Utilization of timber harvesting residues for wood pellet production: A green strategy to improve timber concession’s profitability

Ruslandi, N Novita*, and A Malik
Yayasan Konservasi Alam Nusantara, Jakarta Selatan, 12160, Indonesia

*E-mail: nisa.novita@tnc.org

Abstract. Production forests, which cover 70 million Ha or more than half of total Indonesia’s forest, should be actively managed in a sustainable way to avoid dangers of deforestation of tropical rain forests. A decreasing trend of numbers of operating timber concessions has been observed because of low profitability and supply issues. In an effort to reverse this tide, we conducted a comprehensive study by reviewing existing literature, analyzing financial details from six concessions and their three parent companies, and organizing workshop with multi stakeholders to improve the profitability of logging concessions through logging waste utilization for wood pellet production. Our study showed that timber harvesting waste utilization for wood pellet production is an attractive strategy to enhance profitability of timber concession because of supply availability, cost efficiency, and promising market for sustainable wood pellets in Japan. The waste wood is valuable but wasted resource, as 2.5 to 1 is the ratio of wood waste left behind to that of high value logs removed from the forest. In East Kalimantan, we estimated that the cost for wood pellet production, which corresponds to labor and equipment needed to remove and transport waste wood, to be IDR 327,250/m³ or USD 25 per m³. Further, we calculated that by selling the logging waste for the wood pellet production at the price of USD 37, a typical-sized concession of 50,000 m³ annual timber production could make a profit of USD 570,000 per year instead of losing USD 60,000 under the current financial situation of the concession. This business is recommended for timber concessions with medium road hauls and less dependence on narrow, turbulent sections of rivers for rafting. Large-scale implementation of this strategy will be preceded by conducting a pilot project as a collaborative effort between The Nature Conservancy/Yayasan Konservasi Alam Nusantara and Indonesia Ministry of Environment and Forestry.

1. Introduction
The role of well-managed timber concession in maintaining natural rainforest is prominent to conserve biodiversity, carbon stocks and other ecological functions [1]. About 55% of Indonesia’s forests or 69 million hectares have been allocated to timber production [2]. Yet, recent data shows that only 78% of 197 total timber concessions are still active and they are gradually decreasing over the years due to economic pressure (pers.comm). Based on the current domestic log price and logging cost reported in this study, it was estimated that a typical sized of logging concession with annual timber production of 50,000 m³ lost USD 60,000 annually. Consequently, larger abandoned productive forest will be more
vulnerable to illegal logging and land cover change threats. An effective strategy to help timber harvesting business is required, not only for economy reason but also for reducing further forest and biodiversity loss.

Converting wood waste into wood pellets will improve economic value of forests that help private sectors (HPH: timber concession) earn additional income and increase government revenue from harvested timber levy. Furthermore, wood biomass as bioenergy is considered as low-carbon fuel and a viable option to lowering CO₂ emissions due to fossil fuel replacement. From business point of view, a strong market for wood pellets as low-cost biomass resources in developed countries, particularly east Asia, provides a great opportunity of additional income for logging concessions. Unless something is done to improve natural forest concession profits, irrevocable land use changes will occur leading to changes in local climate, atmospheric release of carbon now locked up in standing forests, loss in biodiversity, and serious changes in watershed integrity. Goh et al [3] identified a strong market growth is anticipated in Japan and South Korea as both countries seek to meet renewable energy quotas. Lately, Indonesia produced 40 thousand tons of wood pellets where more than 94% are mainly exported to South Korea followed by 2.2% to Japan, and less than 1% to European countries (5). Japan is currently the largest importer of wood pellets in Asia for co-firing at power plants and normally seeks for long-term contracts at stable prices. China also has an established wood pellet market (4), as domestic demand for this commodity is growing and the country plays as a key wood pellet exporter to South Korea.

