Expanded perlite commercialization techno-economic analysis in Indonesia

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Abstract. Utilizing a perlite processing plant in Lampung is one of the public services of the Research and Development Center for Mineral and Coal Technology (TEKMIRA). The plant has been fully revitalized and is ready to be developed for commercialization through joint operations. The domestic market for perlite is not as advanced as the world market. These are both opportunities and challenges for the expanded perlite business. Techno-economic analysis can provide an overview of expanded perlite processing and cash flow forecasts during the implementation period of the commercialization project. Based on the financial feasibility indicators, the scenario of the expanded perlite project is feasible to be commercialized. In the proportional scenario, TEKMIRA and business partners will get 70% versus 30%. The alternative scenario of profit-sharing structure is 50% versus 50%. Nevertheless, TEKMIRA still benefits from fixed compensation. These results are expected to attract investors to partner in the commercial business of expanded perlite processing.

1. Introduction

Perlite in Indonesia is spread over several areas including in West Sumatera Province. In West Sumatera Province, precisely in District IV Koto Aur Malintang, Padang Pariaman Regency. There is already a licensed mining company at this location. Its production is supplied to PT IPI SUNIJAYA and PT Perlit Indonesia Abadi (PT PIA) in Cilegon, PT Waka Magma in South Lampung, and PT Toyo Lite Indonesia in West Bandung. PT IPI SUNIJAYA and PT PIA process perlite ore into expanded perlite, while others process it into non-expanded perlite.

The application of raw perlite, which is only milled to a specific size, has limitations in its use, namely for sandblasting materials, silica sources, and slag coagulant materials in the metal casting industry [1]. If the perlite ore is ground and heated at its softening point temperature (± 900°C) to expand 4-20 times its original volume, the product is called expanded perlite. This developed perlite product has various uses: isolate low or high temperatures in cryogenic tanks (LNG tanks, LPG tanks, Ethylene tanks, oxygen tanks, nitrogen tanks, ammonia tanks, and others). In addition, the use of expanded perlite as a cementing material for oil drilling wells (well cementing). Expanded perlite is used in construction as a lightweight brick, ceiling, refractory aggregate, mortar, and plaster. Expanded perlite is used industrially as a filler in paints, a filter in the sugar industry, and an admixture in lightweight insulating castable products in the manufacturing industry. Perlite is a non-combustible, industrial mineral yielding superior dynamic thermal performance. So, It is ideal for use under concrete slabs, chimneys, and high-temperature applications such as pizza ovens and rocket stoves, and LPG tankers [2]. In horticulture, it is used as a growing medium. Based on the reference, perlite is used as a mixture of perlite fertilizer.
The company that processes perlite into expanded perlite is located in Cilegon-Banten. PT IPI SUNIJAYA's flagship product is perlite for insulation in various double-walled (cryogenic) tanks. Meanwhile, PT PIA has an export-oriented market share, especially for filter aids. The domestic perlite market is not as advanced as the world market. This is both an opportunity and a challenge for the expanded perlite business.

Research and Development Center for Mineral and Coal Technology (TEKMIRA) at the Ministry of Energy and Mineral Resources, through the Minister of Finance Decree No. 922/ KMK.05 / 2017, has been designated as one of the government agencies that implement the pattern of Public Service Agency Financial Management. Currently, one of the TEKMIRA is the utilization of a perlite processing plant located in Lampung. This perlite processing plant is the result of the revitalization of the pozzolan cement pilot plant. The expanded perlite pilot plant has been revitalized and tested. This was all done in 2018-2019. The equipment used suitable for producing expanded perlite is the vertical electric furnace model [3,4].

TEKMIRA and PT Waka Magma entered into a cooperation contract in the field of perlite mineral milling services. The perlite is intended for slag removal. The financial feasibility calculation for slag remover from perlite has been carried out [5]. The product produced is non-expanded perlite for slag remover. TEKMIRA opens opportunities for investors to collaborate in the perlite processing business with products up to expanded perlite for business development and equipment optimization. For perlite commercialization which is grown with processing technology developed by TEKMIRA, it is necessary to conduct a techno-economic analysis. This analysis covers process technology, market, and financial feasibility. The goal is to attract investors to partner with this expanded perlite commercialization business. In addition, it can benefit both parties. It is hoped that with the operation of the developed perlite plant, its products can replace the import and export markets.

