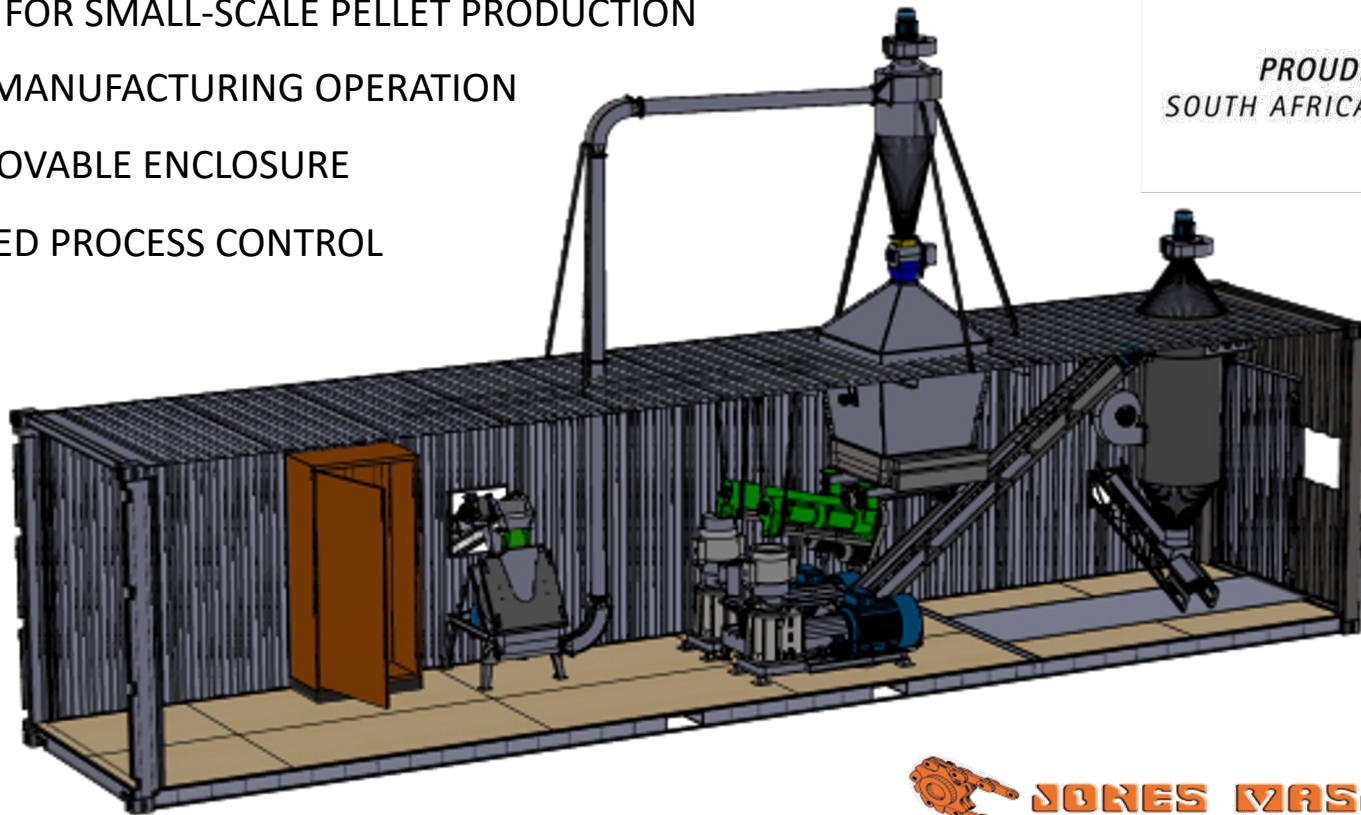


FABTAINER

CONTAINER PELLET PLANT

- DESIGNED FOR SMALL-SCALE PELLET PRODUCTION
- TURNKEY MANUFACTURING OPERATION
- SECURE MOVABLE ENCLOSURE
- AUTOMATED PROCESS CONTROL



PROUDLY
SOUTH AFRICAN



JONES MASJIERE

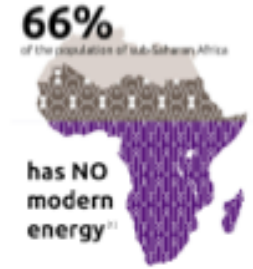
BUILT & SUPPORTED IN AFRICA

BIOMASS PELLETS AS DOMESTIC COOKING FUEL IN AFRICA

EXISTING COOKING ISSUES RELATED TO USING BIOMASS AS A FUEL

Most households in Africa have no access to grid-based power. The production and use of wood fuel is an important socio-economic activity in Sub-Saharan Africa (SSA), but overuse is rapidly depleting natural supplies. High population growth rate and increasing migration to towns and cities is increasing cooking energy demands in urban and peri-urban areas.

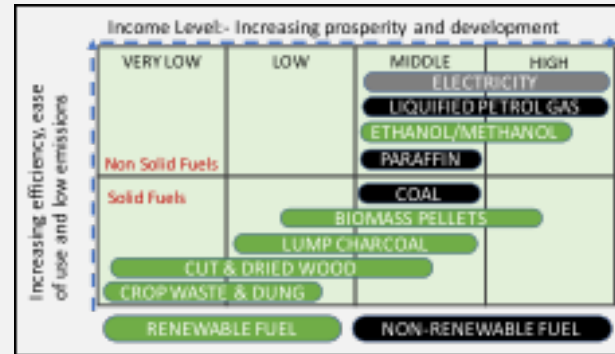
The dominant cooking fuels used in poorer communities are wood-based fuels (firewood and charcoal) and paraffin. Usage of LPG and electricity-for-cooking in these markets is very limited and where available very costly and unaffordable. Over 70% of the population relies on wood fuel as their primary household energy source. Using wood/charcoal with traditional cooking methods also causes environmental and health issues.



