Western Cape Government

Business model for Biochar, Activated Carbon & Wood Vinegar ("BAW") from Alien Invasive Plant clearing

Summary of Findings & Technology Selection Criteria

18 March 2021

Document information

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Key trends

In our review of current local and international trends, we have noted the following indications of where the biggest potential lies:

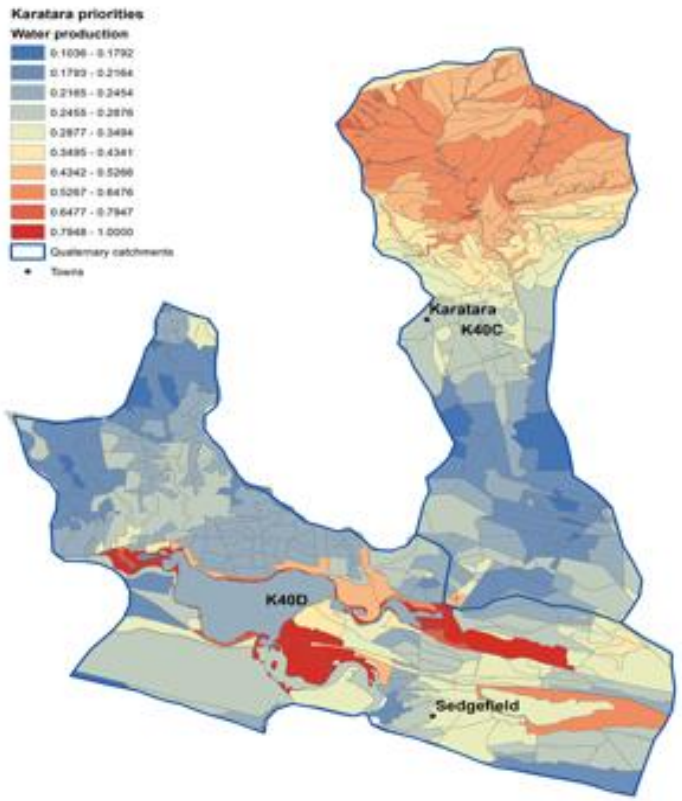
- An industrial symbiosis model is a viable option, implementing a range of initiatives close to Alien Invasive Plants (AIPs), in ways that improve efficiencies
- Collaborative approaches which include private and public landowners
- Hub models and industrial clusters, potentially using a hive-approach
- The identification, training, and support of local entrepreneurs will be key in uplifting and empowering local communities, since these individuals are the ones who enable their communities to grow and thrive.
- SMME integration into value chain together with quality requirements is key.

International and local examples

Value chain approach	Bush Control and Biomass Utilisation Project (Namibia)	Selected value chains were piloted, including the production of animal feed, the modernised production of charcoal and the supply of wood chips for energy use. Evidence of the economic and environmental sustainability of resource utilisation has been provided. Furthermore, a central advisory service for farmers has been set up and business organisations strengthened so that private-sector activities can be meaningfully coordinated. With the support of the project, a national pasture improvement and de-barking strategy was developed as the basis for a future national decommissioning programme. An outcome of particular interest is the concept of Biomass Industrial Park.
Small-scale modular plants	Cool Planet (USA)	Disease infestation from the pine and spruce bark beetles threatens 42 million acres of US forests. Cool Planet is one of the first US companies to offer a reuse for this waste wood. Their business model uses pyrolysis to produce biofuels and biochar from wood, perennial grasses, and corn stover. Cool Planet's business model is based on developing small, modular plants that are "carbon negative" or that achieve a net reduction of greenhouse gases. Louisiana Economic Development reported that the projects will create 72 new jobs with an average annual salary of $59,600, and 422 indirect jobs. The construction phase will create an additional 750 jobs. Earlier, the USDA provided a $9.8 million grant to Colorado State University to work with Cool Planet to convert diseased wood (from the pine bark beetle) into fuel and biochar.
Applications an end-uses of BAW	BioChar Now (USA)	A company that is making biochar from beetle-killed pine trees. The company was incorporated in 2011 with support from the Upstate Colorado Economic Development Corporation and a revolving loan fund. Biochar Now is focused on producing and marketing biochar for specialty uses: used by oil and gas industries to help capture pollutants, to help reduce and treat water pollutants and control odours.
Green jobs in AIP value chain through industrial symbiosis	Howick Eco-furniture factory (SA)	DEFF/NRM/EPWP eco-furniture factories. AIP value chain highlights opportunities for waste beneficiation. The waste biomass from higher-value industries can be beneficiated as wood-pellets, creating additional jobs. The model can also be applied to timber/mill waste beneficiation, offering an exit strategy for once AIP biomass is depleted.
BAW production	New Carbon (SA)	NewCarbon has developed a novel and innovative three-stage thermal pyrolysis-based technology to transform various forms of waste biomass into biochar, activated bio-carbon, wood vinegar, energy and other valuable products. Their technology is designed to be transportable and placed in a 20-50km radius from the biomass source, transporting raw products to regional facilities that process raw products into final packaged products for market distribution.
Water purification	Veolia: BERKEFELD PurBev® Carbon Filter (SA)	Product: An activated carbon filter engineered according to hygienic design guidelines. Used for polishing or de-chlorination of water or condensate in food and beverage production.

