The effect of entry into force of the mining law 2009 began January 2014 in the production of NPI (Nickel Pig Iron) in China

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Abstract. China is the largest producer NPI (Nickel Pig Iron) obtained from the processing of the low grade laterite (oxide ore) with pyrometallurgical process. Furthermore NPI is used as substitute FeNi (Ferro Nickel) to make stainless steel (SS). The low grade laterite are imported from Philippines and Indonesia because China does not have the natural resources of laterite. China mainly imported limonite contains Ni < 1.5 % from Philippines and the low grade saprolite contains Ni > 1.5 % from Indonesia. The entry into force of the Mining Law 2009 began January 12, 2014 which prohibits the export of the raw materials of mineral, and obliged to process minerals in Indonesia. Applicability of the legislation automatically affects the production of NPI in China. The effects in the short term since the enactment of the Act, the production of NPI declined and imports FeNi increased in China in 2014/2015. So that in anticipation, the NPI producers in China are trying to relocate the NPI plant out of China especially to Indonesia. For the producers who do not relocate the NPI plant, they tried to get the low grade saprolite from the other country especially from Philippines. If the NPI factory from China is relocated to Indonesia, it seems that China is likely to relocate the NPI plant to Indonesia. So in anticipation of the government must make government regulations (GR/PP: Peraturan Pemerintah) which in principle do not harm Indonesia. The government regulation (GR/PP) is to be mutually beneficial to both parties or win-win solution. This reality will be studied in this paper.

1. Introduction
The Law Number 4 of 2009 about Mining and Coal give mandate dismiss export the raw materials of mineral, and mandatory for processing the raw materials of mineral within the country. Prior to The Law Number 4 of 2009 enacted began January 12, 2014, Indonesia has been export the large quantities of nickel oxide ore called laterite especially the low grade laterite to China. For Indonesia the low grade laterite consists of limonit and the low grade saprolite contains Ni < 1.8 %. While the high grade laterite is saprolite contains Ni ≥ 1.8%.

Laterite mining primarily come from Southeast Sulawesi especially Pomalaa and Halmahera in North Maluku especially Teluk Buli (Buli Bay). The laterite mining done to take limonite and saprolite for export and processed within the country. Limonite with certain requirements exported to Queensland Nickel in Australia. The high grade saprolite contains Ni ≥ 1.8% exported mainly to Japan, processed to produce FeNi in Pomalaa by PT Aneka Tambang, and to producing Ni matte in Sorowako by PT Vale Indonesia. Laterite contains Ni > 1.5% exported to China, and this laterite are
the low grade saprolite. As for the Indonesian laterite export data to foreign countries from 2005 - 2013, can be seen in table 1 below.

China is the largest producer NPI (Nickel Pig Iron) which is derived from the processing of the low grade laterite imported from Philippines and Indonesia. China was forced to import the low-grade laterite because it has no the natural resources laterite. Limonite contains Ni < 1.5% from Philippines is processed in China using blast furnace (BF) to produce the low grade NPI or the medium grade NPI. While laterite from Indonesia contains Ni > 1.5% processed using the EAF (Electric Arc Furnace) or RKEF (Rotary Kiln Electric Furnace) to produce the high grade NPI. In 2013 China imported the low grade laterite ± 41 million tons from Indonesia and ± 29.6 million tons from Philippines. The low grade laterite is used to produce NPI contains ± 460 kt Ni which equivalent to about 70% production nickel (Ni) in China [2]. Furthermore NPI contains Ni used as substitute FeNi for making stainless steel (SS). As for the production of NPI in China from 2006 until 2013, can be seen in table 2 below.

Table 1. Export Laterite Indonesia 2005 – 2013 (million ton) [1]

| Year | China (+Hk) | Australia | Yunani | Japan | Ukraine | Etc | Total | % change p.a |
|------|-------------|-----------|--------|-------|---------|-----|-------|-------------|
| 2005 | 0.07        | 0.95      | 0.10   | 2.03  | 0.49    | 0.06| 3.70  | 13.6 %      |
| 2006 | 0.66        | 0.71      | 0.15   | 2.07  | 0.73    | 0.08| 4.39  | 18.6 %      |
| 2007 | 5.43        | 0.37      | 0.39   | 1.85  | 0.59    | 0.39| 9.03  | 105.4 %     |
| 2008 | 6.59        | 0.51      | 0.35   | 1.83  | 1.01    | 0.31| 10.59 | 17.3 %      |
| 2009 | 7.88        | 0.00      | 0.39   | 1.46  | 0.58    | 0.12| 10.44 | - 1.5 %     |
| 2010 | 14.35       | 0.84      | 0.24   | 1.45  | 0.63    | 0.21| 17.73 | 69.9 %      |
| 2011 | 36.23       | 0.96      | 0.57   | 1.86  | 0.71    | 0.51| 40.84 | 130.4 %     |
| 2012 | 43.54       | 1.45      | 0.64   | 1.55  | 1.20    | 0.06| 48.45 | 18.6 %      |
| 2013 | 59.17       | 1.57      | 0.46   | 1.98  | 1.48    | 0.14| 64.80 | 33.8 %      |