East Kalimantan is identified as one of the largest potential bioenergy sources in Indonesia based on the total national potential of harvesting and wood processing residues (5). Our study showed that certified timber companies in East Kalimantan have a great potential for biomass/wood pellet investment due to raw materials supply from remaining harvest residues, promising exported market, and accessibility. This finding is supported with our analysis on industry costs based on the major production cost categories and the particular parameters that govern the magnitude of each cost.

2. Materials and Methods
We focused our study in East Kalimantan, with 6 logging concessions (of which 5 are FSC certified) belonging to three timber parent companies (Figure 1). For production cost analysis, we developed an approach of categorizing revenues and costs on the basis of the common cost factors that drive billions of expenses shown on a HPH income statement.

Figure 1. Study area is located in East Kalimantan
That is, some costs can best be calculated by multiplying volume \( (m^3) \) times a cost factor (IDR per m\(^3\)). Yet others (such as hauling or rafting) depend upon both volume and distance, and they can be calculated by multiplying a distance and volume factor \( (m^3 \times km) \) times a cost factor \( (IDR / (m^3 \times km)) \), as shown in Table 1 below:

In addition to production cost analysis, a series of multi stakeholders workshops were conducted in order to validate information and gather inputs from industry, government and timber concessionaires’ perspectives. Firstly, we organized a two-day workshop in Balikpapan with government and industry stakeholders. The workshop reached a group consensus on what it believed were the most fruitful new areas of business that might be pursued by sustainable (FSC certified) timber concessions, in order to improve business profitability. Secondly, a multi-stakeholder dialogue was conducted on 6th November 2018 to discuss the results of a feasibility study on the development of wood pellet business for IUPHHK-HA business sustainability and KPH business development in East Kalimantan. Finally, a workshop was conducted in Jakarta on January, 19th 2019 to discuss the results of a feasibility study on the development of a pellet wood business for IUPHHK-HA business continuity with the Ministry of Environment and Forestry.

### Table 1. Examples of Key Costs and Cost-Drivers

| Cost Example                | What Drives Costs               | Volumetric Measure                             | Times Cost per Unit Volume | = Absolute Cost |
|-----------------------------|---------------------------------|-------------------------------------------------|----------------------------|-----------------|
| Manager salaries            | Fixed                           | 1 (relatively standard per concession)          | IDR fixed per concession   | IDR 000s        |
| PBB tax                     | Size of concession              | Hectares of concession area                     | IDR per hectare of concession | IDR 000s       |
| Haul road maintenance       | Length of haul road             | Kilometers of haul road maintained              | IDR per kilometer maintained | IDR 000s       |
| Planning of RKT and building of branch roads | Size of the RKT (annual cut block) | Area (in hectares) of the annual cut block | IDR per hectare of annual cut block | IDR 000s |
| Felling, skidding, PSDH, DR, fees for villagers | \( m^3 \) felled | \( m^3 \) | IDR per \(m^3\) | IDR 000s |
| Loader cost                 | Repeated loading and unloading of same log | Number of load/unload cycles | IDR per load/unload cycle | IDR 000s |
| Log truck hauling           | Haul distance from TPK/logdeck/log pond and volume hauled | \( m^3 \times km\) travelled | IDR per \(m^3\) x km | IDR 000s |
| Rafting                     | Raft distance and volume rafted | \( m^3 \times km\) rafted | IDR per M3 x km | IDR 000s |

3. Results and Discussions

3.1. Financial problems

We analysed the main financial problems that are currently facing natural timber business. Low profitability and the difficulty to access credit are the main issues reported by sustainable actors in Indonesia’s natural forest timber. Bank prefers to give loans to oil palm business, or other plantation crops, like industrial timber and rubber because of higher credit risk from low profitability. Our
estimate is that on a per hectare/per year basis, clear cutting natural forests and replacing them with palm oil is on the order of 170 times more profitable than natural timber production. Another important problem is reducing profitability which drive into conversion. Area of HPH is declining overtime, yet industrial timber concessions area is increasing rapidly. A clear and significant danger is the continuing conversion of high-quality natural forests at the headwaters of Borneo’s major river basins into monoculture plantations of palm oil or fast-growing pulpwood trees. Since the 1990’s about 60 percent of natural timber concessions (36 million hectares) have gone out of business, with estimates that of the remaining area of 24 million hectares under concession, only about half are actively in business. Meanwhile 15.2 million hectares palm oil have been added nationwide, plus 11.8 million hectares in timber plantations.

