MAGNUM GROUP INTERNATIONAL INC.

BUSINESS PLAN

December 2023

This Business Plan contains conservative financial projections assembled by the Management of the Company based on current information and market conditions available to Management at this time. Actual operating results may differ from those delineated within this Business Plan.

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1. Executive Summary

1.1 Vision Statement

Magnum Group International Inc. ("Magnum", the "Company") is an extraordinary success story, both as an economic entity and as a corporate citizen. It is seen as the industry leader and innovator in the vast untapped field of waste stream remediation. Magnum is a world class producer of high quality by-products from processing organic wastes.

1.2 Competitive Advantage

Magnum Group International Inc. has several sustainable competitive advantages:

- **Unique Patent Pending Technology**: Our Advanced Thermolysis System ("ATS") Technology is now into its fifth generation.
- **Safety:** The ATS System incorporates the latest in safety systems.
- **Quality Products:** The ATS System is designed to produce high quality products: biochar, activated carbon, fuel oil, carbon black and bio-oil.
- **Environmental:** The ATS System meets all current international environmental standards.
- **Innovative Business Model**: The joint-venture approach (in North America) that we employ provides affordability to investors, ensures proper operation of the plants, and allows for more effective marketing and continued fair pricing for our by-products.
- **Pricing**: Other pyrolysis systems are minimally three to four times the cost of our ATS systems.
- **Secured Waste Streams**: Our pricing advantage will result in timely securing of waste stream producing partners. This relationship with the waste stream producers will effectively lock out future competitors.
- **Access to financial markets**: Magnum has access to international financial markets through its partners. Competitors don't typically have this access.
- **Return on Investment** : The normal ROI on investments in our ATS systems is anticipated to be about 3 years.

1.3 Target market and Size

Magnum's target market is twofold. The first market being the input target market consisting of Joint Ventures ("JV") with waste stream providers. These are companies that require a solution for their waste streams. The second market being the market for industrial products that form the output of the patented technology.

Wood fibre from sustainable Canadian forestry enterprises are the feedstock for the plant near Hope, British Columbia ("BC"), operated by Magnum's Canadian Licensee, Emergent Waste Solutions Inc. While the plant can easily be adapted to run any other carbon-based material, it is anticipated that wood fibre will be readily available for the foreseeable future.

The markets into which Magnum will be providing JV Partnership opportunities will be primarily in North America in the first phase are summarized in **Table 1** below. The figures shown represent the total market size and are conservative. For both the recycled plastic and the waste wood biomass, the most recent figures available are several years old, with both on an uptrend over the past number of years. The reader will note that this table does not yet include the immense future volume of processing municipal solid waste or sewage sludge.

Table 1 - Market Size

Feedstock	Number of Potential Plants	Market Size of Potential JV Partnerships (1,000s)
Livestock Manure	644	$8,993,460
Pulp Mills	114	$1,592,010
Used Rubber Tires	23	$320,980
Recycled Plastic	110	$1,536,150
Municipal Solid Waste	784	$10,948,268
Municipal Sewage Sludge	143	$1,997,418
Waste Wood Biomass	1,734	$24,215,310
Total	**3,552**	**$49,603,596**

The 7 areas identified in **Table 1** are seen as providing the best potential starting points for homogenous feedstocks. As can clearly be seen, the size of the potential market for joint ventures is huge, even with these conservative estimates. In subsequent years the company will look to specialized feedstocks to solve specific industry problems. An example of this is the waste produced by the tomato ketchup manufacturing process where 8,446 tonnes are produced from just one greenhouse operation in Ontario. This is enough to fully feed an ATS500 system.

The second important market for the Company is the sales of by-products manufactured by the JV plants. These outputs are industrial products for which world markets already exist. A description of the markets for the by-products follows:

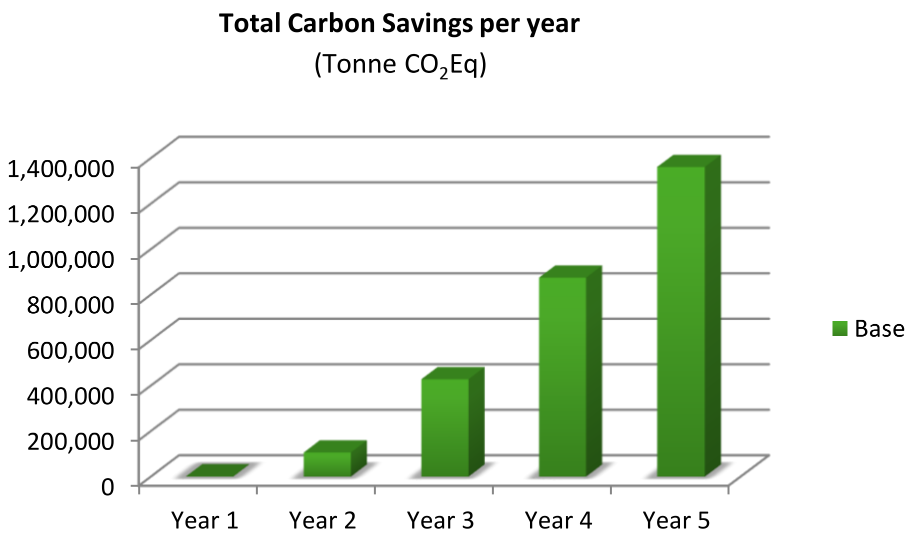
Table 2 – Manufactured By-Products

Market	Size	Description
Syngas	Immediate area only can be serviced	Syngas can be used on site to power generators and dryers, and in nearby buildings for heating. Delivery offsite is generally not practical.
Liquid Fuel Products	Global Market in 2015 was *93.82 million barrels daily *Short-Term Energy Outlook	What is produced is bunker grade and would need additional refining to make it diesel quality. CAGR is approx. 7.1%.
Carbon Black	Approx. 8.1 Million metric tons	Carbon black is primarily used as reinforcement in vulcanized rubber goods, with two-thirds of the carbon black supply used in tires.
Biochar	A new Transparency Market Research report states that the global biochar market revenue stood at US$229.3 million in 2013 and is predicted to reach US$572.3 million by 2020, expanding at a 14.8% CAGR between 2013 and 2020. Additionally, global commercial biochar production is projected to rise from 100 kilo tons to 300 kilo tons in the same timeframe, expanding at a 20.1% CAGR. The title of the report is "**Global Biochar Market - Industry Analysis, Market Size, Share, Growth, Trends and Forecast 2014 - 2020**".	Biochar is the carbon rich product produced by thermal decomposition of organic material such as wood, manure or leaves. It is produced under limited supply of oxygen at relatively low temperatures (<700°C). It should be noted that estimates of biochar growth do not factor in the new uses that are being discovered on a regular basis. There are currently 53 uses of biochar and most of these are not factored into these forecasts.
Essential Oils	Market size is difficult to obtain, but approx. 2,600 tonnes of cedar wood essential oil were produced in the 1990s	Produced from waste bark and needles from the forest industry, these oils are expensive, retailing for $3-$9/ounce, or $135,000 per ton.