2. Methods

2.1. Method of collecting data
The data collected in this study are primary data and secondary data. The methodology for obtaining preliminary data is to conduct a field survey. Survey to mining companies in Padang Pariaman, West Sumatera. Perlite processing industry survey to PT IPI SUNIJAYA and PT PIA in Cilegon, Banten. Survey to end-users in Cilegon, Banten, and Purwakarta, West Java. Conducted experiments on the use of perlite as a growing medium for greenhouse plants in Lembang. In addition, a Focus Group Discussion (FGD) was performed. Secondary data was obtained from a literature search.

2.2. Data processing and analysis methods
The data that has been collected is then processed and analyzed using a descriptive statistics approach and business feasibility analysis. This processing and analysis are supported by the help of a computer program, namely the Microsoft Excel 2016 program.

2.2.1. Descriptive statistics. Descriptive statistics is a method related to the presentation of data in the form of a graph to provide helpful information.

2.2.2. Financial feasibility analysis model. Financial analysis is required in the investment plan. The novelty of this research is to consider the component of fixed compensation in the profit and loss calculation. The amount of compensation is still negotiable. Usually between 3%-5% of revenue. From the financial aspect, the profitability is measured in investment plan using three alternative methods:

- **Net Present Value (NPV).** Net Present Value (NPV) is defined as present value from income cash flow after investment. The NPV is formulated:

  \[
  NPV(i) = \sum_{t=1}^{n} B_t (1 + i)^{-t} - \sum_{t=0}^{n} C_t (1 + i)^{-t}
  \]

  In this formula,

  \[
  NPV (i) = \text{net profit value in present time for interest rate } i \text{ per number of periods.}
  \]
B_t = total net income or benefit for business at period t.
C_t = total cost value (cost) for business at period t.
\((1 + i) - 1\) = discount factor, which is the correction factor of time to money value in t period with the interest rate -i period t.
i = Present the interest rates
\(t\) = time of -t

A business has economic feasibility if NPV \((i)\) is more significant than zero, which is identical with the profit rate is more significant than zero.

- **Internal Rate of Return (IRR).** IRR is a probability index used in business analysis. The IRR is formulated as follows:

\[
IRR = i_1 + \frac{NPV_1}{NPV_1 - NPV_2} (i_1 - i_2)
\]  

In this formula,

- \(i_1\) = Interest rate, which generates a positive NPV.
- \(i_2\) = Interest rate, which generates negative NPV.
- \(NPV_1\) = positive NPV.
- \(NPV_2\) = negative NPV.

The Feasibility level based on the IRR is determined by comparing existing interest rates. A business is feasible if the IRR value has more value than the current interest rates.

- **Payback Period (PP).** In simple terms, the PP is a return on investment through profits within a certain period. Investors are not too happy with investments that payback time is too long. Mathematically, PP is formulated below:

\[
Payback\ Period\ (PP) = \frac{\text{Investment Value}}{\text{Net Cash In}} \times \text{period of time}
\]  

### 3. Literature Review

#### 3.1. Perlite processing technology

The following is a description of the perlite processing process in the expanded perlite factory owned by TEKMIRA. Mined perlite ore is sent to the processing plant. Next, the raw perlite ore is crushed, dried in a rotary dryer, milled, screened, and sent to the expansion plant. Up to this point, the product is called non-expanded perlite and is generally used as a slag remover. If it is continued to the expansion process with a vertical stationary expansion furnace, an expanded perlite product will be obtained. A new dynamic model for perlite grain expansion has been developed for furnace optimization [6,7].

The standard size of expanded raw perlite for use in plaster aggregates ranges from plus 250 micrometers (\(\mu m\)) (60 mesh) to minus 1.4 millimeters (mm) (12 mesh). Expanded raw perlite as concrete aggregates ranges from 1 mm (plus 16 mesh) to 0.2 mm (plus 100 mesh). Ninety percent of raw perlite ore developed for horticultural purposes is more significant than 841 \(\mu m\) (20 mesh).