Availability of AIP in catchment area

- Management Unit control Plan, CSIR & KM consulted
- Previous fine-scale AIP assessment 2008
- Annual expansion of AIP cover ranges between 6-10%
- Current AIP cover per compartment available through the CSIR MUCP tool (projected densities 2008-2020)
- AIP availability confirmed by AIP advisor and expert
- Data required: Current utilisable biomass for BAW production at compartment level based on growth estimates



AIP availability (cont.)

Western Cape is 129 462 km^2 area and has 42 million dry tonnes invasive biomass, but only 24 million oven dry tonnes accessible at less than 20 degrees slope. The distance to road will reduce available volumes further, but this depends on location of processing or value-adding plant from the biomass. Access to additional biomass beyond these parameters will largely depend on economic value created from value-adding industries.

In the catchment area it is estimated that annual expansion of AIP cover ranges between 6-10% (depending on rainfall & excluding any clearing activities). The catchment has been demarcated into more than 158 compartments during previous density analysis exercises with varying levels of alien infestation and density in each compartment. Density per compartment is visible using the Department of Environment Forestry and Fisheries (DEFF) - Natural Resource Management (NRM) Management Unit Clearing Plan (MUCP) tool. Government public works programme champions (EPWP, Working for Water etc.) estimate that there is AIP stock within the catchment that would require consistent clearing for at least the next 20 years.

AIP availability (cont.)

Forward planning for AIP clearing by Knysna Municipality's Planning and Economic Development directorate indicates that a minimum three- year investment would be required:

- to clear 16 072 ha
- cost of R 9,9 million annually
- create 31 733 person days of work (labour-intensive clearing regime)