PROBLEMS ASSOCIATED WITH WOOD DERIVED COOKING FUELS



ALTERNATIVE COOKING FUELS LADDER



BIOMASS PELLETS



THE NEED FOR A MODERNISED EFFICIENT SOLID BIOMASS COOKING FUEL

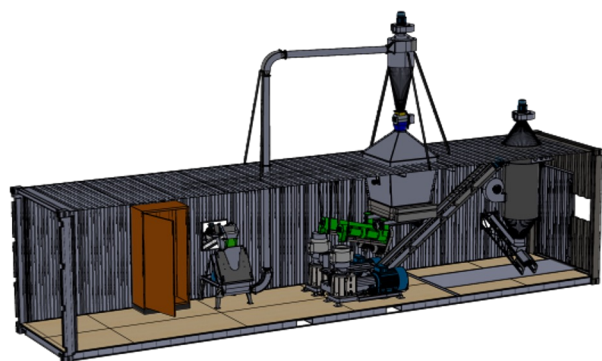
Increasingly it is understood that the need for solid biomass as a cooking fuel will extend well into the future. Strategies to improve sustainability of biomass supply are needed by reducing per capita usage, including the need to build better and sustainable value chains for locally produced solid fuels. Compressed solid biomass fuels can create a viable step in the cooking fuel energy ladder to help reinvent the existing biomass supply chains for charcoal and firewood, without the need for LPG or electricity for cooking. Pellets improve combustion performance, reduce harmful emissions, and reduce per capita usage by over 40%.

SUPPORTING SDG 7 – ACCESS TO CLEAN ENERGY - ADVANCED BIOMASS COOKING

Biomass pellets are a highly efficient form of heating energy. The product is very dense, low in moisture which makes it easy to burn for long periods in a combustion system called gasification, which optimizes the energy in the volatile carbons in the biomass material.

SUSTAINABLE COOKING FUEL

PELLET COOKING FUEL
MANUFACTURED FROM
BIOMASS FEEDSTOCKS



FABTAINER
CONTAINER PELLET PLANT



ADVANCED BIOMASS COOKSTOVE

CLEAN & EFFICIENT COOKING
WITH BIOMASS PELLETS
USING GASIFICATION

FABSTOVE
GASIFIER KIT



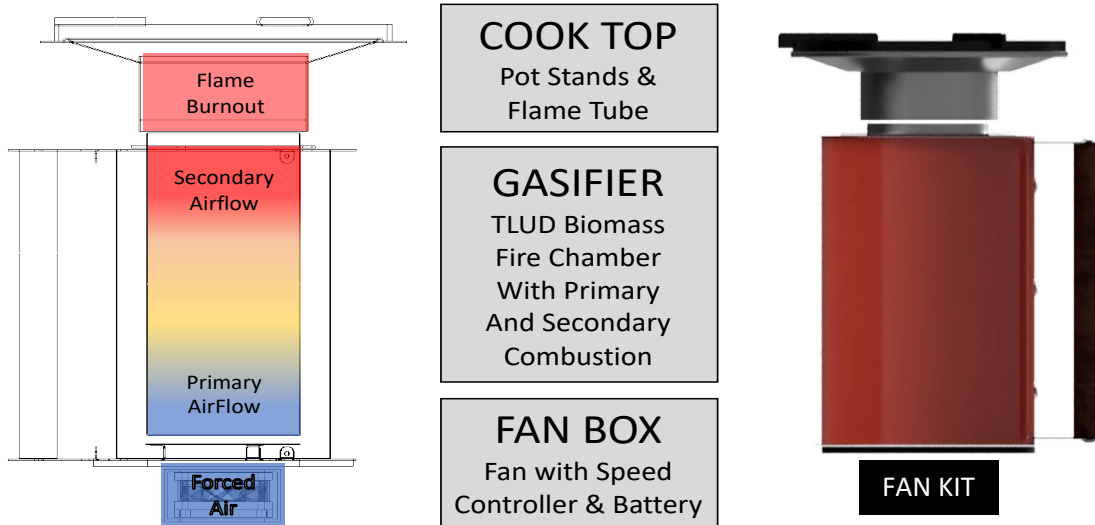
ADVANCED BIOMASS COOKING WITH BIOMASS PELLETS

In numerous independent cooking tests, forced air gasification updraft combustion is proven to meet WHO tier 4 standards for efficiency, low emissions and safety. A forced air gasifier stove with biomass is considered an advanced cooking solution by the ESMAP Multi-Tier Framework (MTF) for Cooking

THE FABSTOVE GASIFIER ENGINE KIT

An efficient 2 stage biomass combustion kit optimized to work with biomass pellets for everyday cooking

FABSTOVE
MAKES & BURNS GAS FROM BIOMASS



- TLUD Gasifier Principles
- Fan Assisted Air Flow
- Optimised for Biomass Pellets
- 40% Combustion Efficiency
- Low CO emissions
- Replaceable Fire Chamber
- Modular Design & Assembly

BIOMASS PELLET FEEDSTOCKS

Pellet fuels are biofuels made from compressed organic matter or biomass. Pellets can be made from any one of four general categories of biomass: untreated lumber, agricultural residues, energy crops, and industrial waste and co-products. As feedstocks are low density, logistic costs play a large role in feasibility coting. Feedstocks are also seldom in a suitable format for final pelleting and will pre-processing processes like drying, sorting and milling. These increase the cost of the feedstock

WOOD RESIDUES

In Europe, wood pellets are produced from sawdust, wood shavings and other woody by-products. Traditionally, production units are located on or nearby sawmills and other wood processing sites, representing by-product streams for these plants



AGRICULTURE RESIDUES

Agricultural biomass wastes/residues are predominantly crop stalks, leaves, roots, fruit peels and seed/nut shells that are normally discarded or burned but are in practice a potential valuable supply of feed-stock material.



