 ktonnes of capacity for phase 1.

To produce 1.5 million tonnes of aluminium, Iran needs 3 million tonnes of alumina which equals 2750 thousand tonnes of deficit (Jajarm included). As discussed above in the study, Iran needs to secure the bauxite and alumina sources for its aluminium development plans, as all other major aluminium companies are doing.

Sometimes people in decision-making organizations within the country discuss that Iran who doesn’t have enough bauxite shouldn’t develop aluminium. Today, with huge amounts of bauxite and alumina being traded globally, this couldn’t be true. Aluminium development is dependent on energy availability and bauxite or alumina could be brought in from other sources. Energy is key for aluminium and Iran has it. At the same time, to produce 1.5 million tonnes, raw materials must be guaranteed. For this, Imidro has defined a portfolio of projects as in Table 11.

Table 11 - Imidro’s bauxite and alumina portfolio, the capex of the projects is estimated and being revised currently

<table>
<thead>
<tr>
<th>Project</th>
<th>Capacity 000 Tonnes</th>
<th>Capex million US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persian Gulf Alumina</td>
<td>1600 (to 3000) Alumina</td>
<td>1500 (phase I)</td>
</tr>
<tr>
<td>SBDT Mine Guinea</td>
<td>4000 bauxite</td>
<td>505</td>
</tr>
<tr>
<td>Nepheline Syenite</td>
<td>200 alumina</td>
<td>680</td>
</tr>
</tbody>
</table>

Table 11

Persian Gulf Alumina and SBDT bauxite mine

PGA’s refinery will have a capacity of 1600 thousand tonnes to be increased to 3000 thousand tonnes. Defined to compensate for part of Iran’s shortage in aluminium raw materials, the first phase of the refinery will be fed by bauxite from SBDT in Guinea Conakry (this is planned for now however Imidro is considering other sources than SBDT to buy bauxite in long-term contracts). Land is already allocated in Imidro’s Parsian Energy-Intensive Special Zone next to huge gas reserves of South Pars fields. Feasibility studies are complete and being updated right now. First studies were done by NFC China in 2004 and again by Corus in 2006. A tender was held in 2013 to get international EPC contractors build the plant yet stopped for two reasons: 1- SBDT Guinean bauxite which was and still is in a state of suspension and 2- Providing finances.

Table 12 is the history of Imidro’s SBDT mine in Guinea. Due to lack of infrastructure and financial resources which brought the risks involved with the project to high levels, Imidro hasn’t been able to develop the mine. Tables 13 and 14 are brief overviews of the project based on feasibility studies done in 2005 [20]. Due to the long distance of the mines from Conakry’s port, feasibility studies showed that transporting the bauxite in form of slurry through pipelines to the port and dewater it at port could be a viable option like Hydro’s Paragominas bauxite mine with the same system. The bankable feasibility studies are being done by an international consortium headed by DMT of Germany.
The aim of this study has been to evaluate Imidro’s position in aluminium industry’s raw materials market. For this, we needed to go in depth into the global market structure of the supply chain of aluminium business including the metal itself, in order to obtain a fair knowledge on how this market has evolved in a way that changed the equations of aluminium industry globally:

1- Aluminium has experienced a number of wonders after recession when fundamentals of the market were dismissed. During 2008-2014, unusual events happened in aluminium market. Premiums rose from nothing to the only viable reason for smelters to keep producing. Market faced physical shortage because of commodity financing while warehouses were full of ingots. Market saw periods during which stocks rose together with prices quite oddly and again stocks and prices fell at the same time. The reasons for this uncommon behaviour were explained above in due sections.

2- Aluminium market unpredictability means we can’t control the market however what we as producers can control is operating cost. Aluminium smelting opex’s main components are electricity and alumina together comprising around 80% of the costs. For having a smelter producing sustainably, cheap abundant electricity is key. Nevertheless, alumina is more than one-third of the cost and securing access to alumina is necessary for smelters. 3- Alumina is produced from bauxite mines in refineries. The difference between the two major cost elements of aluminium production is that electricity cannot be transferred economically in long distances so those growing aluminium capacity need to have local reserves of a kind of cheap energy like hydropower, natural gas and coal. On the other hand, alumina is easily transported without limitations so not having local bauxite mines is not necessarily a bottleneck for aluminium production. This is the case for Iran where there is huge gas reserves and no big bauxite mine.

4- Bauxite transportation between long distances was once considered unfeasible however due to lower freight costs and China’s hunger for bauxite, bauxite trade is more popular than ever these days and it’s predicted that its trade will expand in the future. This has facilitated the access of third-parties (alumina or aluminium producers with lack of bauxite) to this mineral and has defied the old assumption of “the necessity of having bauxite mines at home to grow aluminium smelting”.

5- Aluminium business structure has been changing and evolving since 50 years ago. The integrated model (bauxite-alumina-aluminium) doesn’t work today. Even the more recent models of having bauxite-alumina complexes’ popularity has decreased where according to Harbor Intelligence, the share of integrated alumina refineries close to mines fell from 71% in 2008 to 54% in 2011 [21]. Each entity of the supply chain (bauxite, alumina and aluminium) will grow anywhere throughout the world based on their individual advantages and the margins their independent plant produces.

6- Aluminium producers don’t need direct access to bauxite but they do need secured bauxite and alumina sources. The reason for this obligation is the forecast saying there might be a considerable gap in bauxite market raising the prices and also all major aluminium players of the market have their bauxite mines and alumina refineries secured. Countries like Iran and companied like Imidro who aim to produce bigger
amounts of aluminium, need to insure long-term access to their raw materials.

7- Imidro has aimed to produce 1.5 million tonnes of primary aluminium in 2025 and to supply the shortage of 2750 thousand tonnes of alumina required in that point of time, has defined a project portfolio. The two main projects of this are PGA refinery of 3 million tonnes (in two phases) and SBDT bauxite mine in Guinea with 4 million tonnes of yearly bauxite production which will be fed into PGA. These two projects are being followed up intensely by Imidro. Despite Imidro being the owner of SBDT mine and being determined to develop it in proper time, we are still evaluating other options to supply bauxite for PGA like long-term purchasing from mines whose bauxite will be ready to sell in the next five years.

References
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