In a series of expansion equipment, the processed ore is preheated or fed directly to the furnace. Then, in the furnace, the perlite ore is heated to a temperature of 760° to 980°C (1400° to 1800°F), at which point the perlite ore begins to soften to a plastic state where the trapped combined water is released as steam. This causes the hot perlite particles to expand from 4 to 20 times their original size. The suction fan draws the expanding particles out of the furnace and transfers them pneumatically to the cyclone classifier system for collection. Air suspended perlite particles are also cooled when transported to the collection equipment. The cyclone classifier system collects expanded perlite, removes excessive fines, and discharges the gas to a baghouse or wet scrubber for air pollution control. The grades of expanded perlite produced can also be adjusted by changing the heating cycle, changing the cut-off point for size collection, and mixing different sizes of raw ore. All products are usually stored before being shipped, as shown in Figure 1.
Figure 1. Perlite processing.

Figure 2 shows the mechanism for the formation of expanded perlite. When heated to about 900°C, perlite reaches its softening point and begins to soften. The water content of the crystals trapped inside then evaporates and exits quickly, like popcorn making, which causes the material to expand up to 20 times its initial volume. Another trait that emerges is a color change. Raw perlite is gray, while developed perlite is white. When viewed microscopically, the perlite surface looks cracked, resulting in many cavities and air bubbles. This characteristic is very appropriate to be applied to agriculture in terms of soil repair. Expanded perlite can improve the properties of infertile soil to become loose and hold a lot of air. When further milled to micron size, crushed expanded perlite produces a unique microscopic form of flakes (sheets), which can be used as an ultra-fine filter for various liquids. In addition, with a particular method, perlite can be produced in the form of a spherical (round) with a size of 10 microns for the application of filler (ultra-fine filler) for various products.

3.2. Market potential and opportunities
In strategic industries in Indonesia, such as PT Pertamina, expanded perlite products are used to isolate low temperatures in cryogenic tanks, such as LNG tanks, LPG tanks, and fuel tanks. Fertilizer companies, including PT Pupuk Kujang, used the perlite as insulation in the ammonia tank. This is in line with the results of Seli’s and Rolon’s research [9,10]. For thermal insulation, expanded perlite has been tested for application to aerospace insulation materials [11]. The tanks have two walls. Between the inside and the outside of the tank is filled with expanded perlite. Expanded perlite is used for additional refills. The size of the tank is quite varied. A double-walled tank with a width of 1 meter can be filled with perlite of about 7,000 m³. Expanded perlite is used to cement in geothermal, water, and oil wells, which functions as a binder to prevent the setting.

Expanded perlite aggregate can be used as a raw construction material [12,13]. The results of physical tests on expanded perlite research as a lightweight brick material provide a good picture of compressive strength, specific gravity, and porosity approaching the characteristics of lightweight bricks on the market [14,15]. Expanded perlite can be used to produce geopolymer mortar mixes [16]. Abroad, the use of perlite in lightweight bricks, mortar, refractory aggregates, plastering, and others has become popular and continues to grow. This, in addition to its light physical characteristics, also has fire-resistant, sound-proof properties, reduces heat radiation, feels cool, and so on. In Indonesia, where rainfall is relatively high, it becomes a challenge or obstacle, especially for the exterior, so that the potential for the interior.
Figure 2. The mechanism for making expanded perlite and its characteristics [8].

PT Harbison Walker Internasional (PT HWI) is the first international refractory manufacturer in Indonesia. Perlite is used as a mixture in lightweight insulating castable products. This is in line with the results of Tamiri’s research [17]. Perlite Filter Aids are neutral (non-reactive), sterile and inert, have no taste, odor and color, so they are widely used to filter liquids in beverage industries/companies (beer, etc.), food (agar, fruit juices, and others), pharmaceuticals and sugar factories. In addition to expanded perlite, research on diatomaceous rocks has been carried out as a filter aid [18]. Preliminary experiments using developed perlite to manufacture emulsion wall paint have been successful [19]. However, it is unknown whether the paint industry or plastic industry in Indonesia uses expanded perlite. Based on the information, for certain products, Dulux paint has used expanded perlite.

In the Begonia-Lembang greenhouse, perlite has been tested as a planting medium, including cherry tomatoes and begonia flowers, with satisfactory results. This is evidenced by research by Al-Shammari [20].