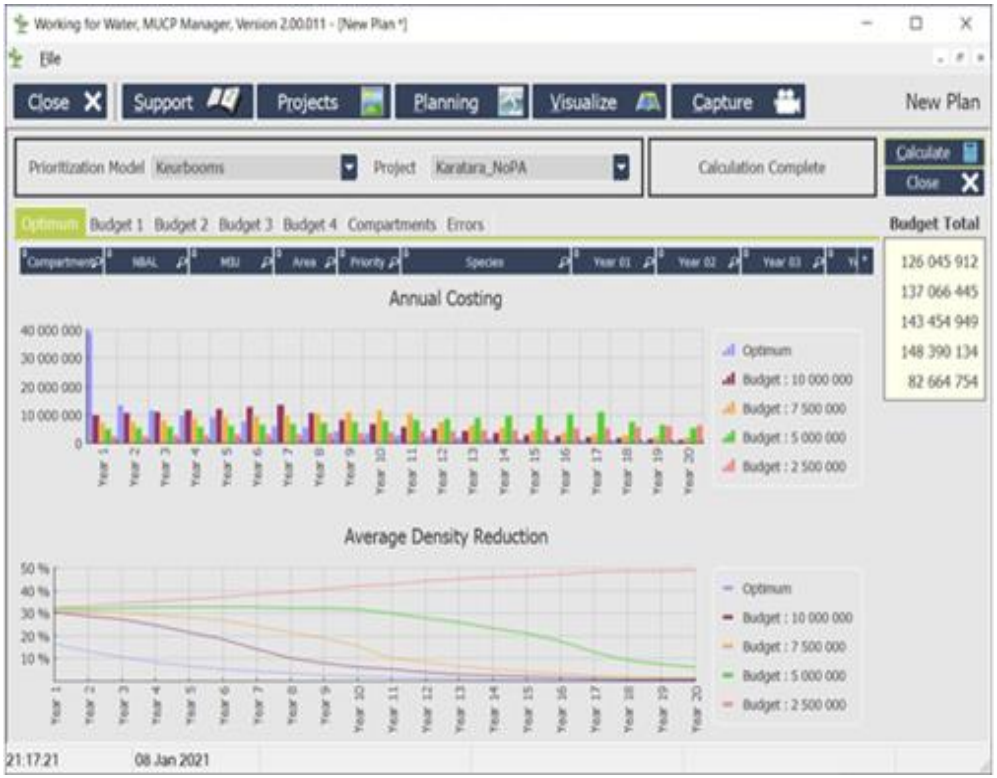
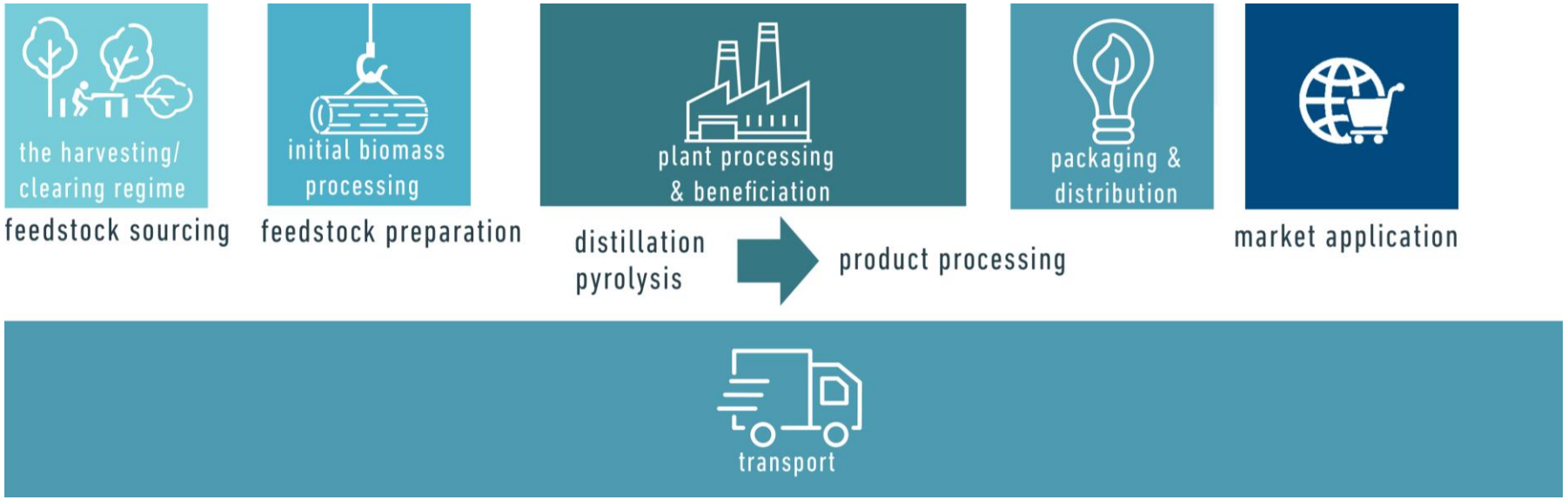


Figure 3 An illustration of clearing all known AIPs on private and public land excluding SANPARKS and CapeNature over a 20-year period. This includes the optimal budget requirement for a consistent density reduction over the 20-year period.