1.4 Financing and Return on Investment

Magnum is focused on the triple bottom line. Not only are we interested in the important aspect of financial return on investment, the Company is also interested in environmental sustainability and community well being. There are many ways to measure sustainability. For Magnum we are focusing on re-using materials considered waste and displacing the use of fossil fuels. Greenhouse gas savings (Carbon Dioxide) are therefore considered an important part of the return on investment.

The total CO_2 savings per year of the base case scenario is provided in the graph on the next page.



1.5 Future Product/Market Development

Magnum sees a number of directions for future growth:

1. Through incorporating an increasing range of specialty feedstock. For example, coal & pet-coke will be examined and experimented with. If either of these two products shows viability, it will represent a massive amount of feedstock. With global climate change being at the centre of attention, the coal industry in particular will be facing massive changes; our technology could provide a means of extending the coal industry while reducing greenhouse gasses from its use by up to 40%.

2. By adding technological innovations to perfect the production of essential oils from wood sources.

3. In building centrally located activated carbon acid washing facilities to enhance the resale value of the activated carbon. This could result in a fourfold increase in the sales revenue of activated carbon.

4. By experimenting with pre-treating feedstocks to enhance the value of the products produced. An example of this is the use of a zinc/chlorine wash to treat the cow manure prior to processing. In lab tests this has been shown to significantly improve the quality & value of the activated carbon produced.

5. By researching new uses for Biochar and creating a strategy for optimizing the value of the product as it is introduced into new markets.

6. Through expanding the uses of Carbon Black in its various forms. Innovative new applications and uses that can create new demands for our products.

7. Through the developing regulatory environment regarding carbon emissions in the US, Canada and Internationally. These regulations include Cap and Trade mechanisms as well as sustainability reporting requirements. An example is the Western Climate Initiative in Canada, with members like BC, Manitoba, Ontario and Quebec. These regulations are still being developed and there are still quite a few items to be worked out. A service sector is expected to develop which will assist corporations and other organizations in adhering to these new regulations. Magnum can look to provide this service at a later date.

8. By heavily marketing the positive impact the ATS Technology will have on global climate change. By keeping upwards of 35% of the feedstock in a solid carbon form, the ATS Technology locks in the greenhouse gasses that would otherwise be released into the atmosphere. Particularly in light of the commitments made at the Climate Change conference in Paris in 2015, we believe our Technology has a compelling case to be made.

9. By strategic partnering with other technology companies. Discussions have been held with First American Scientific and with AquaGeneering Systems. These two significant parties have complementary equipment for pre-processing feedstock by breaking down the particulate matter and by extracting water. Each of them has their own contacts and markets that could often require the use of an ATS plant.

2. The Need and the Solution

2.1 The Need

Waste is a big issue in modern society. Although there is recycling of glass, metal and other products, in North America by far most of the waste is land filled and consists for the most part of organic waste[1] (see Figure 1 below). Thousands of landfills exist internationally. Most communities consider them an eyesore and a source of considerable pollution which threatens the air and ground water, not to mention birds, rats, and attendant vector problems which can spread disease. This waste grows exponentially and is a major concern to humanity.

Besides Municipal Solid Waste (MSW) there are many other organic waste streams that are leading to problems. The plastic waste polluting the oceans, excess animal manure being spread over the land, heaps of old rubber tires that no one knows what to do with.

The present reality is that landfills are not the answer to the disposal of Waste that faces mankind. The social costs cannot be understated and the damage to public health and to the environment is of paramount concern to all.

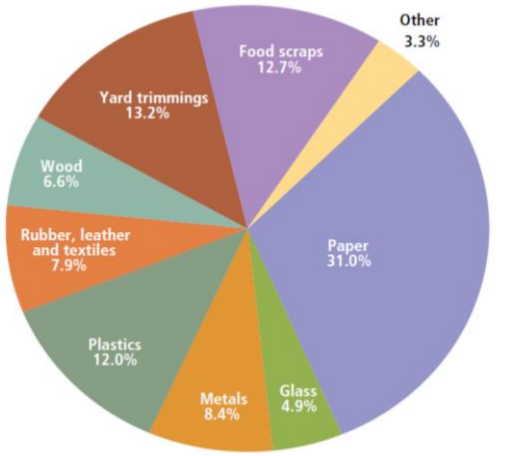


Figure 1 More than 83% of MSW is organic in nature

Table 3 - Decomposition Rates

DECOMPOSITION RATES OF TYPICAL LANDFILL REFUSE	
Paper	2 weeks to 6 months
Rope	3 to 4 months
Cotton Material	1 to 5 months
Metal	More than 100 years
Tin Cans	From 100 to 500 years
Nylon	More than 30 years
Plastics	450 years
Glass	Indeterminate
Used Tires	Indeterminate

One of the answers to the waste problems is conversion, by advanced Thermolysis-gasification, of waste to marketable by products, such as the system manufactured by our Company. This is accomplished by eliminating all the adverse consequences associated with methods currently used to dispose of Municipal Solid Waste (MSW) and other organic waste streams, and instead utilize the ATS Advanced Thermolysis-Gasification Technology which converts the waste and wasted BTUs into valuable marketable by-products. These by-products are then sold to industry, thereby conserving the world's limited resources and creating an unlimited supply of renewable resources, while at the same time, eliminating adverse environmental problems.

Current ways of dealing with waste streams like landfills are an expensive long-term source of maintenance and operational headaches and are difficult and costly to develop and maintain. In most cases, providing landfill sites is the responsibility of the local government. Once the environmental impact study is completed, permits must be obtained from the local, state and federal governments. The cost of developing a landfill site varies according to location, application fees and engineering cost. The cost of landfills in the USA will run approximately $500,000 to

[1] Figure taken from USA EPA department report EPA-530-F-009-021, November 2009.

$1 million for the application and design engineering cost alone, and that does not include the construction of the landfill liner. The liner costs approximately $75,000 per acre. Generally, the money is raised from taxes or municipal bonds.
For instance, if the Company's ATS System is installed on a landfill site, eventually the amount of MSW could be eliminated, thus allowing Reclamation of the site - a win-win solution for all concerned.

The Company's affiliated manufacturing companies offer the ATS plant as a low cost, efficient, modular alternative to inefficient working Pyrolysis systems whose capital costs range from US$35 to US$100 Million and higher, or gasification systems which range between US$40 Million to US$500 Million without the benefits of the ATS Technology[2]. The low-cost alternative makes it possible for smaller municipal centres having populations of up to 25,000 people and companies dealing with organic waste streams to finance a profit making ATS plant for approx. US$15 Million, a cost significantly less than locating and developing a landfill site. The Company seeks to aggressively promote its leading edge patent pending ATS System Technology which can take advantage of the movement away from costly large-scale waste operations and the NIMBY, or "Not In My Back Yard" concerns of the public, associated with such operations.