4. Results and Discussion

4.1. Business scenario model of expanded perlite

In simple terms, the expanded perlite business model can be illustrated in Figure 3. TEKMIIRA plays a role in the land, buildings, equipment, technology, and human resources, while business partners play a role in working capital, fleet, management, and marketing. TEKMIIRA requires a partner who is competent, experienced, and has a similar business.
4.2. Investment / capital cost
TEKMIRA investment includes land, buildings, perlite processing equipment, and forklifts. The investment value is IDR 15,376,000,000. Prospective partners invest in operational vehicles for around IDR 700,000,000, as shown in Table 1.

4.3. Production cost
Production costs consist of variable costs and fixed costs. Variable costs include the cost of raw materials, wages, fuel, electricity, and packaging costs. Fixed costs include maintenance costs and equipment spare parts, promotional and marketing costs, and administrative costs. The total production cost is estimated at around IDR 23,133,567,279, as shown in Tables 2 and 3.

4.4. Working capital
The working capital needed to cover the shortage of operational costs at the beginning of the first year is IDR 5,755,874,091.

4.5. Depreciation of equipment and buildings
The life of processing equipment and vehicles is assumed to be ten years, while the building age is considered 20 years, as shown in Table 4.

4.6. Selling price
The estimate or assumption of the average economic price of expanded perlite in this business is around IDR 5,000,000 per ton. This price is the factory price, excluding transportation costs to the destination (consumers). This price changes every year with adjustments for inflation.

Figure 3. Expanded perlite business model.
Table 1. The value of an investment in expanded perlite commercialization business.

| No | Description                | Quantity | Unit | Unit Price (IDR) | Total Price (IDR) |
|----|----------------------------|----------|------|-----------------|------------------|
| 1  | Land                       |          |      | 255,000,000     |                  |
| 2  | Building                   |          |      | 6,475,394,031   |                  |
| 3  | Equipment                  |          |      | 8,645,605,969   |                  |
|    | Sub-sum (existing)         |          |      | 15,376,000,000  |                  |

Fleet Investation:

| No | Description            | Quantity | Unit | Unit Price (IDR) | Total Price (IDR) |
|----|------------------------|----------|------|-----------------|------------------|
| 1  | Motorcycle             |          | Unit | 25,000,000      | 25,000,000       |
| 2  | Pick-up Vehicle        |          | Unit | 125,000,000    | 125,000,000      |
| 3  | Truck                  |          | Unit | 250,000,000    | 250,000,000      |
| 4  | Operational Vehicle    |          | Unit | 300,000,000    | 300,000,000      |
|    | Sub-sum                |          |      | 700,000,000     |                  |

Total Investment Cost: 16,076,000,000

Table 2. Production cost.

| No | Description                                      | Quantity | Unit       | Price (IDR) | Total (IDR) |
|----|--------------------------------------------------|----------|------------|-------------|-------------|
|    | Variable Cost (per year)                         |          |            |             |             |
| 1  | Raw material                                     | 8,000    | Ton        | 1,000,000   | 8,000,000,000 |
| 2  | Labor wages (67 people x 14 months)              | 938      | Person/month | 3,962,687 | 3,717,000,000 |
| 3  | Gas fuel                                         | 55,715   | MMBtu      | 97,411      | 5,427,205,160 |
| 4  | Fuel oil                                         | 96,000   | Liter      | 11,800      | 1,132,800,000 |
| 5  | Electricity cost                                 | 1,040,000| KWh        | 1,011       | 1,051,440,000 |
| 6  | Packing Cost (@ 10 kg / pack)                     | 640,000  | pack       | 1,500       | 960,000,000   |
|    | **Total Variable Costs**                         |          |            |             | 20,284,445,159 |

| Fixed Costs (per year)                                      |          |            |             |             |
| 1  | Maintenance costs and equipment spare parts       | 3.0      | percent    | 3,435,605,969 | 280,368,179 |
| 2  | Building Maintenance Cost (1% of building price) | 1.0      | percent    | 6,475,394,031 | 64,753,940  |
| 3  | Marketing and Promotion Costs                    | 2.0      | percent    | 32,000,000,000| 640,000,000 |
| 4  | Wages of labor salaries (15 people x 14 months)  | 210      | Person/month | 7,333,333 | 1,540,000,000 |
| 5  | Administrative costs                             | 1.0      | percent    | 32,000,000,000| 320,000,000 |
|    | **Total Fixed Costs**                            |          |            |             | 2,845,122,119 |

Total Production Cost: 23,133,567,279

4.7. Cash flow calculation
The cash flow period is assumed to be ten years. The production rate in the first year is only half that is 3,200 tons (4,000 tons of raw material). Half of it is used for promotions and trials, while the other half is sold at the regular price. Optimization of equipment performance was carried out in the first year as well.