Value Chain: AIP beneficiation



Market opportunities: Biochar

Product	Average local price	Average international price	Use	Detail	Interested parties
Biochar	R13,00-R17,00 /kg	R34,00 /kg	The use of biochar for the treatment of municipal stormwater and wastewater	Sustainable Urban Drainage Systems (Knysna) - a (current) revegetation project which includes tree-clusters for stormwater treatment. The vegetation is being planted on layered substrates: builders rubble, biochar, and compost.	Local, district and metropolitan Municipalities.
			Pasture restoration	Considering the role of **dairy farming in the region** (Karatara Catchment) this procedure may be of interest: It involves feeding biochar to livestock and allowing dung-beetles to distribute and bury the biochar-loaded faeces. This has the dual benefit of soil conditioning as well as increased feed-usage efficiency and weight gain of cattle.	Organisations that have indicated an interest in investigating the benefits of biochar
			With global interest in low-nitrogen fertilisers there is opportunity for biochar and wood vinegar as fertiliser		Organisations that have indicated an interest in investigating the benefits of biochar
			Animal feed	Localised trials have been undertaken with sheep to validate market literature where this form of supplement has been shown to provide improved feed conversion rates and healthier rumen.	The demand for biochar to be utilised in the agricultural sector has been evidenced by direct engagement of local farmers and growing medium suppliers for the purchase of biochar from the technology provider. Engagement has been through site visits and emails substantiated by RFQ's and the subsequent issue of quotations for purchase.

Market opportunities: Wood vinegar

Product	Average local price	Average international price	Use	Detail	Interested parties
Wood vinegar	R 150,00 /ℓ Bulk R 225,00 /ℓ Small	R 359,00 /ℓ	For wood vinegar, agricultural uses have been identified that can be explored to establish a robust local market for wood vinegar.	Pesticide against two species of rice hoppers, cowpea weevil, rice brown plant hopper, armyworm Pesticide against red mites in poultry farming Antifungal/antibacterial agent against seven fungal and three bacterial species Animal feed for weanling pigs	It has been demonstrated through engagement with local seedling growers that there is a local interest and willingness to purchase wood vinegar from the technology provider. Wood vinegar has already been purchased by and supplied to a number of growers in the Western Cape over the last 12-month period. These are relationships which have developed over time and the application and use of our wood vinegar in their operations has resulted in additional orders.
Biochar/ Wood vinegar			Soil enrichment and substrate	Research has indicated that fruit yield was increased with co-application of both biochar and wood vinegar and nutritional quality had been improved (e.g., increased vitamin C and decreased titratable acidity)	Potential interest from berry producers

Market opportunities: Activated Carbon

Product	Average local price	Average international price	Use	Detail	Interested parties
Activated Carbon	R24,00-R33,00 /kg	R 37,00 /kg	Water filtration and purification	Activated carbon is currently the most widely used example of purification substrate that incorporates nanoscale features and tailorable chemical properties. It is often applied for POU devices, with many commercial systems utilising this material for home applications.	Local, district and metropolitan Municipalities.
			Agri-processing	Current uptake of wastewater treatment in the sector is relatively limited. However, internationally, food and beverage companies are increasingly seeing the benefits of creating value from wastewater. This is largely driven by a growing pressure to meet or exceed environmental standards, tightening wastewater regulations, increasing water stress and the risk of brand damage if local communities are affected by their wastewater.	
			Mining sector	Adsorption for mining sludge treatment	
			other uses	Cosmetics Health Wine fining Food and beverage	

SMMEs and sustainable job creation

To ensure positive economic development and impact to the Karatara area, active inclusion of SMMEs in the business model is essential.