The combination of waste reduction and conversion into marketable by-products is the most economical and profitable application of waste to energy conversion systems available. When considering the reduction of vector problems associated with land filling and the potential income from the sale of marketable by-products, the ATS System is a superior economical and environmental Win-Win business proposal.

2.2 The Solution

<u>ATS Technology Overview</u>

ATS Technology utilizes the principle of Medium speed Thermolysis; the process of using super heated steam to break down and decompose complex organic substances to produce high quality by-products.

The ATS Technology is the most advanced waste management system in the world which will convert all organic wastes to valuable by-products such as biochar, bio-oil, carbon black, activated carbon, and fertilizer, fuel, etc. while producing no measurable pollution at all.

The ATS Technology also reduces CO_2 emissions as it does not burn waste. It combines thermal Thermolysis, steam Thermolysis, fast Thermolysis, and a second stage gasification process into one system incorporating the best attributes of each of the above systems.

Although there are other competitive systems operating or in the process of development, the Management of Magnum is unaware of any other waste system incorporating all of the above including the use and method of producing super heated steam to act as a heating and penetration agent into the feedstock material, and as well, creating a method of incorporating the process to produce activated carbon. When compared to all other systems, the ATS System is the most efficient system available today in the world. The unique technology in combining super heated steam and radial heat creates the most efficient method of converting organic wastes to valuable by-products.

[2] For example, in the UK Pyreco is constructing a tire processing plant that costs ~US$130 million, although four times as large, it is more than eight times as expensive as the ATS plant. http://www.pyreco.com/articles/press/04_10_10.php

The **highlights** of the ATS system are:

- The ATS system is a leading edge, safe and efficient Thermolysis system.
- The ATS system is a continuous system requiring no additional fuel once the system commences operation.
- The ATS system achieves a 30% energy saving over any other waste systems.
- The ATS system produces a far superior quality of by-products than any Pyrolytic systems.
- The ATS system is a continuous Pyrolytic system, having a high production rate.
- The ATS system is a unique multi-purpose Pyrolytic system.
- The ATS system incorporates a unique three stage process in one system thereby eliminating production of hazardous products.

The ATS Technology with its technological advancements is **significantly superior to any other waste systems,** as shown by the following:

- A reactor housing design which maximizes heated air flow and efficiency of heat transfer to the tubular reactors.
- A method of separating steam from the fuel oil during condensation thereby producing steam free of soot and eliminating the problem of tar build-up in the condensers and piping system.
- A method of creating steam free of organic particulates, thereby eliminating the problem of a repetitive build of organic soot which enables the reusing of steam by the boiler.
- A method whereby the time is extended for removal of volatiles from the residual carbon black produced from the pyrolyzing of the feed stock materials by adding a 3rd tubular reactor in the reactor chamber, thereby increasing the purity of the carbon black from 95% to 99%
- A method of increasing the flash point temperature of the fuel oil from 40˚C to not less than 75˚C by incorporating the use of a Venturi condenser, thereby enhancing the merchantability of the fuel oil and providing a sufficient quantity of residual off-gas for heating purposes.
- A method for cleaning the fuel oil by incorporating a Laval separator which separates the combustible light liquid fuel oil fractions (highly desired by the market) from the heavy fuel oil fractions. The heavy oil fractions (approx.2-3%) remain and are added to feedstock material and reprocessed through the system.
- A method providing for a vortex pre-mixing chamber for the off gas burning furnace, with a special oil burner for starting and lighting the fuel gas during the operation mode of the ATS system.
- A method of ensuring that at least 30% of superheated steam by weight in relation to the weight of the feedstock material is injected into the Thermolysis tubular reactors, thereby causing a more thorough Thermolysis of the feedstock material while reducing the possibility of outside air entering into the reactor tubes.
- A method using hinged dual flap air lock gates instead of dual blade gates, thereby eliminating a particulate build-up in the sliding gate blades and eliminating the risk of outside air entering into the tubular reactors.
- A method of extracting outside air from the first loading hopper bin prior to the feedstock material being pyrolyzed, thereby eliminating air from entering into the first tubular reactor and assisting in eliminating odours during the Thermolysis operations.
- A method of connecting an emergency nitrogen fire suppression system to the reactor to extinguish any fires in the reactor chamber.
- A method of dispersing explosive pyro-gas safely in the event of a shut down due to a power failure.
- A method for providing access to the piping system for the purpose of removing any build-up of soot.
- A method whereby the auger system contained in the tubular reactors incorporates one or more blending zones, enabling a more thorough penetration of the superheated steam into the feedstock materials

Traditional Pyrolysis technology is a one stage process. It is designed and engineered to handle only one kind of uniform organic material during the same process. Also, it has to change the thermal condition to match the uniform organic material, or it cannot completely crack or decompose the organic matter leaving a carbon residue containing an organic composition. As a result, these by-products are not marketable to industry and the reason most Pyrolysis systems are only used on materials such as used tires, rubber, and plastics.

For application in the waste management field, where there is a variety of waste feedstock materials, a one stage process cannot adequately process the waste feedstock. Most waste in the waste management field is a mixed waste of un-predictable composition. To deal with waste material such as used tires, manure, waste plastics and MSW, etc., the state of the art ATS System incorporates a three stage Thermolysis Technology, although with some feedstocks such as MSW and used tires, pre-sorting and pre-processing may be required to remove the non-organic components and further milling may be required to create a proper and homogeneous particle size prior to processing.

1. The first stage acts as a Thermolysis mode. It converts most of the organic composition to fuel at the critical cracking stage. The most important function in this stage is to obtain the greatest amount of fuel oil, depending on what the feedstock is. The temperature in the first stage is under 450C.
2. The second stage is gasification deep Thermolysis; carbon activated, and fuel gas synthesis system. The purpose of the second stage is to completely de-compose the organic compounds. The processing temperature in the second stage is adjustable between 450C ~ 550C.
3. The third stage completes the breakdown to create a pure and superior form of carbon by-product, operating at a temperature range of 550C-650C.

With the three-stage Technology, the ATS system can deal with different types of organic wastes, whereas other pyrolysis systems just cannot. Table 4 provides the range of applications of the ATS system:

Table 4 - Waste Streams

Used tires or waste rubber	Organic sludge	Animal Manure
Waste plastic PP, PE, HDPE, PVC	Coal and oil waste	MSW*
Agricultural waste/ biomass	Wood biomass	Other organic waste

The ATS system is not only an energy converting system but also a leading-edge waste management system and can be used in waste applications such as, recovery of landfills, removal of oil and coal waste, address animal manure problems and retreatment of activated carbon. It can be applied by industries to produce carbon black and fuel oil. This advanced Technology is also able to reduce CO2 emissions when treating waste and is the best solution to replace incineration while at the same time maximizing revenues.

The ATS System is a modular system allowing for a significant reduction in manufacturing lead time. The development of the contemplated assembly facilities could reduce manufacturing time from the current 8 months to between 3-5 months or less. The ATS System is designed to be environmentally friendly with no measurable pollution. Operational noise levels are below 80 db.