ENERGY BIO-CROPS

Energy crops break down into two categories: herbaceous and woody. Herbaceous energy crops are perennial grasses that are harvested annually and include switchgrass, miscanthus, bamboo, sweet sorghum, wheatgrass. Short-rotation woody crops are fast-growing hardwood trees that are harvested within 5 to 8 years of planting.



BIOMASS PELLET PROCESS VALUE CHAIN – FEEDSTOCKS TO COOKING FUELS

An effective biomass value chain is essential to delivering an efficient cooking fuel solution. From sourcing through processing and manufacture and onto distribution requires careful planning, risk mitigation and cashflow management.

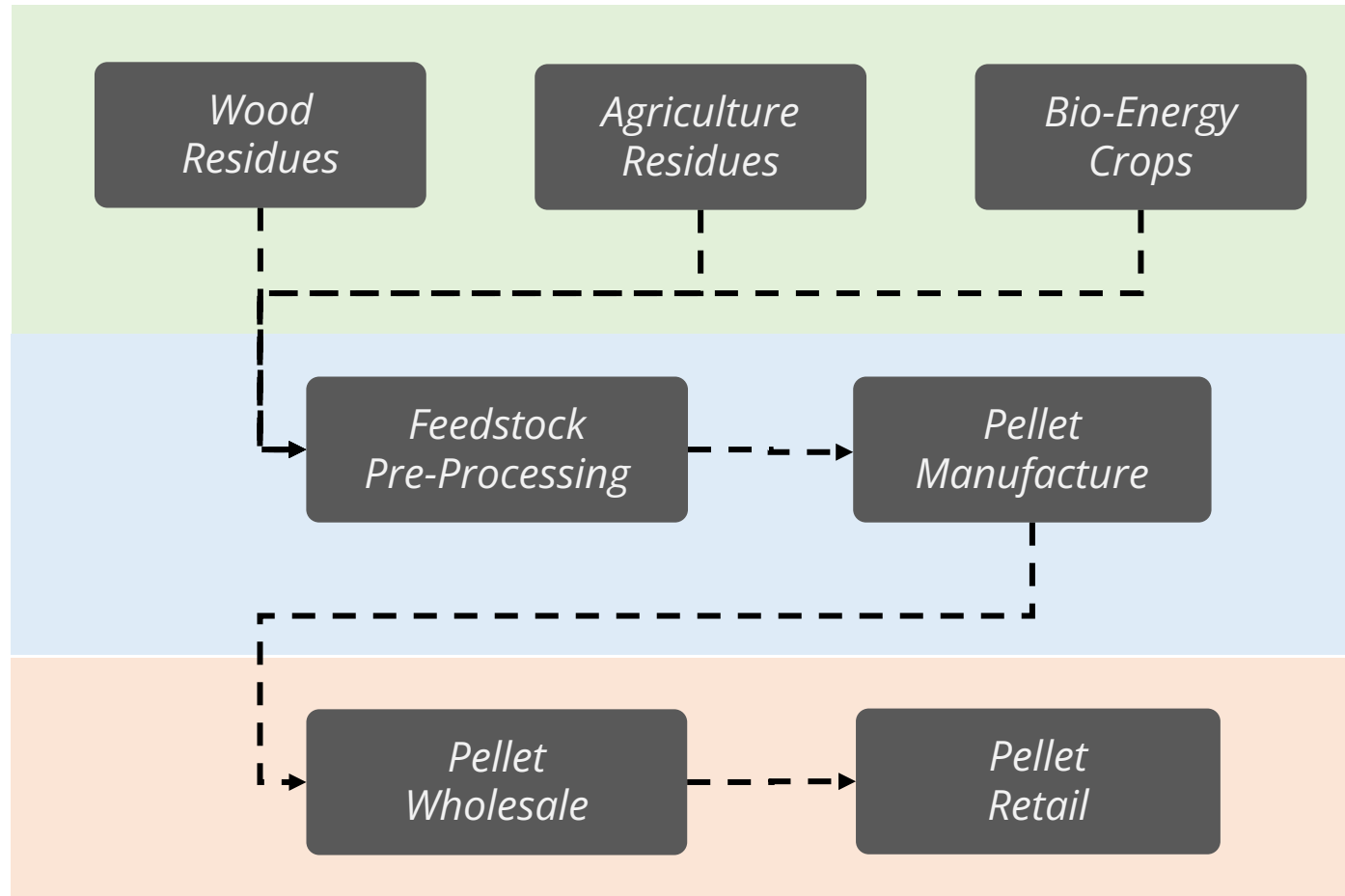
PELLET FEEDSTOCKS



PELLET MANUFACTURE



PELLET DISTRIBUTION



THE BIOMASS “FEEDSTOCK TO PELLET” MANUFACTURING PROCESS

1: PRE-PROCESSING: Collection, Drying, Sorting, Reduction

Biomass feedstock comes in many forms and conditions. It needs to go through a number of pre-processes (dependant of the raw material) before it is finally ready for pelleting.

Material needs to be free of contamination (sand, metal), dry (<16% moisture) and ready for milling before it can enter the final processes.

The costs and complexity of the pre-processing steps required will depend on the raw material used and its location to the plant. The costs for these processes need to be separately determined.

2: HAMMER MILL: Reducing Raw Material To Biomass Fibre

Raw material input into the hammermill needs to have under 15% moisture. This is necessary to optimize the milling process and to make sure that the reduced material can be directly fed into the pelleting process.

The hammermill reduces the feed into biomass fibre of less than 6mm via a screen in the hammer mill. All foreign metal is also removed via a large magnet in the intake.