- The identification, training, support of these local entrepreneurs will be key in being able to uplift and empower.
- Preference to impact-driven small businesses that can play a myriad of roles in the supply chain
- Supported through supplier development programs and with green procurement policies.
- Capacity building plan for the BAW sector implemented as an incubation model
- The Knysna Municipality has run an incubator programme over the last decade that could ideally support this incubation approach. The Knysna Municipality LED department, SEDA, CASIDRA and other partners already have the basic SMME incubation proposition and curriculum in place. Corporate partners (Nedbank, SAB etc.) can also fund specific, customised "biomasspreneur" incubation.

Estimating the number of potential job opportunities depends on the quantum of utilisable biomass and production capacity of processing and manufacturing. The estimated utilisable biomass in the Karatara catchment over a 3-year cycle is used as a baseline for purposes of the business case.

The future job creation potential will also depend on the skill needs analysis for the pilot project, such as required engineering and technical skills to manufacture the final product (and quality management) as well as that needed in harvesting and processing.

Job creation potential

Value Chain Component	Clearing Operation	Harvesting and transport to roadside	Logistics/Transport (*At all intersects)	Manufacturing & Packaging	Marketing & Business Services
Job Creation Potential					
Stakeholder/ Employer/ Business Type	Knysna Municipality SANParks Cape Nature Private Landowners DFFE	Private forestry transport companies	Transport & logistics companies (freight forwarding etc.); Forestry primary processing contractors	Technology owners/BAW manufacturers	BAW producers Marketing and sales agents
Direct Job opportunities	Chainsaw operator Herbicide applicator General worker (Health and safety reps; first aid) Team supervisor/ contractor Driver	Truck drivers (truck with crane); Bell operators; tractor drivers.	Truck drivers, chipper/mulcher operators. Transport of raw biomass to processing site or primary processing at roadside and then transport to 2ndary processing site. Small contractors with chippers and/or larger contractors with conveyor belt mulchers.	Engineers Mechanics (specify) Electricians (specify) General workers (Manufacturing, packaging, labelling)	Professional business services in relation to product marketing, sales and distribution.
Indirect benefits to local SMME's	PPE suppliers; Tools, machinery, and equipment suppliers; chainsaw maintenance, servicing, and repairs; Vehicle rental; Consumables – parts, spares, fuel, oil etc	Vehicle and machine maintenance, repairs, consumables etc	Vehicle and machine/plant maintenance, repairs, and consumables.	Input suppliers (components for technology); Service and maintenance. Product branding & packaging specialists.	Business support services

Business model

Business model canvas

<table>
<tr>
<td rowspan="2">Key IAP partners
DEADP
DoA
DEDAT
SANPARKS
CAPENATURE
Local municipalities
Landowners
DEFF Natural Resource Management programme</td>
<td>Key activities
Manufacturing BAW;
Technology manufacturing
Maintenance;
Training and skills development;</td>
<td rowspan="2">Value propositions
Support eradication of AIP by production of high value, in-demand beneficiated products.
Support for local economic growth while ensuring water security.

Creation of entrepreneurial opportunities for local communities.</td>
<td>Customer relationships
Transactional in the case of tenders;
Close relationship (engagement-driven) for sector development</td>
<td rowspan="2">Customer segments
Municipalities (water treatment)
farmers (agriculture)
Producers of value add products (various industries);
Resellers (various industries);</td>
</tr>
<tr>
<td>Key resources
Access to biomass (AIP)
Stratified types of biomass (wattle, pine, etc) - has impact on product quality
Skilled engineers/ key personnel</td>
<td>Channels
Government procurement sector-specific solutions for high-profile identified customers, including producers (early adopters):
Bulk resellers (commodity products);</td>
</tr>
<tr>
<td colspan="3">Cost structure
Cost of biomass harvesting and transport
Operations (logistics, transport)
Partners
Distributors</td>
<td colspan="2">Revenue streams
Direct sales, including wholesale sales to secondary industries
Technology sales / licencing / POD sales
Support and maintenance
Training and skills development</td>
</tr>
</table>

