Calculation of Domestic Raw Materials Using Domestic Resource Cost Method

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Abstract. BATAN, as one of the research institutes, development and utilization of nuclear power, considers establishing and operating non-commercial or experimental power reactors (RDEs). RDE is a nuclear reactor for electricity generation, heat for various industrial processes and producing hydrogen on an experimental scale. One option of RDE type used is High Temperature Gas Cooled Reactor (HTGR). HTGR has distinctive characteristics that are different from other types of power plants but on the other hand has the same general components as other conventional power plants, especially civil structures such as the use of portland cement for the manufacture of concrete in the nuclear island (NI) and the balance of plant (BOP). The purpose of this research is to obtain the readiness of Indonesian industry in its contribution in the development of RDE, especially the saving of foreign exchange so that it can be used as one of the basic considerations in decision making and the policy of NPP development. The methodology used is the method of calculating Domestic Resource Cost (DRC) and literature study. The results obtained are the Indonesian cement production in the period 2010-2016 can generate or save foreign exchange because the value of DRC coefficient less than 1 so it has a comparative advantage, contribute to economic development, and improve the standard of living of the people.

1. Introduction

The National Nuclear Energy Agency (BATAN) as the implementing body has duty in the research, development and utilization of nuclear power in the framework of the mastery of nuclear science and technology for the safety, security, peace and welfare of the people [1]. In addition, BATAN may undertake the construction, operation and commissioning of non-commercial power plant [2].

BATAN have plans to establish and operate a non-commercial reactor, hereinafter referred to as the Reaktor Daya Eksperimental (RDE) [3], [4]. RDE is a nuclear reactor for electricity generation, heat generation for various industrial processes and producing hydrogen on an experimental scale [4]–
for the purpose of demonstrating small scale nuclear power plants (NPP) as well as conducting research, development and mastery programs NPP technology [4].

High Temperature Gas Cooled Reactor (HTGR) is a generation of IV [7], [8] and HTGR is one of chose option of the future nuclear power plant that have a layered safety system (dual barrier system) with passive safety systems [9]–[14].

As a high temperature type nuclear power plant, HTGR has different characteristics with other nuclear power plants but on the other hand has common components similar to other conventional power plants, especially civil structures such as the use of portland cement for concrete in nuclear island (NI) and balance of plant (BOP) [12]–[20].

Components industrial of conventional power plants in Indonesia such as steam power plants, have grown well [21]. NPPs are capital-intensive, technology-intensive and labor-intensive industries that involve many industries in forward linkages and backward linkages [21]–[24].

According to the Presidential Instruction of the Republic of Indonesia number 2 of 2009 and Regulation of the Minister of Industry No. 54 of 2012, the involvement or participation of national industries or Indonesia industries for every development in Indonesia has been in setting in order to optimize, drive growth and empower domestic industries and economy. One component that can be produced by Indonesian Industry with Indonesian National Standard (SNI) for RDE development is portland cement with SNI 15-7064-2004 and SNI 15-0302-2004. Cement is a starch made by calcining lime and clay, mixed with water to form mortar or mixed with sand, gravel, and water to make concrete. Concrete constructions in nuclear power plants have the purpose of placing the components of the piping system, mechanical, electrical, instrument and control, and as containment or nuclear radioactive release shields in the NI [25]–[27]. Indonesian industry in producing cement with the use of materials and domestic human resources in the manufacture of concrete, can save foreign exchange or foreign currency [28], [29].

Domestic resource cost (DRC) is a methodology used in the calculation of foreign exchange savings previously conducted literature studies to obtain Indonesian industries that have the potential to produce HTGR type 10MWth nuclear power plants [4], [24], [29], [30]. The literature study was conducted online and in print media into Indonesian industries previously listed as industries that could potentially produce nuclear or RDE components [29], [30]. Then the calculation of DRC after data obtained.

The purpose of this study is to obtain the readiness of Indonesian industry to contribute in the development of RDE, especially the foreign exchange savings from RDE components produced by Indonesian industry, especially cement for RDE civil construction, so it can be used as a basis for consideration in decision making and development policy of NPP.

2. Methodology

The DRC method assesses the cost of using domestic resources in producing commodities or tradeable products. The cost of domestic use in the form as of the use of raw materials; design and engineering (contain elements of manufacturing, fabrication, assembly); completion of work; utilizing manpower including experts staff; work tools including software; supporting facilities up to the final delivery derived from and implemented domestically. The DRC provides a comparison between the domestic costs of generating certain products with their added value on international prices that can be used to evaluate projects and exchange policies. The DRC was first applied by Israeli economic authorities in the 1950s as an instrument in project appraisal. It was later used as an investment criterion by Michael Bruno in the 1960s [30]–[37].