4.8. Financial feasibility analysis
A feasibility study is an activity that studies a business activity to assess whether or not the business is feasible. In other words, a feasibility study is research on whether or not a project (usually an investment project) can be implemented successfully [21]. The aspects used to state whether or not they are feasible are the same even though the business fields are different, namely Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP).
Table 3. Labor cost.

| Labor                              | Sum (men) | Wage (IDR) | Total Wage (IDR) | Category |
|------------------------------------|-----------|------------|------------------|----------|
| Director                           | 1         | 25,000,000 | 25,000,000       | OPEX     |
| Production Manager                 | 1         | 15,000,000 | 15,000,000       | COGS     |
| Administration and Finance Manager | 1         | 15,000,000 | 15,000,000       | OPEX     |
| Marketing Manager                  | 1         | 15,000,000 | 15,000,000       | OPEX     |
| Production Manager Assistant       | 3         | 10,000,000 | 30,000,000       | COGS     |
| Administration and Finance Manager Ass. | 1 | 10,000,000 | 10,000,000       | OPEX     |
| Marketing Manager Ass.             | 1         | 10,000,000 | 10,000,000       | OPEX     |
| Production Staff                   | 48        | 3,500,000  | 168,000,000      | COGS     |
| Driver                             | 12        | 3,500,000  | 42,000,000       | COGS     |
| Mechanics                          | 3         | 3,500,000  | 10,500,000       | COGS     |
| Administration and Finance Staff   | 2         | 3,500,000  | 7,000,000        | OPEX     |
| Marketing staff                    | 2         | 3,500,000  | 7,000,000        | OPEX     |
| Security                           | 6         | 3,500,000  | 21,000,000       | OPEX     |
| Sub-sum (COGS)                     | 67        |            | 265,500,000      | 3,962,687 |
| Sub-sum (OPEX)                     | 15        | 156,000,000| 110,000,000      | 7,333,333 |

Table 4. Depreciation of equipment and buildings.

| Description                               | Quantity | Unit | Unit Price (IDR) | Total Price (IDR) |
|-------------------------------------------|----------|------|------------------|-------------------|
| Depreciation and Amortization:            |          |      |                  |                   |
| - Depreciation of Equipment (10 years)    | 1        | package | 9,345,605,969   | 934,560,597       |
| - Depreciation of Building (20 years)     | 1        | package | 6,475,394,031   | 323,769,702       |
| Sum of Depreciation Cost                  |          |       |                  | 1,258,330,298     |

Based on the data described above, a financial feasibility calculation is carried out, as shown in Tables 5 and 6. From the value of the economic feasibility indicator, it is known:

- NPV is positive, which is IDR 10,808,293,729, then this expanded perlite commercialization project is economically profitable;
- The IRR of 19.35% is quite large compared to the Weighted Average Cost of Capital (WACC). Based on the WACC calculation of 9.2%;
- PP for five years and five months is considered short enough for a payback.

Thus, it is concluded that the expanded perlite business project scenario is financially feasible.

4.9. Profit-sharing structure

The investment value in the expanded perlite business is TEKMIRA worth IDR 15,376,000,000 and partners worth IDR 6,455,874,091. Proportionally, TEKMIRA and Partners will get IDR 3,056,502,232 and IDR 1,285,604,036 per year for 10 years. In the alternative scenario, 50% versus 50%, so that each will get IDR 2,171,053,134. In addition, TEKMIRA gets a fixed compensation value of IDR 1,894,335,343 per year.
## Table 5. Profit and loss.