The ATS System offers an attractive Rate of Return on Investment (ROI) estimated to be about 3 years from the sale of high quality by-products. Conservative wholesale selling prices for processed carbon range between $600 and $2,600 per metric tonne for biochar (with 53 different market applications), to $1,850 to $2,500 per metric tonne for N220 carbon black and $2,700 - $10,000 for activated carbon. Specialty activated carbon, depending on the quality, can sell for as much as US$5,000 to US$10,000 /MT. See Appendix E for current pricing of some of the major products. The ATS System has a carbon purification component designed to increase the quality of processed carbon from that of biochar to a high quality by-product, like 'N' Grade Carbon Black and activated carbon.

2.2.1 Plant Construction

A typical ATS plant layout and components are described below. Each of the components is readily available from a variety of manufacturers and will be outsourced by the Company as required for each specific situation. The Company's engineering team will be responsible for assembling the core and ancillary components at the Plant site, testing the System to ensure it meets the performance specifications of the Unit and training the local staff in the operation of the equipment. Currently, the lead time will be approximately 8 months for the manufacture and assembly of each plant. The Company intends to shorten this lead time to less than 5 months by creating a permanent assembly facility and streamlining the manufacturing process. Additionally, when the company is able to meet initial demand, ATS systems can be built ahead, allowing quick commissioning of plants in the future.

While the initial ATS plants have been constructed in Europe, the Company is currently in discussions with an ISO certified major Canadian manufacturing firm. All staff, consultants and subcontractors will be required to sign Non-Disclosure Agreements. The Company is also in negotiations to have the ATS System manufactured in China and India to serve the markets in the developing countries.

Figure 2 and Figure 3 below provides an overview of a working ATS plant, which includes several parts to handle waste streams. In the pictures below each item is identified.

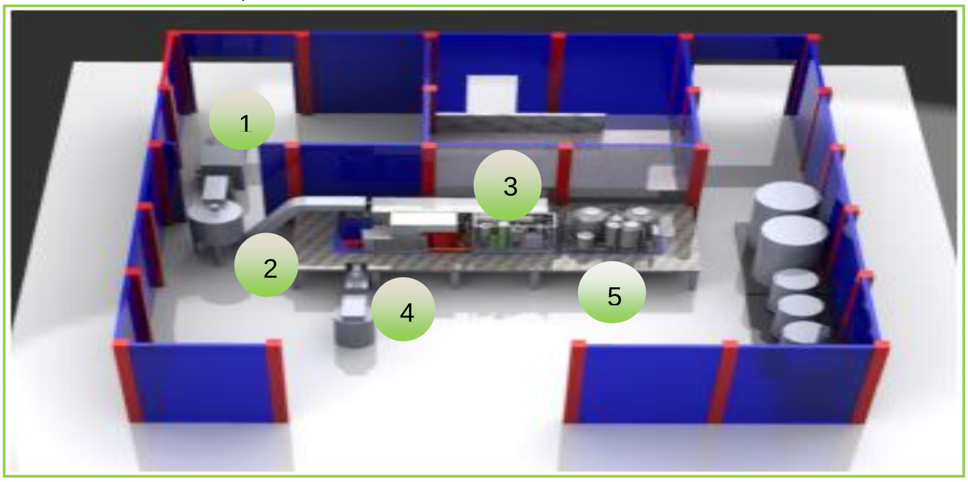
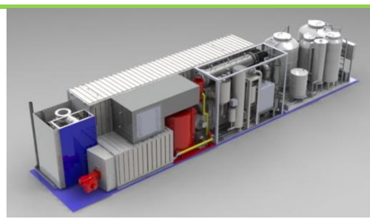


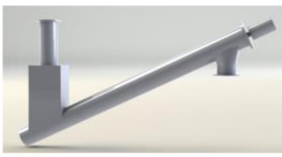
Figure 2 The ATS plant and its components

1. Shredder

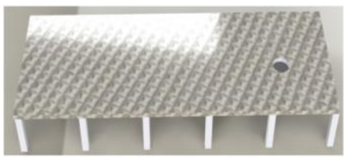
2. Loading Machine



3. ATS Conversion Unit



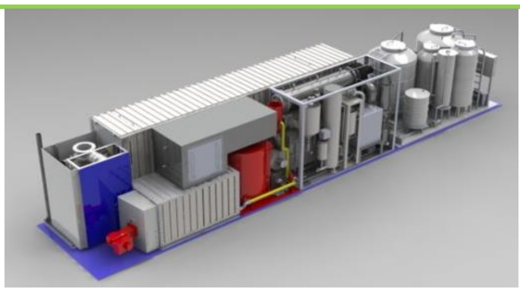
4. Unloading Machine



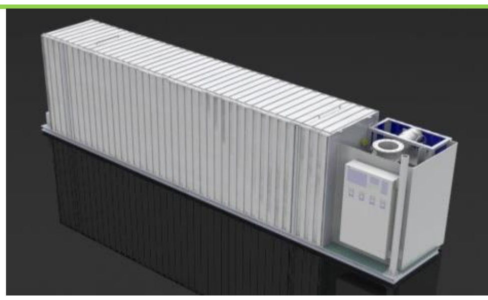
5. Platform

Figure 3 ATS Plant elements

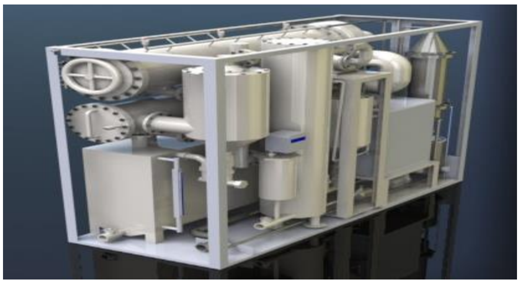
The ATS Conversion Units consists of the components depicted in Figure 4. The control system (not depicted) will be manufactured by our technical and engineering team.



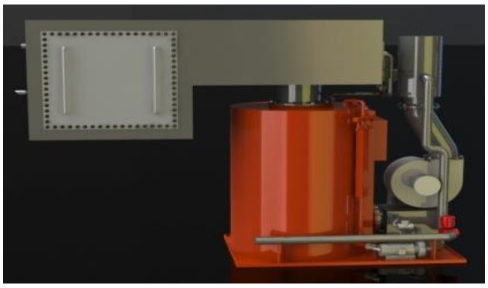
ATS Conversion Unit



Reactor



Oil & Gas Treatment



Heat Exchanger

Furnace

Oil & Water Treatment

Figure 4 ATS Conversion Unit components

2.2.1.1 Product Solutions

The ATS Technology is very versatile and the Company can and will provide different solutions to meet the market needs. There will be three models that will be able to service most of the market demands:

ATS500 – the smallest model that is economically viable. This model will be able to process around 500kg of waste an hour.
ATS500-M – A need has been expressed for a mobile waste conversion system. This model is the ATS500, built on a trailer, comparable in size to a large sea container. See Figure 5 and Figure 6 for drawings of the ATS500-M.
ATS1000 – capable of processing up to 1,500 kg an hour of feedstock.
ATS2000 – two ATS1000 systems sharing components and taking full advantage of economies of scale. Larger systems can be made up of several modules. This system can process up to 3,500kg of wood waste an hour.
ATS4000 – This is in the development stage and the anticipated roll out is scheduled for 2025.