DRC is indicator of comparative advantage as it provides a relatively efficient comparison of inter-sector in cross-sectoral production. Because it does not take into account actual trade flows, DRC can be a good substitute for indicators when trade barriers have a significant effect on the configuration of trading structures. The DRC can also be used to assess the objectives and incentives provided by economic policy and as an indicator of the impact of restrictions on trade. This gives an estimate of the
impact of trade policy on the efficiency of allocation of production resources and the effect of trade policy on productive structures in a country [31]–[37].

In DRC calculations, the price should reflect the real cost not always seen by the market price. The influence of prices can come from market imperfection or government intervention. In the sense that the DRC is a broad measure because it includes not only the distortions created by tariff and exchange control policies but also other distortions that exist in the economy at a time such as distortions created by inter-state trade, financial sector regulations, and restrictions on foreign investment or the influence of labor policies. For this reason, the DRC has been regarded as the ideal instrument for measuring the loss of efficiency in less developed countries where distortions in the economy are the result of various interventions by governments [31]–[37].

DRC is a cost calculation used to produce a tradeable product that in the production process sometimes using materials originating from abroad purchased by issuing a number of other countries currency. With the calculation of this DRC will get how much the value of goods in the country per country currency purchase of materials as a value added with the formulation as follows:

\[
DRC = \frac{D_d}{R - T_i}
\]

(1)

\[
DRC = \frac{P_d Q_d}{P_o Q_o - P_t Q_t}
\]

(2)

where: DRC is domestic resources cost; D_d is cost of domestic inputs; R is world price; T_i is input cost; P_d is selling price domestic; Q_d is phusical domestic; P_o is selling price output; Q_o is phusical outputs; P_t is selling price input; Q_t is phusical inputs;

Coefficient calculation DRC

\[
\text{Coefficient DRC} = \frac{DRC}{SER}
\]

where: SER is price of shadow exchange rate;

Shadow Exchange Rate (SER) is the price of domestic money in relation to other currencies that occur in the currency market in competitive conditions. Bank Indonesia (Central Bank of Republic of Indonesia) has made reference point of spot rates of exchange rates between countries with Rupiahs in which data are obtained in real time and accurate to support the deepening of the domestic foreign exchange market, namely Jakarta Interbank Spot Dollar Rate (JISDOR) [38].

3. Significance of DRC

The method to show the comparative advantage is to compare the DRC to the shadow value of the exchange rate so that the DRC coefficient is obtained [31]–[37]:

- If the value of the coefficient DRC = 1, then the economy is not conducive and the savings of foreign exchange is not the same as the product (the product produces neutrality);
- If the value of the DRC coefficient <1, the value of domestic resources for production can generate or save foreign exchange (a product with competitive advantage in the world market).
- If the coefficient value of DRC> 1, the value of domestic resources for production can not produce or save foreign exchange (the product has no competitive advantage in the world market).

Table 1. Domestic and world cement price comparison
4. Results and discussion

The RDE project is estimated to cost Rp318,656,595,000 for civil construction work. Total procurement of portland cement required by 54,978.65 tons. Procurement of cement can be done with two policies that import or utilize Indonesian industry with price comparison as in Table 1.

The import policy brings both positive and negative impacts. Positive impacts are improving the domestic industry and the transfer of technology. While the negative impact of creating competition in the domestic industry and the weakening of the exchange rate of money.

DRC is the result of value calculation which can show comparative advantage compared to exchange rate shadow price. Determining the value of DRC, it needs to identify the cost of domestic resources to generate a ton of cement, export prices in US dollars and the cost of foreign sources in US dollars. The cost of each product in the production phase is recorded in the total cost of the product for one cycle of cement production divided by the total production amount of one cycle of cement production in one year. The DRC will measure the level of production efficiency of the product by analyzing costs as an indicator of the measurement of domestic cost efficiency and how much it can save.

The cost of raw materials is the cost of materials to be processed through the production process into finished goods. The cost of raw materials of cement production consists of limestone, clay, silica sand, iron sand, gypsum, trass, sepertine which can be obtained domestically. While there are other costs such as the procurement of additive materials, sac, transportation, fuel, electricity, maintenance and other costs that some can already be in the country but also some are still imported.

The calculation result in Table 2 shows the value of DRC cement obtained by Rp1,723,30 per dollar with DRC coefficient value of 0.18970 in the year 2010. This result is to prove the production of cement can generate or save foreign exchange because the value of DRC below exchange rate and coefficient less than 1.