Cost and funding models

Payment for ecosystem services	**Water tariffs - AIP clearing water charge** In the best case, the cost of clearing provides a minimum water charge which is equivalent to R1,00 /kl. According to the Business Case for PES (2018) the estimated potential value of additional water to be between R25,1 and R307,3 million per year.	**Disaster regulation - Fire risk premium.** It is envisioned that the removal of AIPs will mitigate the fire risk in the area and thus reduce insurance risk premiums. The feasibility of this depends on cooperation amongst landowners as well as between landowners and a collective of insurers.	
Carbon Markets	**Carbon Tax** Biochar complexities: large-scale manufacture will be subject to carbon tax while the utilisation of biochar is known to reduce CO2e emitted to atmosphere from agricultural soils. The Carbon Tax Act makes no provision for trading tax liabilities for mitigation measures.	**Carbon offset** Investigate the carbon financing opportunities for pilot project implementation plan.	**Carbon Credits** Dual source of income/investment in BAW. Notably VER market. It is estimated that, in terms of the existing VCS soil carbon methodology, a carbon credit is worth approximately R350 per ton biochar or activated carbon applied and BAW project certification and issuing of credits will be done in accordance with the biochar methodology currently being developed by the VCS which is expected to be completed by September 2021. The steps for eligibility and compliance requirements are outlined in the business model report (Promethium Carbon).

Technology review: selection criteria

- Proximity to catchment area / sustainability of biomass supply / cost reduction – mitigation of logistics and transport costs, and lowering carbon footprint – compliance with NEMBA
- Implementation of and compliance to Health, Safety, Quality, Environmental Standards and applicable legislation - NEMA / ISO 9001 / 14001 / etc
- Ability to sustainability produce consistent engineered BAW products conforming to quality standards and volume requirements of the specific target markets
- Minimum economical viable production volumes based on BAW
- Ability to process and produce products within a specified quality range from various targeted AIPs, with redundancy / flexibility to augment during supply interruptions
- Potential to scale up operations to meet demand. Modular and phased systems
- A robust business model that enable, incorporate, empower, and support SMME stakeholders to successfully participate in the value chain

Considerations beyond technology

The value of an integrated value chain assessment

1. **Holistic approach or integrated value chain**
   a. Decentralised, localised model directly benefiting catchment area i.t.o job creation and water security.
   b. Targeted end markets for high value BAW products will drive economic viability of AIP clearing. Market driven approach.
2. **Resource intensity**
   a. Security and volume of supply; access to AIPs crucial to underpin success of pilot project in proving the case for a profitable sustainable model.
   b. Energy and other resource requirements
3. **Environmental requirements - which actions will trigger NEMA**
   a. Volume of biochar production; Technology-specific requirements.
   b. Location specific.
   c. Legislative triggers to be compiled with the Knysna Municipality's input.
4. **Emissions**
   a. This is specific to technology selected and scale of production.
5. **Carbon economies**
   a. Carbon finance opportunities