#3: PELLETISE: Compression, Cooling & Fines



The pelleting process uses a roller and flat die to compress the biomass material into 6mm or 8mm pellets, with a moisture content of less than 10%. The compression process increases the raw material to a temperature of close to 100C which softens the lignin and acts as a binder. Pellets have density of over 650 – 750 kg per cube, roughly 3x that of the raw feedstock

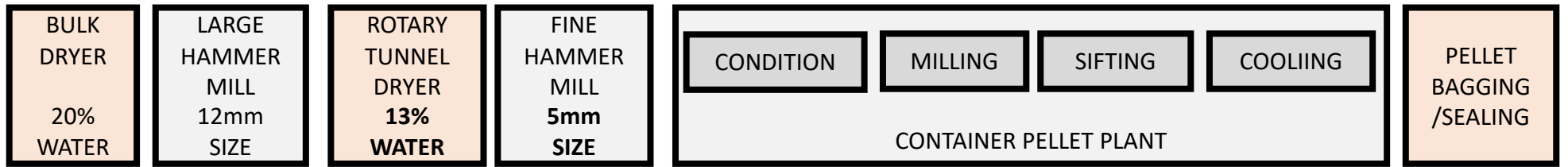
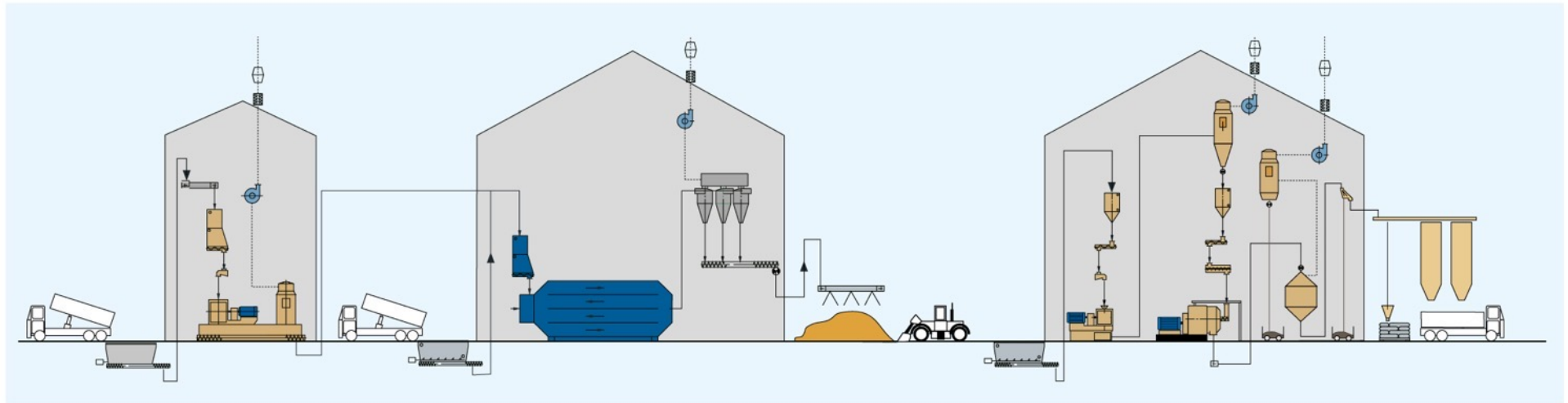
Once compressed the pellets need to be cooled down to improve the integrity and durability of the pellet prior to packaging. All loose fibres and fines also need to be removed as they will affect combustion of the pellets in the burn device.

#4: PACKAGE: Bagging & Distribution

Pellets are fed from the cooling bin via a conveyor into bags for distribution. This could either be via smaller bags (1,10, 15kgs) or in large bulk bags.

Raw material conversion to a reduced and compressed product close to the source reduces both the logistics and storage costs associated with normal biomass products. Localised production also offers regional value add benefits!

GENERIC PELLET MANUFACTURING PROCESS FROM BIOMASS FEEDSTOCKS



PRE-DRYING & SIZING

FINAL DRYING & SIZING

FINE MILLING, PELLETTING & COOLING

PACKAGING

FEEDSTOCK PRE-PROCESSING

PELLET MANUFACTURE

THE ECONOMICS OF MANUFACTURING BIOMASS PELLETS

FEEDSTOCKS: Wood Residues, Agro-Residues, Energy Crops

The price of waste biomass / feedstock is very dependent on its availability and location. This includes in many cases seasonality and competitive uses such as agriculture or other markets/uses.

Material needs to be delivered as dry and clean (free of foreign materials) as possible. This reduces further material handling which will increase costs. Most biomass has sufficient lignin to naturally bind the product. Feedstock low in lignin will require a binder in the form of low-cost starch to bind the pellets.

In bound logistics need to be carefully managed both in timing and cost to effectively manage product storage & flow into the plant.

LOGISTICS: Moving Product from Source to Market

Compared to other fuels such as petroleum liquids and gases, biomass pellets are still a relatively low value product by volume. Logistics costs relative to their value are thus very dependent on the location of the market relative to the production point. This is relevant in Africa that relies mainly on road transport powered by diesel.

Costs also increase as load sizes decrease with 30-ton loads being optimal for any long distance. We believe that biomass fuel pellets will be most competitive when sold in a radius of 200kms from the plant. Loads of 4 – 8 tons within this distance will make distribution cost effective both in terms of local stock holding and delivery cycles. This is a key advantage over competing fuels in a local market.

BIOMASS CONVERSION COSTS: Operational Expenses

The three major input costs are **power**, **labour**, and **machine maintenance**. Conversion costs are estimated at \$40 - \$60 per ton.

Plant power consumption is estimated at 250 kWh / ton. This includes reduction, compression, cooling and material handling.