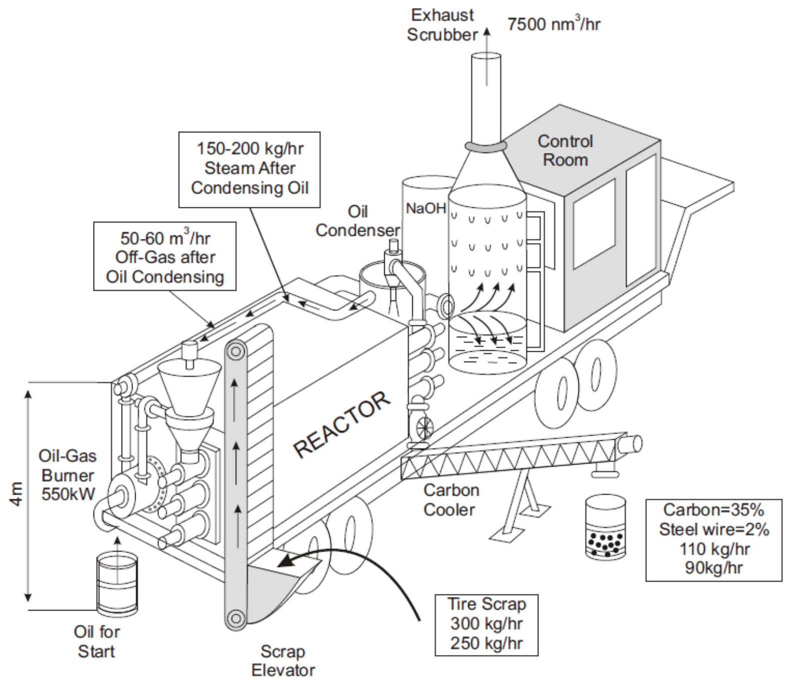


Figure 5 The ATS500-M seen from behind.

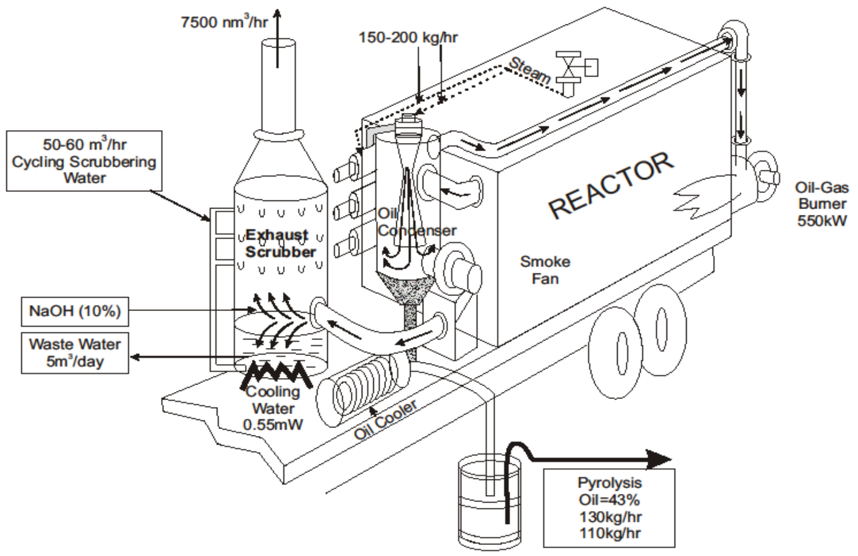


Figure 6 The ATS500-M Detail

2.2.1.2 ATS Manufacturing Process

In its manufacturing process Magnum's affiliated manufacturing company, intends to use a JIT (just-in-time) inventory planning and delivery system which is a natural inventory management method. The logistics planning will provide the Company with an efficient inventory system defined by a rapid turnover and minimal inventory of component parts. Further, the use of the JIT inventory method obviates the need for complex calculations concerning the optimum use of space to store component parts. Regardless, there will be ample space for storage of component parts at its assembly facilities so as to greatly reduce the manufacturing cycle of 8 months.

The table below shows the manufacturing schedule for construction of the ATS System.

Table 5 - Manufacturing Timeline

Step	Description	Month												
		1	2	3	4	5	6	7	8	9	10	11	12	13
1	**Process and equipment soft calculation**	■												
2	**Standard Units, facilities (fans& pumps) and Control-monitor system specifications**		■											
3	**Equipment Assembly and detail design**		■	■	■	■								
4	**Equipment purchase and Manufacturing**				■	■	■	■						
5	**Purchasing of carbon black processing equipmen**t				■	■	■	■						
6	**Machine Installation and testing-adjusting**								■	■	■	■	■	
7	**Thermolysis Process technology specifications**													■

2.3 By-Products

2.3.1 Activated Carbon

DUBLIN, Feb. 5, 2020 /PRNewswire/ -- The "Global Activated Charcoal Market Size, Market Share, Application Analysis, Regional Outlook, Growth Trends, Key Players, Competitive Strategies and Forecasts, 2019 to 2027".

"The activated charcoal market was valued at US$ 4.64 billion in 2018 and is expected to reach US$ 11.12 billion by 2027, rising at a CAGR of 10.3% throughout the forecast period of 2019 to 2027. The evolving need to control carbon emission will spur revenue growth during the forecast period driven primarily by Asia-Pacific and North American region for applications in water treatment and air purification. Stricter government regulations across regions for air purification and water treatment will drive the market for powdered and granular activated carbon."

In Canada and the USA, the market for activated carbon is approximately 160,000 tonnes annually; equally split between granular and powdered product. The North American market for water treatment applications is about 55,000 tonnes per year for granular activated carbon and 75,000 tonnes for powder. In the northwest, the market is approximately 6,300 tonnes per year valued at $7.5 million. The market is quite diverse with many different potential customers as shown in Exhibit 1. Many of the primary manufacturers in BC, Alberta, and Saskatchewan use some activated carbon in their processes.

Table 6 - Activated Carbon Uses

	Granular	Powder	Total
Potable water	225	680	905
Municipal wastewater	45	100	145
Boiler feedwater	400	100	500
Aquarium filters	5	0	5
Pulp and paper mill wastewater	10	130	140
Chemical plant wastewater	500	330	830
Sweetener de-colorization	340	455	795
Chemical processing	125	115	240
Glycol purification	30	0	30
Ammine purification in gas plants	50	0	50
Electroplating	10	20	30
Vegetable oil processing	110	195	305
Beer manufacturing	20	80	100
Mining	80	125	205
Groundwater	10	50	60
Household uses	70	45	115
Dry cleaning	35	20	55
Oxygen plants	500	0	500
Gasoline emission control	50	0	50
Indoor air filtration	100	0	100
Other gas phase applications	1,150	0	1,150
Total	**3,865**	**2,445**	**6,310**

Approximately 1,060 tonnes per year of activated carbon use goes to the treatment of drinking and boiler feedwater. While household use by way of tap water filers accounts for some of this usage, most of the demand is from municipalities and industrial plants where about 1,120 tonnes per year are used. As the public becomes ever more concerned about the safety of their drinking water, demand for potable water carbon filtration is increasing.