3.2. Average production cost in HPH in East Kalimantan

Table 2 and Table 3 show production costs from two concessions (i.e. concession 1(C1) and concession 2 (C2) with relatively similar size, but located in different headwaters of the same large river basin. Both concessions harvested relatively similar wood volume (41–44 thousand m³ per year) and had roughly similar total production costs around IDR 56 billion. C1 has enormous fixed costs, even though the total concession areas and the total harvested concession areas (not shown for confidentiality reasons) are virtually identical with those of C2. C1’s fixed costs are more than double C2’s, an extra IDR 8 billion. However, even with lower fixed costs, C2 has a number of unit operating cost factors and some accounting glitches that bring its reported total costs back closer to those of C1. C2 also is burdened by spending much more per kilometre of haul road maintained, than C1 (IDR 45 million/km/year at C2 vs. IDR 20 million/km/yr at C1). Finally, some of C2’s apparent transportation costs (loading, hauling, and rafting) actually relate to harvest volumes of the prior year that appear to have been moved during the year we examined. C2 actually has slightly lower unit costs per km/year, yet industrial timber concessions area is increasing rapidly.

| Cost Driver                        | Volume Factor            | Volume Value | IDR/unit volume | Product         |
|-----------------------------------|--------------------------|--------------|----------------|----------------|
| Fixed Cost                        | Concession Fixed O.H     | 1            | 15,000,000,000 | 15,000,000,000 |
| Cut block planning and concession | Ha cut/year              | 2,345        | 540,000        | 1,266,300,000  |
| Maintenance per Km/Year           | Ha cut/year              | 2,345        | 1,300,000      | 3,048,500,000  |
|                                    | Haul road maintenance/Km | 70           | 20,000,000     | 1,400,000,000  |
| Logging and Skidding Cost/ m³     | m³ harvested             | 44,649       | 156,000        | 6,965,244,000  |
| CSR and Community                 | m³ harvested             | 44,649       | 20,000         | 892,980,000    |
| PSDH and DR/ m³                   | m³ harvested             | 44,649       | 286,000        | 12,769,614,000 |
| Loading/Unloading Cost/ m³ cycle  | Cycles per m³/ m³        | 133,946      | 31,000         | 4,152,326,000  |
| Hauling/ m³-Km                    | Logs m³ Km Hauled        | 2,857,523    | 2,047          | 5,849,349,581  |
| Cost/ m³ Km Bad River            | Bad River Km* m³         | 4,464,880    | 600            | 2,678,928,000  |
| Cost m³ Km Good River            | Good River Km* m³        | 17,859,520   | 110            | 1,964,547,200  |
| Total                             |                          |              | 55,987,788,781|                |
Based on our survey at representative HPHs in East Kalimantan, we also calculated the averages reasonable values to use for an idealized concession modelled for the purpose of examining impacts of policy and business strategy changes, as described below:

*Fixed costs* seem to relate strongly to concession size, productivity, etc. Most concessions seem to have fixed cost components and total fixed costs, with the exception of certain concessions that had better base camp facilities, much larger staff, etc. Note that our estimates of fixed costs do not include overhead allocations for various head offices in Samarinda, Jakarta, etc. We limited costs to those operationally linked to the physical concession area. Based on this calculation, for creating a “generic” concession model we would be inclined to use a figure of about IDR 8 billion for fixed costs.