Eksport 2013 91.3 % 2.4 % 0.7 % 3.1 % 2.3 % 0.2 % 100 %

Table 2. The production NPI in China 2006 - 2013 Based The Grade Nickel [3]

| Year | Low | Medium | High | EAF | RKEF | Total Ni (kilo ton) | Growth |
|------|-----|--------|------|-----|------|---------------------|--------|
| 2006 | 9   | 17     | 3    | -   | -    | 29                  | -      |
| 2007 | 29  | 57     | 10   | -   | -    | 96                  | 231 %  |
| 2008 | 10  | 39     | 36   | -   | -    | 85                  | 11 %   |
| 2009 | 45  | 24     | 43   | -   | -    | 112                 | 32 %   |
| 2010 | 38  | 62     | 108  | -   | -    | 208                 | 86 %   |
| 2011 | 42  | 64     | 148  | 35  | 289  | 39 %                |
| 2012 | 49  | 64     | 148  | 35  | 289  | 28 %                |
| 2013F| 52  | 21     | 205  | 232 | 510  | 38 %                |

Outside China, PT Indoferro in Cilegon Banten Indonesia is the first factory of NPI commissioning April 2012 uses blast furnace (BF) to producing NPI. The production capacity of PT Indoferro ± 250,000 ton NPI p.a then the capacity increased to 500,000 tonnes NPI p.a in 2014 [4]. Ingots a weight 8.5 kg are the form of NPI product from PT Indoferro. The size of ingot 230 mm X 160 mm X 50 mm with a composition of Ni: 6.0 % min, Cr: 2.0 % min, C: 5.0 % max , S: max 3.0 %, Mn: 1.5 % max, P: 0.08 % max, S: 0.3 % max, Cu: 0.10 % max, Pb: 0.05% max, Fe rest (± 80.97%) [5].
The entry into force of the Mining Act 2009 on January 12, 2014 which prohibits export the raw materials of mineral, and obliged to process the raw materials of mineral in Indonesia. The enactment of laws will automatically affects the production of NPI and stainless steel (SS) in China. For example the effect in the short term from 2013 until 2015, the production of NPI decreased and FeNi imports increased. This is shown in figure 1 below [6].

Figure 1. Decrease of NPI Production And Increased Imports FeNi (Ni kt)

For long-term anticipation the producers NPI in China are trying to relocate the NPI plant to outside China mainly in Indonesia. For the producers who do not relocate the NPI plant they tried to get the low grade saprolite from the other countries especially from Philippines.

It seems that NPI producers from China are more interested in relocating the NPI plant to Indonesia. This is proven in early 2014 the government has given permission to the investors especially from China to build smelters to process laterite. The smelters are mainly used to process the low grade laterite for producing NPI (Nickel Pig Iron). As for the definition the low grade laterite for Indonesia consists limonite and the low grade saprolite contain Ni < 1.8 %. It is estimated that there are 60 companies from China partnership with the local companies will build the smelter. Of the 60 companies estimated 13 companies started producing NPI (Nickel Pig Iron) by the end 2017. Of thirteen (13) companies turned out two (2) already in operation before the Mining Law 2009 was enacted January 2014, namely PT Indoferro has been in operation since April 2012 and CIMM since late 2013. As for the 13 companies producers NPI in Indonesia, can be seen in figure 2 below [7].
According to government writers should be smart to address the fact of relocation of NPI plant, namely by issuing government regulations (GR/PP : Peraturan Pemerintah) which in principle the GR/PP does not harm Indonesia. The regulation is to be mutually beneficial to both parties or win-win solution. Do not let the natural resources of laterit (nickel oxide) in Indonesia is spent by China, and the Indonesian nation is only a spectator in his own country. The reality will be assessed in the article with the above title.