Activated carbon filters are able to remove over 90% of cadmium, manganese, mercury, chromium, silver and tin. They can also remove many disagreeable odours and tastes and are able to remove turbidity. They are very effective in removing chlorine and potentially dangerous and carcinogenic organic compounds present as a result of chlorination or industrial pollution. As consumers become ever more aware of the health risks inherent in our drinking water, the demand for water filters is increasing steadily.

With the cost of fresh water ever more expensive, industrial users are finding it economical to remove suspended solids, toxic contaminants and hazardous micro-organisms from their wastewater and increasingly to reuse the water. An example of this can be found in pulp mills in Western Canada; the first in the world to completely recycle all wastewater through the use of activated carbon. Wastewater treatment systems in British Columbia’s Okanagan region and in Alberta and Saskatchewan have been refitted with activated carbon tertiary treatments systems to preserve water quality for downstream communities.

Alberta, Saskatchewan and Manitoba are home to ten large vegetable oil production plants, all of which use activated carbon in the oil purification process. The carbon removes unacceptable colour, taste and odour as well as extending shelf life. Approximately 800 tonnes per year are used for purification of sugar beet syrup. In the US North West about 80 plants spread throughout 10 states process vegetable oils and utilize activated carbon.

Breweries use the product to remove haze causing compounds from beer. The proliferation of micro-breweries with a demand for high price activated carbon to serve this purpose has increased demand in the Canadian market. Soft drink producers use activated carbon to remove free chlorine from their water supply.

There are six large urea plants in Alberta and Saskatchewan that use activated carbon to remove contaminants from urea and with demand for urea growing the demand for activated carbon is growing as well.

The pulp mills and chemical plants in Western Canada all use activated carbon in boiler feedwater treatment, as do over half of the 720 natural gas and gas liquids processing plants in western Canada, which also use it for amine or glycol purification.

Pressure swing absorption plants are one of the fastest growing users of activated carbon where they use it to separate oxygen from air. There are more than ten oxygen plants at pulp mills where activated carbon is used to produce oxygen which is used in place of chlorine bleach.

There are also some medical and health uses of activated carbon such as for removing toxins from blood. It is also formed into pills for oral ingestion to remove toxic materials.

Another area of growing demand has developed with new automobiles featuring canisters containing activated carbon to capture and recycle fuel vapours that escape from vents in the fuel systems. Future growth may come from proposals to capture vapours resulting from vehicle refuelling.

Typically, the absorption vessels contain about 10 tonnes each of activated carbon and are regenerated by application of a vacuum. The vapour that is pumped off is recovered by absorption into liquid gasoline. These systems are now in use in the Seattle area and are being introduced in British Columbia.

The Canadian and worldwide outlook for activated carbon is for continued growth as increasing stringent environmental requirements drive both developed and developing regions to incorporate the material in water and air treatment systems. The US and Canada are expected to continue their 5% per year increase in volume, while developing areas will see even stronger growth over the next five years. [3]

2.3.2 Biochar

Biochar is the carbon (C) rich product produced when biomass, such as wood, agricultural biomass, manure or leaves, is heated with little or no available oxygen. In more technical terms, biochar is produced by thermal decomposition of organic material under limited supply of oxygen (O_2), and at relatively low temperatures (<700°C). This process often mirrors the production of charcoal, which is perhaps the most ancient industrial technology developed by humankind. However, it distinguishes itself from charcoal and similar materials by the fact that biochar is produced with the intent to be applied to soil as a means to improve soil health, to filter and retain nutrients from percolating soil water, and to provide carbon storage.

Sustainable biochar is a powerfully simple tool that can 1) fight global warming; 2) produce a soil enhancer that holds carbon and makes soil more fertile; 3) reduce agricultural waste; and 4) produce clean, renewable energy. [4] In some biochar systems all four objectives can be met, while in others a combination of two or more objectives will be obtained. The ATS system, utilizing the livestock manure, is a biochar production system that meets all four objectives.

[3] Accessed on the Internet March 3, 2011. http://www.hanamcanada.com/carbon.htm

[4] http://www.biochar-international.org/biochar

Biochar can be made in many different ways, primarily using one of three dominant processes of thermal decomposition: Thermolysis, gasification and hydrothermal carbonization. Energy products in the form of gas or oil are produced along with the biochar. These energy products may be recoverable for another use or may simply be burned and released as heat. In addition, biochar can be made from a wide variety of biomass feedstocks. As a result, very different biochar systems emerge on different scales. These systems may use production technologies that do or do not produce recoverable energy as well as biochar and range from small household units to large bioenergy power plants.

There is a large body of peer-reviewed literature quantifying and describing the crop yield benefits of biochar-amended soil. Field trials using biochar have been conducted in the tropics over the past several years. All showed positive results on yields when biochar was applied to field soils and nutrients were managed appropriately. Large scale field trials have recently begun on highly fertile Iowa Mollisols (soils that have deep, high organic matter) by the US Department of Agriculture's Agricultural Research Service (USDA-ARS). First year results are positive, yet it will take several years before definitive results are available (Laird, D., 2009)

Figure 7 Biochar Research in Japan

There is also evidence from thousands of years of traditional use of charcoal in soils. The most well-know example is the fertile Terra Preta soils in Brazil, but Japan also has a long tradition of using charcoal in soil, a tradition that is being revived and has been exported over the past 20 years to countries such as Costa Rica. The Brazilian and Japanese traditions together provide long-term evidence of positive biochar impact on soils.

Biochar provides a unique opportunity to improve soil fertility for the long term using locally available materials. Used alone or in combinations, compost, manure and/or agrochemicals are added at certain rates every year to soils in order to realize benefits. Application rates of these can be reduced when nutrients are combined with biochar. Biochar remains in the soil, and single applications can provide benefits over many years. Farmers can also receive an energy yield when converting organic residues into biochar by capturing energy given off in the biochar production process. In both industrialized and developing countries, soil loss and degradation is occurring at unprecedented rates with profound consequences for soil ecosystem properties. In many regions, loss in soil productivity occurs despite intensive use of agrochemicals, concurrent with adverse environmental impacts on soil and water resources. Biochar can play a major role in expanding options for sustainable soil management by improving upon existing best management practices, not only to improve soil productivity but also to decrease nutrient loss through leaching by percolating water.

The stability of biochar is of fundamental importance in determining the environmental benefits of biochar. There are two reasons why stability is important: first, stability determines how long carbon (C) applied to soil as biochar will remain sequestered in soil and contribute to the mitigation of climate change; and secondly, stability will determine how long biochar can provide benefits to soil and water quality. Biochar is not a single material, and its characteristics vary depending upon what it is made from and how it is made. Most biochars have a small labile (easily decomposed) fraction in addition to a much larger stable fraction. Scientists have shown that the mean residence time of this stable fraction is estimated to range from several hundred to a few thousand years.