*Costs for planning and documenting the annual cut block* are calculated based on IDR per ha of cut block. As such, they are fairly tightly grouped, which makes sense especially in the context of two major expenses, the timber cruise and road/boundary surveying, both of which are clearly driven by size. In general, these figures could be obtained from accounting statements relatively easily. A figure in the IDR 750,000 per ha range seems reliable.

*Road building for the annual cut block*, could be predicted on a per ha of cut block basis for most concessions that have been active for a long time, especially since virtually all the concessions we looked at had relatively similar, rough terrain. However, in practice, some concessions had particularly harsh terrain in the years for which we could obtain data, making the results more variable than we expected. For an industry figure, we would be inclined to use a number in the IDR 2.0 million per hectare range for cut block roadbuilding.

*Maintenance of haul roads*, is absolutely critical and high-cost activity. In practice, the recorded and reported costs were surprisingly small for the few situations in which we could obtain good data. In part this was because some concessions had very good roads based on excellent original construction and good past maintenance, thus needing less maintenance currently. Some experienced operators quoted us a rule of thumb of IDR 100 million/km/yr. We would be inclined to use a haul road maintenance figure of IDR 50 million/km/yr as a more reliable long-term cost estimate.

### Table 3. Production cost for concession #2

| Cost Driver                        | Volume Factor           | Volume Value | IDR/Unit Volume | Product   |
|-----------------------------------|-------------------------|--------------|-----------------|-----------|
| Fixed Cost                        | Concession Fixed O.H    | 1            | 7,051,879,848   | 7,051,879,848 |
| Cut block planning and            | Ha cut/year             | 1,497        | 747,960         | 1,119,696,120 |
| concession                        |                         |              |                 |           |
| Cut Blok Roads                    | Ha cut/year             | 1,497        | 3,378,416       | 5,057,488,752 |
| Maintenance per                   | Haul road               | 80           | 44,558,540      | 3,564,683,200 |
| Km/Year                           | maintenance/Km          |              |                 |           |
| Logging and Skidding              | m³ harvested            | 41,236       | 148,267         | 6,113,938,012 |
| Cost/ m³                          |                                            |              |                 |           |
| CSR and Community                 | m³ harvested            | 41,236       | 30,031          | 1,238,358,316 |
| PSDH and DR/ m³                   | m³ harvested            | 41,236       | 293,326         | 12,095,590,936 |
| Loading/Unloading Cost/           | Cycles per m³ * m³      | 180,000      | 31,522          | 5,673,960,000 |
| m³ cycle                          |                                            |              |                 |           |
| Hauling/ m³-Km                    | Logs m³ Km Hauled       | 2,400,000    | 1,581           | 3,794,400,000 |
| Cost/ m³ Km Bad River             | Bad River Km* m³        | 8,400,000    | 651             | 5,468,400,000 |
| Cost m³ Km Good River             | Good River Km* m³       | 36,560,000   | 76              | 2,778,560,000 |
| Total                             |                         |              |                 | 53,956,955,184 |

Based on our survey at representative HPHs in East Kalimantan, we also calculated the averages reasonable values to use for an idealized concession modelled for the purpose of examining impacts of policy and business strategy changes, as described below:

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Logging and skidding costs, after digging deep into the numbers, appear to be relatively similar across concessions. It is difficult to obtain reliable figures in some cases because work is done by contractors and local camp managers and production managers do not necessarily even have contract details. A figure in the IDR 130,000 per m³ range seems reasonable for an industry-wide estimate.

Costs for payments to surrounding local communities appear to be relatively similar and were obtained from accounting statements. The payments appear to be relatively small compared to other cost factors; and in the context of overall cost figures in the range of IDR 1.2+ million per m³ these costs are far smaller than we had been led to expect (approximately 2 percent of costs). We recommend using a round IDR 30,000 per m³.