Labour costs are estimated at \$15 per ton. This is based on a 25-day month, and three trained operators at any point in time.

Machine maintenance includes replacement rollers and dies, lubricants and servicing. We estimate a cost of \$15 / ton, but this is very dependent on the quality of the material. Down time and excessive roller/die wear can affect these costs dramatically.

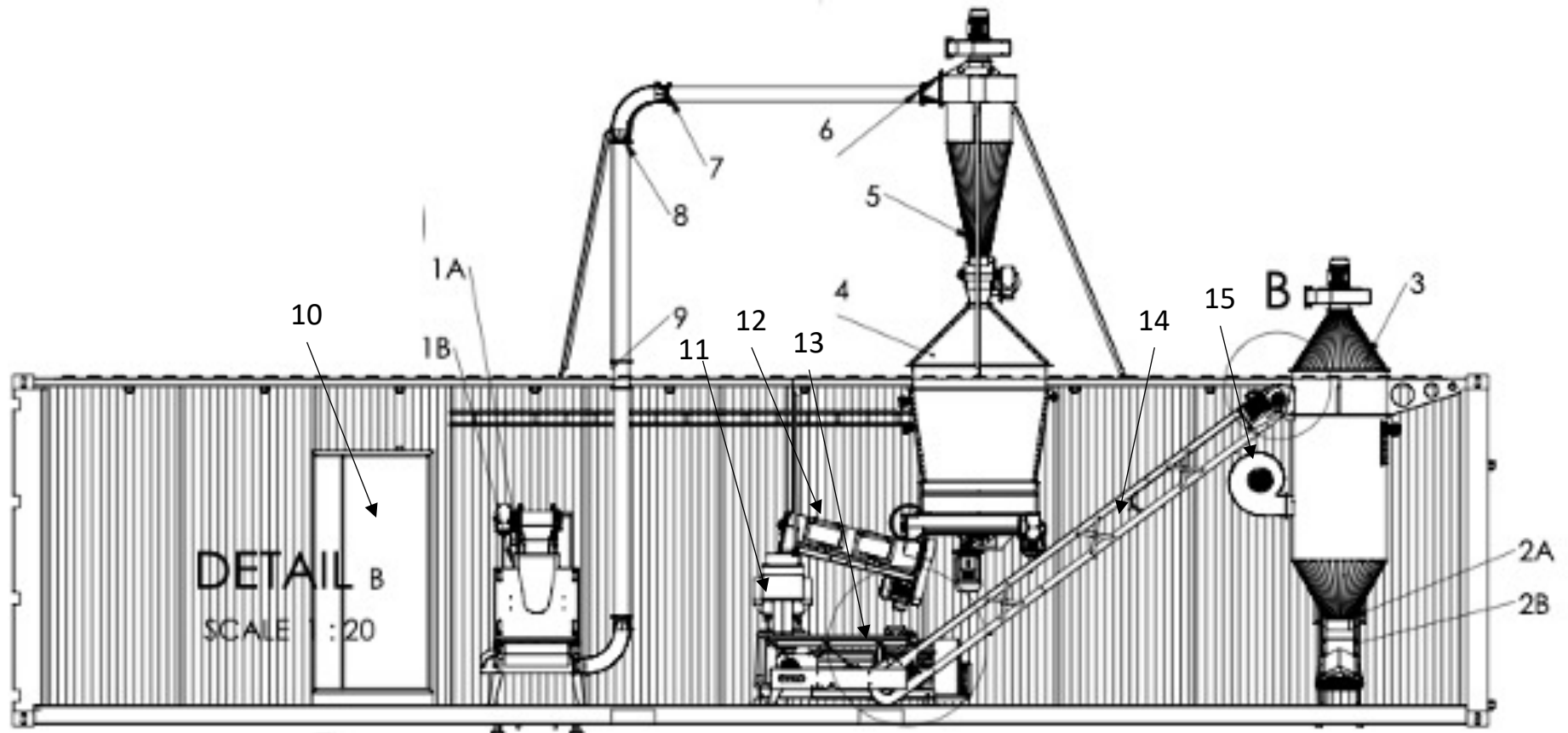
CAPITAL COSTS: Plant & Machinery

The estimated half life of the container pellet plant is about 6,000 tons production. At a levelized cost including interest and inflation, this is about \$40 per ton, based on 1,200 tons per year on a 5-year term. Equipment financing over a 60-month term is optimal.

Depending on site and input material specifics, storage needs, and the material handled, additional costs could be needed. This includes transport, bulk material handling and storage.

As a containerized mobile solution, i.e., movable to where the raw material exists, move costs need to also be factored in. Movement of the plant should be on a project-by-project basis with project periods of at least 6 months per site to optimize move costs.