2.3.3 53 Uses of Biochar

Biochar has a tremendous number of applications and new applications are appearing at a rapid rate. As our ATS derived biochar is of such high quality it can easily be used in decontamination applications normally reserved for activated carbon.

2.3.3.1 Farming

Soil amendment

1. *Carbon fertiliser*
2. *Compost*
3. *Substitute for peat in potting soil*
4. *Plant protection*
5. *Compensatory fertiliser for trace elements*

Livestock farming

6. *Silage agent*
7. *Feed additive / supplement*
8. *Litter additive*
9. *Slurry treatment*
10. *Manure composting*
11. *Water treatment in fish farming*

1 % Biochar for Livestock Feed
Increases energy efficiency of digestion, 77% less dysentery, 62% animals are calmer and balanced, 77% less odour in barns
Observation: cells in milk decreased, less streptococcus, less rumen ulcer, better fitness, adsorption of gram-positive bacteria (botulisme), pesticides, herbicides, reducing odours, fixation of nutrients, and improvement of barn climate.

Biogas Production

12. *Biomass additive*
13. *Biogas slurry treatment*

5 - 10 % Biochar in litter
Reducing humidity and odours (84%), fixation of nutrients, reducing ammonia and methane emissions, ameliorates hygiene, hoof infections

Poultry farms
3 days after beginning of treatment with fermented biochar, vermifugation of round worms took place
Cow farm
One year after beginning administration; cows did not need any veterinary treatment during the first year of administration
Swine farms
Pigs did not need any more antibiotic treatment during the first six months of administration
Chicks
The mortality rate decreased in a chicken farm, while at the same time a high and continual increase in weight of 90 - 100g per day was observed

2.3.3.2 Decontamination

Decontamination of soil and natural water

14. *Soil additive for soil remediation*
15. Highly adsorbing, fertile soil substrates
16. *A barrier preventing pesticides getting into surface water*
17. *Treating pond and lake water*

Effects of Biochar-Plaster
- Regulation / buffering of humidity
- Insulation
- Noise protection
- Toxin binding (solutes, VOC)
- Blocking of high frequency radiation
- Low electrostatic charging of air
- Conservation of wood
- Reduction of dust
- Deodorising
- Aesthetic
- Anti-bacteriological, fungicide (repellent)
- Air cleaning
- Increase of redox potential
- Emission of far-infrared radiation

Wastewater and sewage treatment

18. *Active carbon filter*
19. *Pre-rinsing additive*
20. *Soil substrate for organic plant beds*
21. *Composting toilets*

Treatment of drinking water

22. *Micro-filters*
23. *Macro-filters in developing countries*
24. Exhaust filter
25. *Controlling emissions*
26. *Room air filters*

2.3.3.3 Industry

Building material

27. *Insulation*
28. *Air decontamination*
29. *Decontamination of earth foundations*
30. *Humidity regulation*
31. *Protection against electromagnetic radiation ("electrosmog")*

Textile industry

32. *Fabric additive for functional underwear*
33. *Thermal insulation for functional clothing*
34. *Deodorant for shoe soles*

Food industry

35. *Conservation of food*
36. *Digesting helper*

Regulation of humidity, anti-bacteriologic, adsorption of ethylene

Wellness

37. *Filling for mattresses*
38. *Filling for pillows*

Radio protection

39. *Shield against electromagnetic radiation (*microwaves, TV, computer and other sources requiring power supply)

2.3.3.4 Further uses

Industrial materials

40. carbon fibres
41. plastics

Electronics

42. Semiconductors
43. batteries

Metallurgy

44. metal reduction

Cosmetics

45. SoATS
46. skin-cream
47. therapeutic bath additives

Paints and colouring

48. food colorants
49. industrial paints

Energy production

50. Pellets
51. substitute for lignite

Medicines

52. Detoxification
53. carrier for active pharmaceutical ingredients

Source:
For all information in this section – Ithaka Institute – Hans-Peter Schmidt – www.ithaka-institut.org

2.3.4 Biomass Thermolysis Oils

Pyrolytic liquid is referred to by many names including Pyrolytic oil, bio-oil, bio-crude-oil, bio-fuel-oil, wood liquids, wood oil, liquid smoke, wood distillates, Pyrolytic tar, Pyrolytic acid, and liquid wood.

The crude Pyrolytic liquid from an indirect-heat Thermolysis process is usually dark brown and free flowing with a distinctive smoky smell. Chemically, it is closely related to biomass in elemental composition and is composed of a very complex mixture of oxygenated hydrocarbons. Solid char may also be present. Table 9 below shows the content of biomass from indirect-heat Thermolysis process.

The physical properties of bio-oils are described in several publications. These properties result from the chemical composition of the oils, which are significantly different from that of petroleum derived oils. Bio-oils are multi-component mixtures comprised of different size molecules derived primarily from de-polymerization and fragmentation reaction of three key biomass building blocks, cellulose, hemicelluloses, and lignin. Therefore, the elemental composition of bio-oil resembles that of biomass rather than that of petroleum oils.

Considering the fact that energy consumption is increasing and limited fossil fuels are nearly exhausted with increasing populations and economic developments, renewable energy should be widely explored in order to renovate the energy sources structure and keep sustainable development safe.

Biomass is clean for it has negligible content of sulphur, nitrogen and ash, which give lower emissions of SO_2, NO_x and soot than conventional fossil fuels. Zero net emission of CO_2 can be achieved because CO_2 released from biomass will be recycled into the plants by photosynthesis quantitatively. The energy crisis and fuel tension made biomass fast Thermolysis liquefaction a more important area of research and development. Thermolysis has been supported with the highest amount of funds provided by the European Union for liquid bio-fuel technologies.

Bio-oil from biomass fast Thermolysis is mainly produced from biomass residues in the absence of air at atmospheric pressure, a low temperature (450–550^{o}C), high heating rate (10^3–10^4 K/s) and short gas residence time to crack into short chain molecules and be cooled to liquid rapidly. Fast Thermolysis, an effective biomass conversion with high liquid yield as much as 70–80% and a high ratio of fuel to feed, is regarded as one of the reasonable and promising technologies to compete with and eventually replace non-renewable fossil fuel resources.[5]

[5] *www.che.ncsu.edu/.../**biomass-bio**fuels/Review-of-**Biomass**-Thermolysis.pdf*

Table 7 - Biomass Content from Indirect-Heat Thermolysis Process[6]

Physical Properties	Typical Value	Notes
Moisture content	25%	Water comes from moisture in the feed and reaction waster and cannot be separated. Values can range from 15%-35%.
pH	2.5	The low pH comes from organic acids
Density	1.20	Very high at around 1.2 kg/l compared to light fuel oil at around 0.85 kg/l. Bio oil has about 40% of the energy content of fuel oil on a weight basis, but around 60% on a volumetric basis.
Elemental analysis		Typically: C:57%, H:6%, O: 37%, N: trace, Ash: trace depends on char content
Ash	0%	All ash is associated with the char
HHV as produced (depends on water)	18 MJ/kg	Bio-oil has a higher heating value of about 18MJ/kg as produced with about 25% wt. Water that cannot be separated.
Viscosity (at 40 ^{o}C and 25% water)	50 cp	Viscosity as produced can vary from 20 cSt to as high as 1000 cSt (measured at 40 ^{o}C) depending on feedstock, water content, light and ageing.
Solids (char)	0.2%	0.1% is a good level and 1% often encountered.