2. Why China Producing NPI (Nickel Pig Iron)?
Starting in 2004 global nickel supply is limited while the price is high and fluctuate, and reached the highest price US $ 50 / kg in 2007. As for the fluctuations in nickel prices from 2000 - 2014 with the highest price in 2007 and laterite exports from Indonesia, can be seen in figure 3 below.

![Proposed and existing smelters capacity addition](source)

**Figure 2.** The Companies Producer NPI in Indonesia

![Price of Nickel 2004-2014 And Export laterite From Indonesia](source)

**Figure 3.** Price of Nickel 2004-2014 And Export laterite From Indonesia [8]
At that time nickel very needed by China to make stainless steel (SS) to build infrastructure within the country in connection with the Beijing 2008 Olympic Games. Maybe this fact cause the Chinese government made policy all smelters in China must made NPI (Nickel Pig Iron) from the low grade laterite. As for the purpose of the policy is to get nickel (Ni) at price "relatively cheap" to make stainless steel (SS). Furthermore the whole product NPI contains 4-13% Ni bought by the government at the price of nickel (Ni) according to standard International price LME (London Metal Exchange). The price of nickel (Ni) “relatively cheap” is derived from the low grade laterite imported mainly from the Philippines and Indonesia. Because China does not have the natural resources of laterite. Furthermore the low grade laterite are enhanced add value to be NPI (Nickel Pig Iron) by means used the existing facilities for producing iron / steel in the country. These facilities are BF (Blast Furnace), EF (Electric Furnace), and RKEF (Rotary Kiln Electric Furnace). Furthermore product NPI (from BF, EF, and RKEF) are used replace of FeNi to make stainless steel (SS).

The Chinese government issued policy to make NPI (Nickel Pig Iron) because China including the country in the world with the high enough consumption for stainless steel (SS) per capita (kg / year). The high enough consumption for stainless steel (SS) per capita (kg / year) means the consumption of nickel (Ni) per capita (kg / year) also high. Because to make stainless steel (SS) always required nickel (Ni). As for the comparison of the production and the consumption of stainless steel (SS) per capita (kg / year) in China with the other countries especially the Western countries (the European Union), shown in figures 4 and 5 below.

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Figure 4. Production of Stainless Steel (SS) Globally [9]

Figure 5. Consumption of Stainless Steel (SS) Per Capita In China [6]
Table 3. The Comparison Production of NPI In China Use BF, EAF, Dan RKEF [3]

|            | Blast Furnace (1.7% Ni) | Blast Furnace (6% Ni) | Shandong EAF | Inner Mongolia EAF | RKEF |
|------------|-------------------------|------------------------|--------------|--------------------|------|
| Ni ore     | 19%                     | 13%                    | 24%          | 28%                | 29%  |
| Cargo cost | 17%                     | 17%                    | 15%          | 23%                | 16%  |
| Antrasite  | -                       | -                      | -            | -                  | 14%  |
| Coke       | 34%                     | 30%                    | -            | 4%                 | -    |
| Fine Coke  | 8%                      | 11%                    | 13%          | 10%                | 3%   |
| Chalk      | 2%                      | 2%                     | 2%           | -                  | 1%   |
| Fluorite   | -                       | 6%                     | -            | -                  | -    |
| Energic cost | 6%                    | 4%                     | 40%          | 24%                | 28%  |
| Labor cost | 4%                      | 4%                     | 2%           | 2%                 | 2%   |
| Etc        | 10%                     | 13%                    | 6%           | 7%                 | 7%   |
| Cost (US$/ton Ni) | 20,300 | 14,500 | 13,900 | 13,000 | 12,600 |
| Selling price (US$/ton Ni) | 22,700 | 13,900 | 13,900 | 13,900 | 13,900 |

Although the price of nickel high as shown in figure 2 above but China in producing NPI (US $/ton Ni) was still economical. So that the production of NPI in China continues to increase from year to year as shown in table 2 above. Furthermore the products of NPI contains Ni (From the processing uses BF, EAF, and RKEF) are used to make stainless steel (SS). Stainless Steel (SS) primarily to meet the domestic demand to build infrastructure in connection with the Beijing 2008 Olympic Games. After the completion of the Olympics, stainless steel (SS) apart being used in the country also exported. As for the comparison of the production of NPI in China uses BF (Blast Furnace), EAF (Electric Arc Furnace), and RKEF (Rotary Kiln Electric Furnace), can be seen in table 3.

3. The production of NPI in China after the applicable of Mining Law in Indonesia
The entry into force of the Mining Act 2009 began January 12, 2014, automatically the supply of laterite from Indonesia to China stopped. This fact led to the production of NPI in China disrupted so that the production of stainless steel also impaired. According to experts the production of 510 kt Ni in the form of NPI in 2013 will dropped to 330-370 kt Ni after 2013 as shown in figure 6 below.