CONTAINERISED BIOMASS PELLET PLANT – COMPONENT REFERENCE

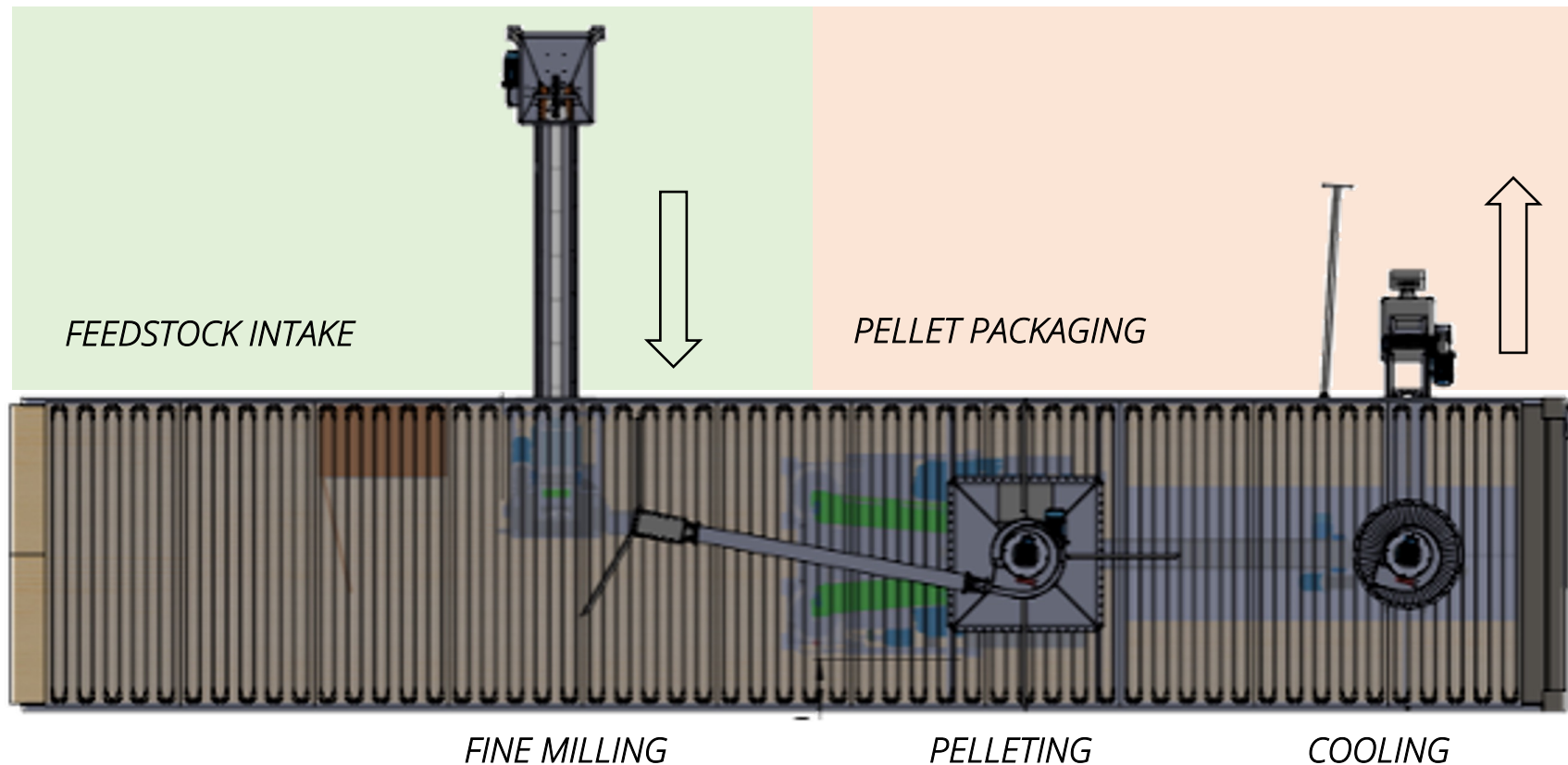


- | | | |
|-----------------------------------|-----------------------------|-------------------------|
| 1. Hammer Mill and Conveyor | 6. Hammermill Extractor Fan | 11. Flat Die Pelletiser |
| 2. Cooling Bin and Conveyor | 7. Milled Material Duct | 12. Conditioner |
| 3. Cooling Bin Cover & Extractor | 8. Milled Material Duct | 13. Dust Shaker Table |
| 4. Live Bottom Bin & Cover | 9. Milled Material Duct | 14. Pellet Conveyor |
| 5. Live Bottom Cyclone & Air Lock | 10. Plant Control Panel | 15. Cooling Fan |

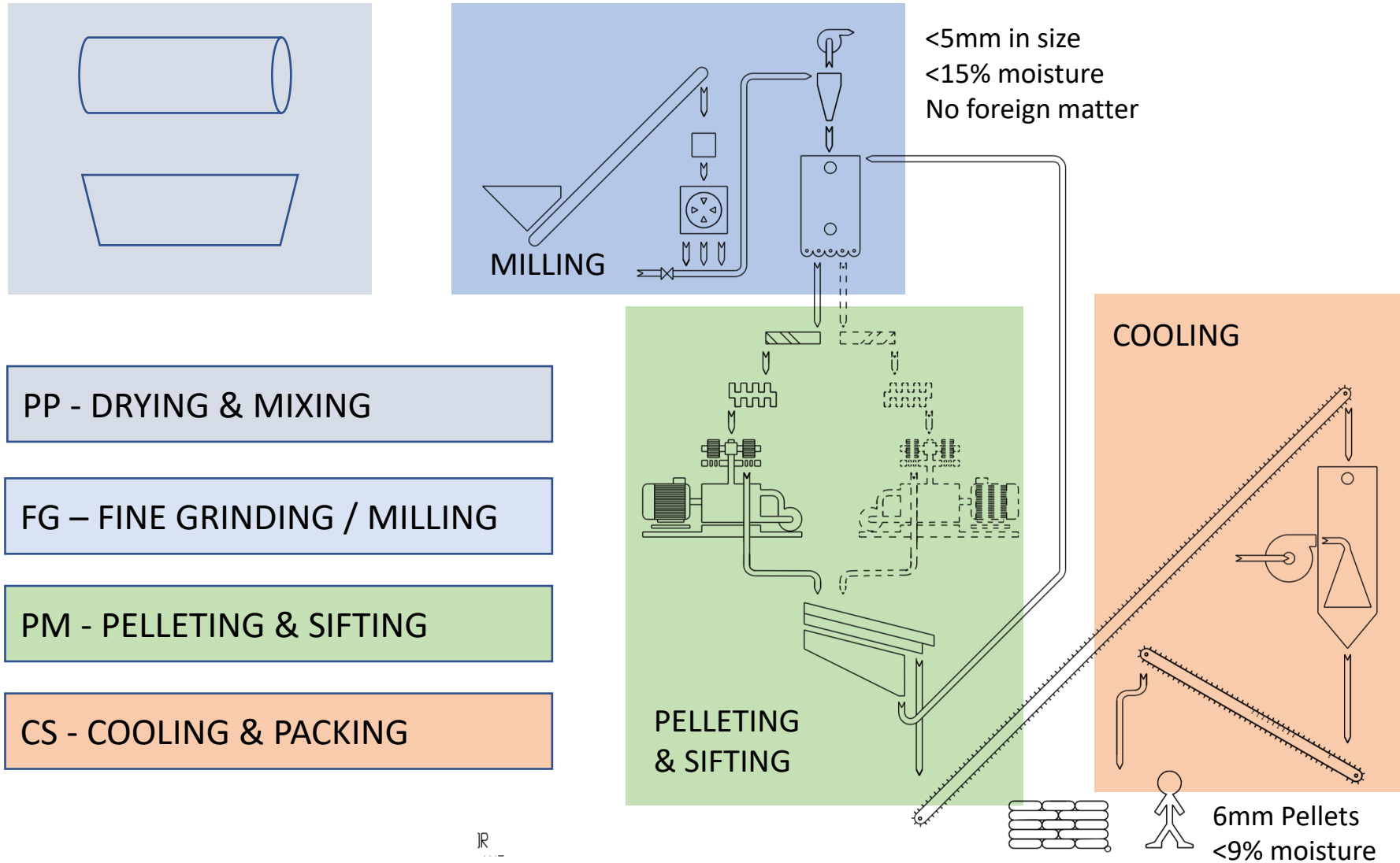
CONTAINERISED BIOMASS PELLET PLANT LAYOUT