Available technologies

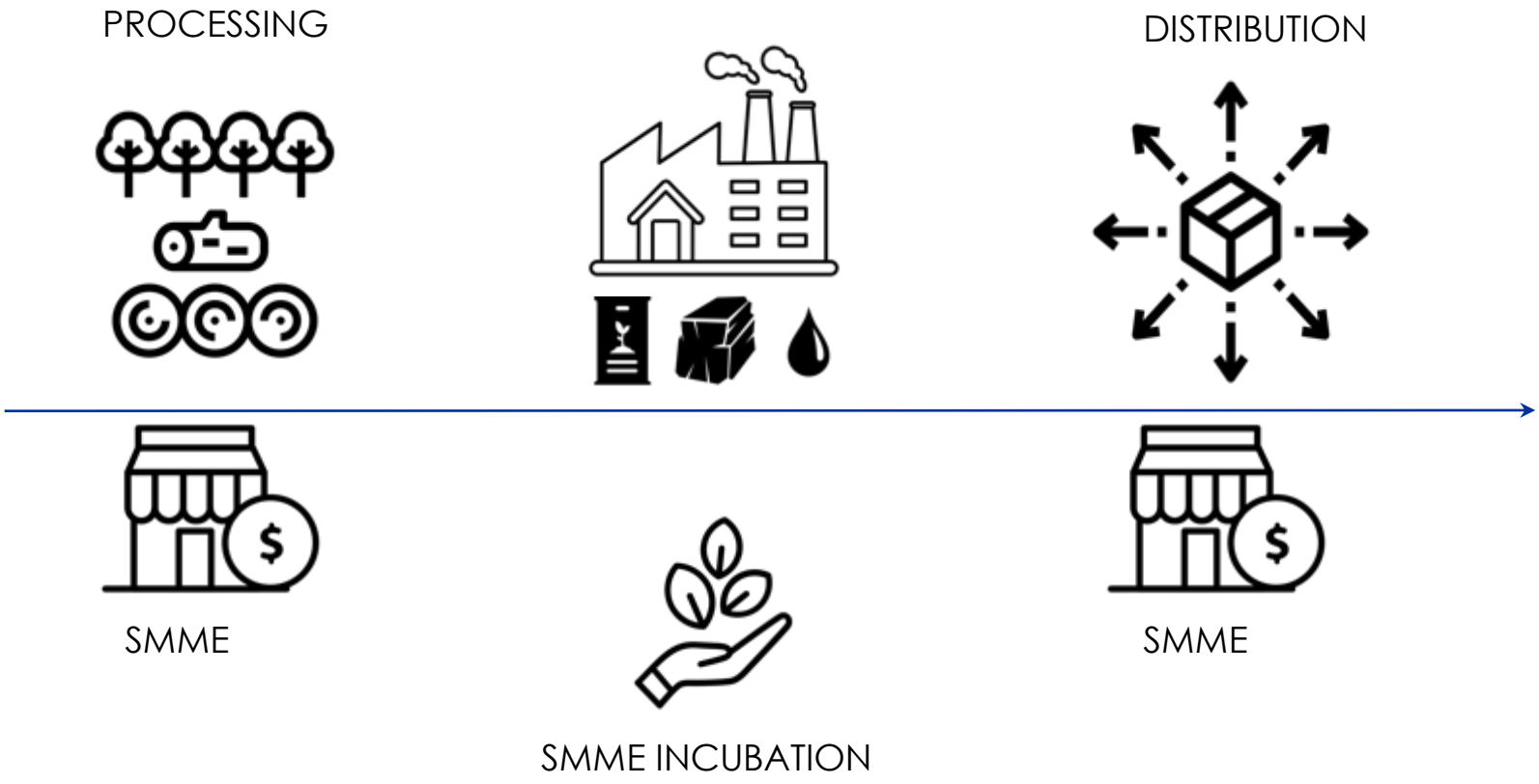
Biomass Pellet Production	Wood Gasification	Batch Type Retort / Kiln	Carbonising. Activation	Carbonisations, Activation, gasification, distillation

Available technologies

	Biomass Pellet Production	Wood Gasification	Batch Type Retort / Kiln	Carbonising. Activation	Carbonisations, Activation, gasification, distillation
Plant Components					
- Carboniser	No	Yes	Yes	Yes	Yes
- Gasification	No	Yes	No Info	Yes	Yes
- Distillation	No	No	No	No	Yes
- Fixed Plant	Fixed	Mobile	Mobile	Fixed	Fixed
Product Produced					
- Biochar	No	Yes	Yes	No	Yes
- Activated Carbon	No	No	Yes	Yes	Yes
- Wood Vinegar	No	No	No	No	Yes
Raw Biomass Need in tonnes per month	No Info	87	12-20	1000-2000	350-700
Potential to scale up - Modular and phased	No Info	No Info	Yes	Yes	Yes
Proximity to catchment area (20-50 km Radius)	No	Yes	Yes	No	Yes
Ability to work across multiple biomass feedstock types	No Info	No Info	Yes	No Info	Yes
Carbon Status	No Info	Neutral	Neutral	Neutral / Negative	Neutral / Negative