Loading/unloading costs are surprisingly high. We use a round IDR 30,000 per load/unload cycle for industry estimates, and a round IDR 100,000 per m³ if data is not available for a concession as to the number of load/unload cycles.

Hauling costs are a function of m³ carried, distance carried, and the degree to which rough roads permit trucks to be fully loaded. There are a number of possible efficiency, investment and regulatory suggestions that could greatly reduce hauling costs and inter-related loading costs that are beyond the scope of this report. Other things being equal we would use a figure of IDR 1,750 per m³ that is hauled for a distance of one kilometre.

Rafting and barging costs are a high absolute number for most concessions, since most surviving concessions are far up into the headwaters of major river systems, for example the Mahakam River. Most costs on major river systems seemed to converge on approximately IDR 1,000 per m³ per kilometre for small rafts and IDR 90 per m³ per kilometre for large rafts.

Based on the current survey of profitability, it is estimated that HPH free cash flow as being in the area of USD 5 to 20 per year per hectare of concession area. (To use a realistic example, a 60,000-hectare concession, harvesting 2,000 hectares per year, taking 20 m³/ha, and making an IDR 200,000 per m³ profit, earns IDR 8 billion or USD 615,000 per year). Thus, USD 615,000 per year on 60,000 hectares is about USD 11 per HPH hectare per year.) Ignoring all sunk investment costs, the NPV at 10 percent over 50 years would be approximately USD 109 per HPH hectare.

3.3. Why wood pellet is promising alternative to improve HPH’s profitability

3.3.1. The estimated cost for the extraction of raw materials for wood pellet production is 25 US$/m³. Based on our assessment, logging concessions in East Kalimantan generate approximately 3 m³ of high quality wood waste for every 1 m³ extracted sawn timber or plywood. Biomass could be a new product that can help timber concessions financially with a small incremental expense. A list of additional equipment that would likely be needed in order to remove waste wood from cutting blocks, and transport it to a wood pellet mill, is provided in Table 4 below. We are optimistic about the competitiveness of this products and our analysis results in IDR 327,250 or 25 US$/m³ as incremental cost for wood pellet production.
Table 4. Incremental expenses for wood pellet production