FABTAINER CONTAINER PELLET PLANT

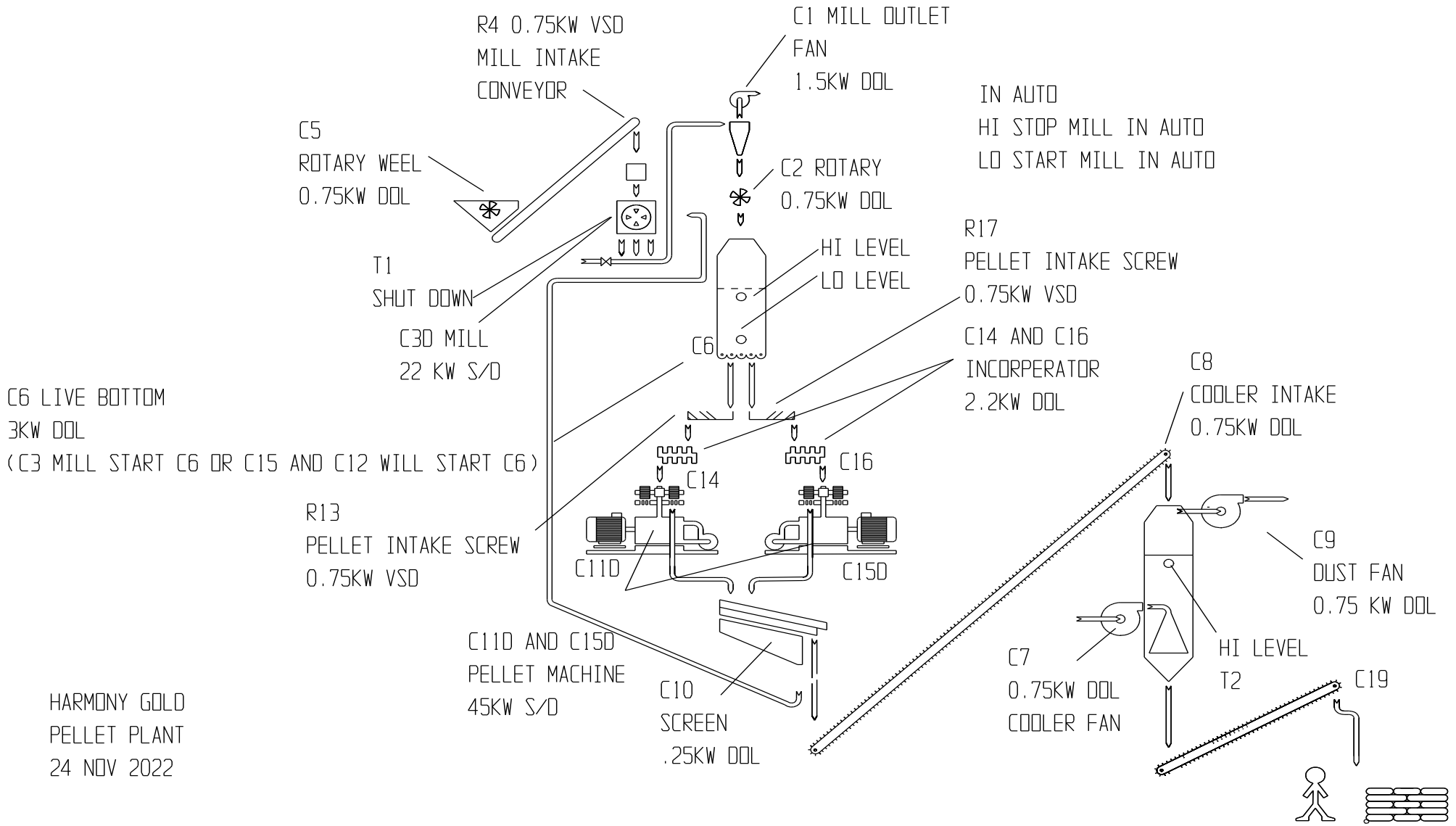
The pellet plant is built into a 12m hi-top container and is fully contained. The adjoining shed is about 12x6,6m making the whole plant area about 12x10 m².