|                      | 2021        | 2022        | 2023        | 2024        | 2025        | 2026        | 2027        | 2028        | 2029        | 2030        |
|----------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Net Revenue          | 8,399,333   | 35,084,668  | 36,407,864  | 37,806,535  | 39,310,714  | 40,898,899  | 42,606,445  | 44,327,305  | 46,089,006  | 47,936,930  |
| Fixed Compensation   | 419,966     | 1,754,233   | 1,820,393   | 1,890,326   | 1,965,535   | 2,044,944   | 2,130,322   | 2,216,365   | 2,304,450   | 2,396,815   |
| Cost of Goods Sold   | 11,961,090  | 23,446,580  | 24,433,520  | 25,325,541  | 26,290,634  | 27,309,592  | 28,419,799  | 29,545,341  | 30,532,359  | 31,703,524  |
| Gross Profit         | (3,981,724) | 9,083,854   | 10,153,950  | 10,590,665  | 11,048,543  | 11,544,352  | 12,056,323  | 12,569,586  | 13,252,196  | 13,835,967  |
| Non-Depreciation Expense | 1,706,846  | 3,677,731   | 3,790,471   | 3,937,854   | 4,102,907   | 4,272,449   | 4,465,520   | 4,661,914   | 4,790,995   | 4,987,583   |
| Maintenance costs and equipment spare parts | 358,832     | 709,397     | 733,005     | 759,766     | 788,899     | 819,287     | 852,593     | 883,630     | 915,970     | 951,103     |
| Building Maintenance Costs | 119,610     | 236,446     | 244,335     | 253,255     | 262,966     | 273,095     | 284,197     | 294,543     | 305,323     | 317,033     |
| Marketing and Promotion Costs | 335,973      | 701,493     | 728,137     | 756,110     | 786,214     | 817,977     | 852,128     | 886,346     | 921,780     | 958,726     |
| Administrative costs | 83,993,333  | 350,846     | 364,076     | 378,065     | 393,107     | 408,988     | 426,644     | 443,273     | 460,890     | 479,363     |
| Personnel Fee        | 808,453,833 | 1,679,367   | 1,720,894   | 1,790,636   | 1,871,720   | 1,953,094   | 2,050,535   | 2,113,921   | 2,187,030   | 2,281,355   |
| Depreciation         | 64,753,940  | 64,753,940  | 64,753,940  | 64,753,940  | 64,753,940  | 64,753,940  | 64,753,940  | 64,753,940  | 64,753,940  | 64,753,940  |
| Operating Profit     | (5,753,324) | 5,941,329   | 6,298,725   | 6,588,057   | 6,880,882   | 7,207,149   | 7,526,049   | 7,969,930   | 8,396,476   | 8,783,627   |
| Other Income (Expense) | (2,550,000) | (2,550,000) | (2,550,000) | (2,550,000) | (2,550,000) | (2,550,000) | (2,550,000) | (2,550,000) | (2,550,000) | (2,550,000) |
| EBIT                 | (5,555,874) | 5,938,779   | 6,296,175   | 6,585,507   | 6,878,322   | 7,204,999   | 7,523,494   | 7,967,380   | 8,390,876   | 8,781,077   |
| Earnings Before Tax  | (5,555,874) | 5,938,779   | 6,296,175   | 6,585,507   | 6,878,322   | 7,204,999   | 7,523,494   | 7,967,380   | 8,390,876   | 8,781,077   |
| Tax                  | (1,484,649) | 1,574,043   | 1,646,376   | 1,719,583   | 1,801,449   | 1,880,874   | 1,991,845   | 2,098,474   | 2,195,263   | 2,359,360   |
| Net Income           | (5,555,874) | 4,584,084   | 4,722,131   | 4,939,130   | 5,158,749   | 5,403,449   | 5,642,624   | 5,975,351   | 6,295,423   | 6,585,907   |
| Dividend Paid        | (3,785,571) | 4,013,811   | 4,198,200   | 4,384,936   | 4,592,932   | 4,796,230   | 5,079,204   | 5,351,098   | 5,597,936   | 5,897,813   |
| R/E                  | (5,555,874) | 668,112,701 | 708,349,739 | 740,869,353 | 773,812,405 | 810,517,470 | 846,339,685 | 896,330,253 | 944,313,498 | 987,871,187 |
| EBITDA               | (4,562,297) | 7,197,109   | 7,554,505   | 7,843,837   | 8,136,662   | 8,462,930   | 8,781,829   | 9,225,710   | 9,652,228   | 10,039,405   |
### Table 6. Financial feasibility.