Comparative advantages of a country's products can only be viewed within a certain period of time, production process costs and product prices fluctuate as shown in Table 3.
Table 2. Cost of cement production in 2010

| No | Item                | Unit  | Amount                     |
|----|---------------------|-------|----------------------------|
| A  | Domestic costs [50], [51] |       |                            |
| 1  | Limestone           |       | 59,700,223,803.00          |
| 2  | Clay                |       | 15,952,163,358.00          |
| 3  | Silica sand         |       | 6,634,344,195.00           |
| 4  | Iron sand           |       | 3,677,564,321.00           |
| 5  | Gypsum              |       | 38,878,255,612.00          |
| 6  | Trass               |       | 27,990,926,326.00          |
| 7  | Sepertine           |       | 1,273,113,498.00           |
| 8  | Manpower            |       | 1,949,222,515.00           |
| 9  | Sac                 |       | 203,145,917,421.00         |
| 10 | Transportation      |       | 7,231,262,441.25           |
| 11 | Fuel                |       | 497,496,717.00             |
| 12 | Electricity         |       | 57,607,516,107.00          |
| 13 | Maintenance         |       | 124,483,029,029.25         |
| 14 | Other costs         |       | 15,912,114,668.00          |
| B  | Foreign costs [50], [51] |       |                            |
| 1  | Additive            | US Dollar | 38,379.79        |
| 2  | Transportation      | US Dollar | 265,347.95     |
| 3  | Electricity         | US Dollar | 2,113,882.14    |
| 4  | Maintenance         | US Dollar | 4,567,849.30    |
| C  | DRC                 |       | 1,723.30                   |
| D  | SER                 |       | 9,084.55                  |
| E  | Coefficient DRC    |       | 0.18970                   |

Source: data has been processed from several sources

Table 3 shows fluctuations in cement prices. In the period 2010-2012, world cement prices are relatively down and then increased in the period 2010-2016. In the period 2010-2016 the DRC coefficient is always less than 1. In 2010 the DRC coefficient has the lowest value of 0.18970 due to increased production costs and the rupiah exchange rate against the US Dollar weakened even though world cement prices are higher than in 2011 and 2012. The highest DRC coefficient in 2016 is 0.03302. This is because the world cement prices are rising, the price of domestic raw materials is decreasing and the company can increase the efficiency of production cost.

Table 3. Volatility of DRC coefficient of cement

| Year | Domestic Costs (Rupiah) | Foreign Costs (US Dollar) | World Cement Price (US Dollar/Ton) | DRC | SER [39] | Coefficient DRC |
|------|-------------------------|---------------------------|-------------------------------------|-----|----------|-----------------|
| 2010 | 564,933,150,011.50      | 6,985,459.18              | 92.00                               | 1,723.30 | 9,084.55 | 0.18970         |
| 2011 | 507,196,422,200.00      | 2,645,893.01              | 89.50                               | 1,462.02 | 8,779.49 | 0.16653         |
| 2012 | 513,676,394,400.00      | 2,508,039.48              | 89.50                               | 1,247.46 | 9,380.39 | 0.13299         |
| 2013 | 686,693,846,800.00      | 3,009,230.22              | 95.00                               | 1,120.03 | 10,451.37 | 0.0894          |
| 2014 | 501,800,421,200.00      | 1,934,827.45              | 100.50                              | 757.22   | 11,878.30 | 0.06375         |
| 2015 | 512,828,374,600.00      | 3,825,543.57              | 106.50                              | 756.61   | 13,391.97 | 0.05650         |
| 2016 | 332,648,156,800.00      | 2,497,228.11              | 111.00                              | 439.41   | 13,307.38 | 0.03302         |

Source: data has been processed from several sources

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5. Conclusion

The RDE project is estimated to cost Rp318,656,595,000 for civil construction work. Total procurement of portland cement required by 54,978.65 tons. In the period 2010-2016 the DRC coefficient is always less than 1. In 2010 the DRC coefficient has the lowest value of 0.18970 and the highest DRC coefficient in the year 2016 is 0.03302. The cement component for civil construction RDE has a comparative advantage with less than 1 DRC coefficient. Indonesian industry involvement, especially in producing cement for RDE development, can save foreign exchange and contribute to economic development.

Recommendations

Further detailed and comprehensive research needs to be done to determine the level of Indonesian industrial competence in the manufacture of NPP and to further emphasize the specifications of NPP components in relation to the specifications and quality assurance of those components.

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