BIOMASS PELLET PLANT - PROCESS FLOW OVERVIEW DIAGRAM



CONTAINERISED BIOMASS PELLET PLANT – DETAILED PROCESS FLOW



HARMONY GOLD
 PELLET PLANT
 24 NOV 2022

HARMONY MINES - CONTAINERISED BIOMASS PELLET PLANT



HARMONY MINES – ELEPHANT GRASS & BIOMASS PELLETS

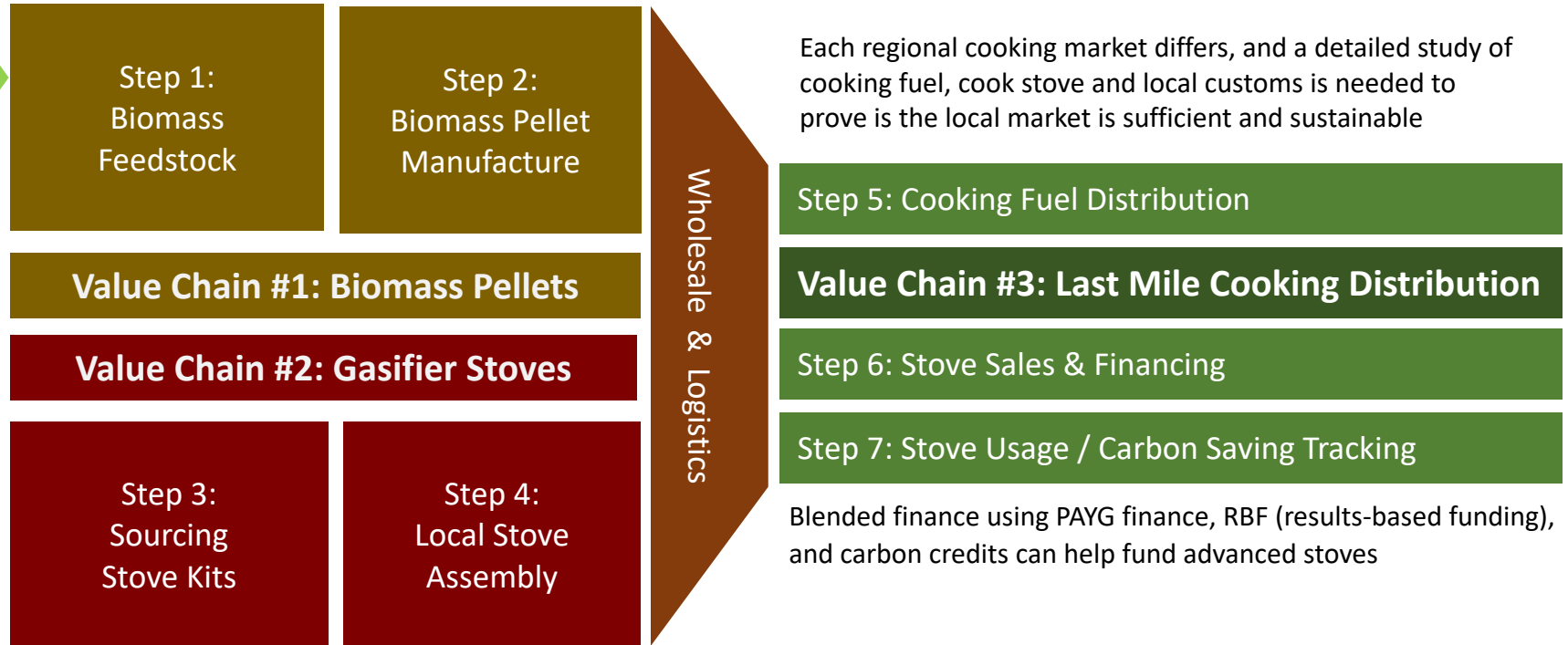


EKASI ENERGY FRANCHISED COOKING FUEL BUSINESS MODEL

We provide a 7-step market development program across 3 different value chains



We follow a **“fuel first”** strategy meaning that without an affordable and available cooking fuel, no viable value chain exists



Local stove assembly is part of our value model

PELLET PLANT: TECHNICAL SUMMARY

The turnkey plant is fully automated. All the installed equipment is locally produced and supported in Africa. It is designed to be operated as close to the biomass waste resource as possible and requires only 100 kWp to run

Pellets as a heating alternative are now used in many European heating applications. The Ekasi Energy solution provides the ability to operate a small pellet plant with the same automation of a large plant without the same investment and/or risk.

• Output and Production Capacity

- Rated Output- 2 pellet mills: 400 kg per hour
- Pellet Size 6-8mm Biomass Pellets
- Moisture < 10%
- Durability 95% Durability
- Input Material: Various Biomass Feedstocks

• Capital Cost ex Factory :

- Cash Price Ex Works (excl VAT) \$100,000
- Estimated Commercial Half Life: 15,000 hours / 6,000 tons
- Maintenance Cost incl Dies < \$15 per ton
- Return on Capital Investment > 30% per Year

• Plant Configuration

- Packaging 12M Shipping Container
- Shipping Weight < 8 tons
- On Delivery Fully assembled and tested

• Power Required:

120 kWh / ton

- Hammer Mill 28 kWh / ton
- Pellet Mill 60 kWh / ton
- Other Automation 32 kWh / ton
- Maximum Draw 100 kWe

Ekasi Energy is a for profit social enterprise, focused on providing efficient, cost effective and environmentally friendly biomass energy solutions in Africa, where energy challenges are present.

Africa has used biomass for centuries, but inefficient combustion technologies have led to overuse and depletion of natural forests. With new technology adapted for the market in Africa, biomass pelleting is one technology that can change the energy market in Africa.

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