| Year | Net Income | Depreciation & Amortization | Adjustment after non-cash | Interest (1-tax) | Capital expenditure | Changes in working capital | Free Cash Flow to the Firm | WACC | Discount Factor | Present value of cash flow | Cumulative cash flow | Discounted cumulative | Firm Value / NPV | Pay Back Period |
|------|------------|-------------------------------|---------------------------|------------------|--------------------|------------------------|-------------------------|------|----------------|------------------------|------------------|-------------------|-----------------|-----------------|
| 2021 | (5.755.874.091) | 1.258.330.298 | (4.497.543.792) | - | (16.076.000.000) | (1.380.712.329) | (16.076.000.000) | 9.20% | 0.916 | (20.104.680.561) | (20.104.680.561) | (20.104.680.561) | 10.808.293.729 | 5 years |
| 2022 | 4.454.064.687 | 1.258.330.298 | 5.712.414.986 | 1.258.330.298 | - | (4.386.630.457) | 1.325.784.528 | 9.20% | 0.839 | 1.111.908.136 | (21.954.256.121) | (20.104.680.561) | 19.35% |
| 2023 | 4.722.111.728 | 1.258.330.298 | 5.980.482.026 | 1.258.330.298 | - | (217.511.955) | 5.762.935.431 | 9.20% | 0.768 | 4.425.682.314 | 1.325.784.528 | 10.808.293.729 | 19.35% |
| 2024 | 4.939.130.368 | 1.258.330.298 | 6.197.440.666 | 1.258.330.298 | - | (229.918.618) | 5.967.542.049 | 9.20% | 0.703 | 4.196.713.195 | 4.425.682.314 | 10.808.293.729 | 19.35% |
| 2025 | 5.158.749.364 | 1.258.330.298 | 6.417.079.663 | 1.258.330.298 | - | (247.262.209) | 6.149.817.454 | 9.20% | 0.644 | 3.774.842.785 | 4.196.713.195 | 10.808.293.729 | 19.35% |
| 2026 | 5.403.449.801 | 1.258.330.298 | 6.661.780.100 | 1.258.330.298 | - | (261.069.893) | 6.400.700.207 | 9.20% | 0.590 | 3.575.306.834 | 3.774.842.785 | 10.808.293.729 | 19.35% |
| 2027 | 5.642.624.568 | 1.258.330.298 | 6.900.954.866 | 1.258.330.298 | - | (280.694.089) | 6.630.260.773 | 9.20% | 0.540 | 3.417.746.977 | 3.575.306.834 | 10.808.293.729 | 19.35% |
| 2028 | 5.975.535.021 | 1.258.330.298 | 7.213.665.319 | 1.258.330.298 | - | (282.881.082) | 6.950.984.237 | 9.20% | 0.498 | 3.289.965.840 | 3.417.746.977 | 10.808.293.729 | 19.35% |
| 2029 | 6.295.423.320 | 1.258.330.298 | 7.553.753.618 | 1.258.330.298 | - | (289.594.764) | 7.264.158.854 | 9.20% | 0.453 | 3.127.397.345 | 3.289.965.840 | 10.808.293.729 | 19.35% |
| 2030 | 6.585.807.914 | 1.258.330.298 | 7.844.138.212 | 1.258.330.298 | - | (303.665.777) | 7.540.472.435 | 9.20% | 0.415 | 3.127.397.345 | 3.127.397.345 | 10.808.293.729 | 19.35% |

**Notes:**
- WACC = Weighted Average Cost of Capital
- IRR = Internal Rate of Return
- Pay Back Period
  - 5 years
  - 5 months
5. Conclusion
To increase the added value, perlite needs to be developed through processing into expanded perlite. Expanded perlite products have the unique characteristics of being lightweight, sterile, insulated, and fire-resistant. Excellent for a wide variety of applications. Applications in construction, industry, insulation, horticulture, and the environment. The market opportunity is quite promising, both for import substitution and for export. TEKMIRA can be involved in developing the assets of the expanded perlite processing plant. Its business partners are competent, have working capital, experience, and have similar businesses to cooperate in the management, marketing, and development of process technology. Economic analysis provides a clear picture for both parties. Even profit-sharing structures can be offered which are more attractive to business partners. TEKMIRA will get a fixed profit in addition to the proportional profit sharing.

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