![Figure 6. Estimated Production NPI (Nickel Pig Iron) In China After 2013](image)

In order the production of NPI is not disturbed, China kept trying to get the low grade laterite especially the low grade saprolite contain Ni > 1.5% from the other country than Indonesia. Or the factories of NPI relocate out of China especially to Indonesia. According to experts exports laterite to
China from Philippine continued to rise after the Indonesian Mining Law came into effect January 12, 2014, the predictions of experts shown in figure 7 below.

![Figure 7. Exports laterite from Philippines to China [10]](image)

4. Relocation Factories NPI (Nickel Pig Iron) from China to Indonesia
The Mining Law opens opportunities for domestic and foreign investors to process the raw materials of mineral in Indonesia. Because the mandate of Mining Law 2009 obligatory to process the raw materials of mineral in Indonesia, and stopping export the raw materials of mineral began January 12, 2014. By processing the mineral within the country then there is add value for the mineral, and the opportunities job will open for the nation's children in Indonesia. If the raw materials of mineral continuous exported, Indonesia practically get no benefit however only disadvantages from the environmental damage. Because mining is always damaging to the environment, and the environment must be restored after finished mined (post-mine). If the raw materials of mineral exported continuous, only foreigners get benefit from Indonesia's mineral which processed by them. For example laterite export to China or DSO (Direct Shipping Ore) in 2013, Indonesia only get ± US $ 1.7 billion. Whereas the value of nickel (Ni) contained in the raw materials laterite which exported ± US $ 10.5 billion if processed first [10].

With the enactment of the Minerba Act, China must relocate its NPI plant to Indonesia if China wants to survive as a stainless steel (SS) producer in the world as shown in figure 4 above. Since most of China's NPI products are high grade NPI (see table 2 above) made from imported laterite from Indonesia. Meanwhile, to produce stainless steel (SS) nationally the use of NPI reached 53%, the reality can be seen in figure 8 below [11].
Figure 8. The use of NPI, Primary Nickel, And Scrap of Stainless Steel (SS) To Produce Stainless Steel (SS) in China

According to the authors of the Indonesian government both at the central and regional levels should be smart in anticipating the relocation of NPI factory from China. The anticipation is by making strict regulations for labor, the environment, industry and trade. Because the Chinese people in living a life known as a tough and hardworking people. So it can beat the other nations including Indonesia if the nation not smart. The defeat mainly in industry and trade. For example the United States (USA) lost to China in the world of industry and commerce. For the same television quality, television products from China circulating in the United States (USA) are cheaper than television products from the United States (USA).

5. Conclusion
- The entry into force of the Mining Law 2009 began in January 2014 affect the production of NPI in China. The production Ni ± 510 kt in the form of NPI in 2013, it is predicted the production Ni dropped to 330-370 kt Ni after 2013.
- To keep the production of Ni in the form of NPI in China remained stable then China relocate factories NPI mainly in Indonesia.
- According to the authors of the Indonesian government both at the central and regional levels should be smart in anticipating the relocation of NPI factory from China. The anticipation is by making strict regulations for labor, the environment, industry and trade. Because the Chinese people in living a life known as a tough and hardworking people. So it can beat the other nations including Indonesia if the nation not smart.

References
[1] Lennon J 2014 The nickel market outlook: from over - supply to shortage? Consultant to Macquarie Research.
[2] Jiang K, Wang H, Li L and Liu S 2014 The Process Research And Development For Copper, Nickel And Cobalt In BGRIMM (Beijing General Research Institute Of Mining And Metallurgy). ALTA Free Paper
[3] Glencore 2013 The Realities of Nickel Market
[4] Anonim 2016 Presentasi PT INDOFERRO.
[5] Anonim 2016 Nickel Pig Iron. PT Indoferro. Origin Indonesia. Fondel Metals BV www.fondel.com
[6] Di Maulo T 2015 Golman Sachs Global Metals & Mining, Steel Conference December 01
[7] Mackenzie W 2015 Nickel Processing Falmouth UK
[8] Jansson M 2014 From Indonesia to China and Back Again Commodity Strategy Handelsbanken Capital Market
[9] Anonim 2015 Industrial Metals Focus Capital Economics
[10] Glencore 2014 Sell-side analyst visit *Nickel*
[11] Anonim 2016 Presentation on NAC Nickel Asia Corporation