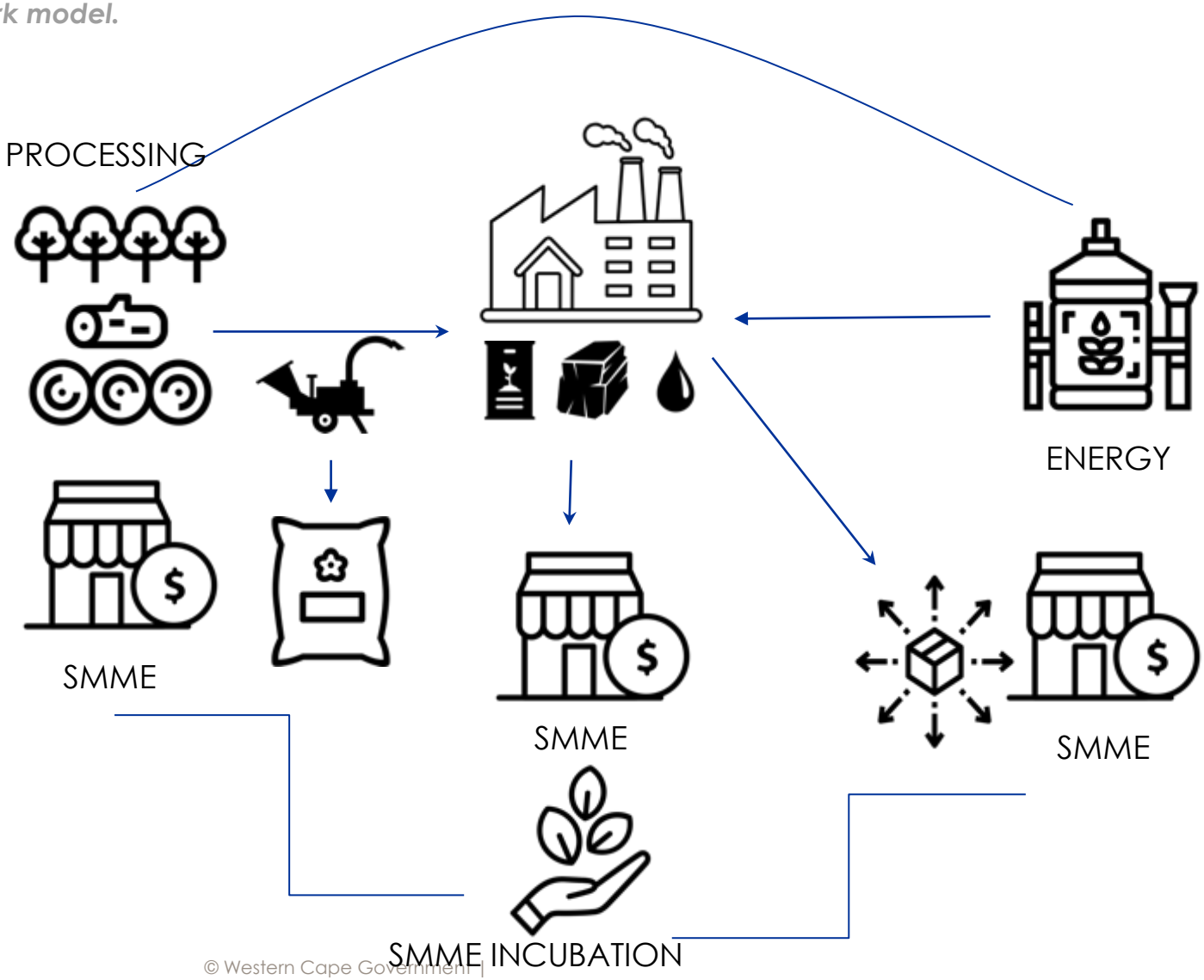
Scenario 1

Single technology, producing BAW, where the technology owner takes responsibility for the entire value chain from primary processing to packaging and distribution, including producing all three identified products in the scope of this project.



Scenario 2

The pilot project could be used to trial out various scales of technologies, creating a cooperative biomass eco-industrial park model.



Thank you

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