| Activity                          | Corresponding labor and equipment                                                                                                                                                                                                 | Expected incremental cost to be paid                                                                                                                                 |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Felling & bucking labor; skidding labor | Trees have already been cut, and they are typically bucked to remove the pieces that will be left in the woods as waste. Some extra effort is required to de-limb at the first branches. So actual incremental feeling and bucking expense will be near zero. | Fellers and helpers collectively earn about IDR 7,000 (i.e., USD 0.54) per m³. Skidders and helpers collectively earn about IDR 7,000 (i.e., USD 0.54) per m³. Weshouldexpectthat they’d be paid the same on waste wood volume removed by themselves, to ensure their cooperation in salvaging wood. Total IDR 14,000. |
| Skidding                         | Tractors will be needed to skid waste wood to the log deck. Full tree stems shorn of their branches could be hauled up in a single go by bulldozers, with ply and saw logs to be separated from the waste wood at the log deck. Forthist reason, for wood higher up the tree trunk (or stem) from the main commercial log, incremental skidding cost would be near zero. (Note: the largest commercial logs we saw had volumes on the order of 10 to 12 m³. HPH managers say a dozer can skid up to 20 m³-i.e., in no cases is a second bulldozer trip required to bring the waste segments on the stem of an intentionally felled tree up the skid trail.) | Actual incremental skidding equipment cost (in terms of fuel, oil, and spare parts, but without depreciation) is in the range of IDR 68,000 per m³ for normal commercial logs. If we assume half the skidded volume of waste wood were from the normal commercial logs (nil incremental cost) and half from collateral damage from felling and road building, we could expect skidding costs of 34,000 per m³. |
| Loading                          | Extra log loaders may be needed to load wood waste on and off log trucks at intermediate log yards.                                                                                                                                                                                                 | We should expect normal loading costs of IDR 30,000 per m³ of loading and unload. With midpoint values of 1.5 cycles, that would suggest IDR 45,000 per m³ |
| Hauling                          | Truckswill be needed to truck log waste to the log pond. Regular log trucks already owned by concessions could be used. Alternatively, using the method for hauling natural forest or plantation logs from industrial timber plantations, two four-meter lengths of waste logs could be stacked end to end on the bed of special modified-for-purpose trucks (we saw Renault trucks in use at APP plantations). | We would expect normal hauling costs in the range of 950 per m³ per kilometer, hence approximately IDR 61,750 for hauling at a distance of 65 kilometers. |
| Rafting                          | We have been told that logs of relatively small diameter (i.e., 30 cm) can be conventionally rafted. If barges can be used, costs may be lower.                                                                                                                                                        | Assuming 50 kilometers of small rivers, and 350 kilometers of larger rivers (with a plant located upriver as the ultimate destination) we would expect rafting costs of IDR 122,500 per m³. |
| Taxes                            | Under review. Few parties seem to understand royalty treatment clearly.                                                                                                                                                                                                                      | Assuming diameter below 40 cm, taxes are approximately USD 7 per m³ or IDR 91,000. Approximate total: IDR 327,250/m³ or USD 25 per m³ cost of production. |
3.3.2. High potential market in Japan
Rapid growth in long-term demand for pellets and other biofuels from the highest price and most stable market in Asia: Japan. According to industry researchers, Japan’s market for all biomass fuels is expected to grow rapidly as standards for carbon dioxide released per MWh of electricity generate tighten. This has also been further enhanced by the Fukushima accident. The use of biomass energy is expected to expand positively due to their operational stability, independent of the natural conditions. According to IEA report (6), Japan uses 298 PJ of its renewable energy from solid biomass (1.6% of total primary energy supply). It is estimated about 70% of the biomass used by Japan will be in the form of wood chips to be burned in small, dedicated biomass power plants and 30% will be in the form of pellets that can be mixed with coal and “co-fired” in conventional large pulverized coal power plants. Demand from Japan is so significant because Japanese power plant buyers are oriented towards obtaining long-term contracts at stable prices so as to be able to derive accurate cost estimates of their compliance efforts. This type of contract exactly corresponds to the type of long-term contracts desired by lenders to biomass fuel production facilities. And Japan wants sustainable pellets: “The basis for the policies in Japan, the decarbonization of the power sector, require[s] that the suppliers show that the pellet supply chain meets sustainability criteria. Japanese buyers therefore prefer to engage with counterparties from countries with strong rule of law strong forest management practices, and stable macroeconomic conditions)

3.3.3. Existing mill facility
The facility for wood pellets processing already exist in Samarinda. The mill is owned by a Korean engineering and raw materials conglomerate, Wonjin, and is located about 100 km upriver from Samarinda. The existing facility is not perfect but it could begin operating at a modest level of production for very little capex. Demonstrated capabilities and cash flow from initial operations could serve as a solid proof of concept to attract the funding needed to tune up the facility to first class status.

3.3.4. Emission reduction strategy
Lastly, from the perspective of Indonesia’s commitment to reduce national GHG emissions by 29% in 2030, a broader use of biomass-derived fuel would be a positive contribution towards the GOI’s meeting its Paris commitments. Numerous reports have emphasized two disturbing trends, both of which could be addressed by biomass pellet production or biomass power plants. First, significant emissions are forecast to continue from deforestation, i.e., exactly what will happen if ever more HPHs go out of business because they have not developed new revenue sources.

3.4. Potential profit for logging concession by utilizing logging waste to produce wood pellet
Based on our estimation, wood pellet factory could afford to buy the logging waste as the raw materials for the wood pellet production at the price of USD 37/m³. With this price, a typical-sized concession of 50,000 m³ annual timber production could make a profit of USD 570,000 per year.

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