2.3.4.1 Other Oils

When taking a homogenous wood product like pine wood, besides carbon products and fuel-oils, other oils can also be produced. One particular interesting product is essential oils, a very high value product. The following products will be produced by the ATS System using pine wood:

- Essential Oil: 1%~3%
- Bio-Oil: 12%~15%
- Carbon product: 35%
- Hydrosols: 17%

The re-condensed water is referred to as a hydrosol, hydrolith, herbal distillate or plant water essence, which may be sold as another fragrance product. Popular hydrosols include rose water, lavender water, lemon balm, clay sage and orange blossom water. The use of herbal distillates in cosmetics is increasing. Some plant hydrosols have unpleasant smells and are therefore not sold.

To produce the essential oils and hydrosols, the ATS System will operate as a distillation system. The processing temperature is under 200ºC. To produce the Bio-Oil, the ATS system will operate in a Thermolysis mode. The ATS technology can work in dual mode. See Appendix A for more details on this application.

[6] CentiStokes (cSt) is the ISO 3440 grading system for Engine Oils –midpoint viscosity of oil in cStokes at 40ºC.

2.4 Significant Feedstock Sources

2.4.1 Wood Biomass

2.4.1.1 Wood Biomass – The Need

In recent years, the young and dense pine forests of Canada have suffered extreme insect outbreaks. To restore these forests to an ecologically sustainable condition, a large number of small-diameter pine trees are being harvested. Whether the operation is for salvage or fuel reduction, large volumes of timber and slash are generated. The economic value of small-diameter pine as timber, however, does not offset capital and operation costs of handling and processing. Options for overcoming this constraint include recovering more value from the biomass as energy, wood products from larger diameter trees, and chemicals. Advanced timber manufacturing processes can produce engineered lumber, beams, and sheets from small dimension stock[7]. Heat and power can be generated by combustion; hydrocarbons can be produced in a reformer; and other chemicals produced with Thermolysis.

It should be mentioned as well that with global climate change, dry conditions in British Columbia forests are creating increasingly dangerous conditions for forest fires. With that in mind the BC Forest Service is bringing in tighter regulations regarding the waste wood left in the forest; inevitably this will add to the waste challenge that MGI is uniquely positioned to address.

Renewable energy is of growing importance in satisfying environmental concerns. Wood and other forms of biomass including energy crops and agricultural and forestry wastes are some of the main renewable energy resources. These can provide the source of renewable liquid, gaseous and solid fuels. Biomass is considered the renewable energy source with the highest potential to contribute to the energy needs of modern society for both the developed and developing economies worldwide. Energy from biomass based on short rotation forestry and other energy crops can contribute significantly towards the objectives of the Kyoto Agreement in reducing the greenhouse gases emissions and to the problems related to climate.

Wood Biomass – The Solution

The proposal for the plant for treatment of wood waste is with an ATS System, which we will be able to process approximately 50 tons per day (assuming moisture is removed by centrifugal moisture removal equipment) because the density of wood is about 0.34 ton/m^3.

[7] http://www.for.gov.bc.ca/hfd/library/documents/bib97154.pdf

REQUIRED EQUIPMENT

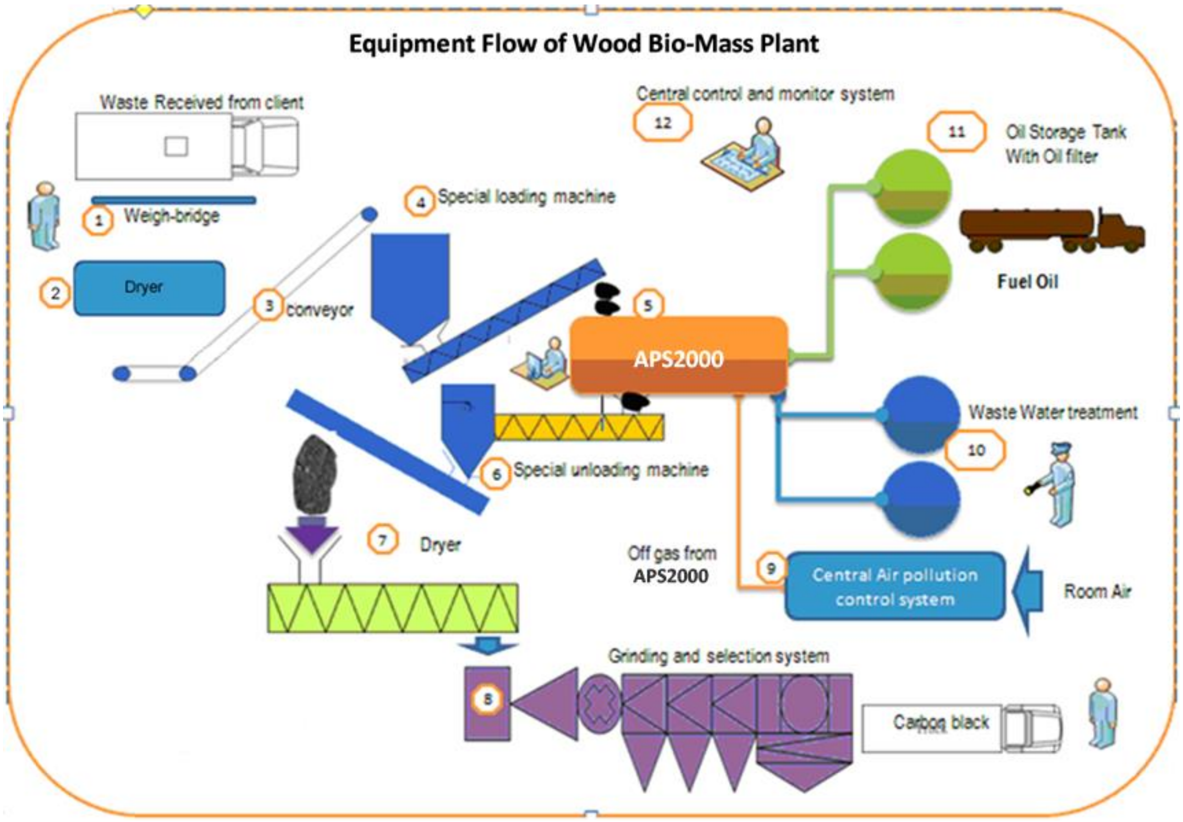


Table 8 - Annual Gross Revenue Projections for Wood Waste

Wood Waste				
Product	**% of Output**	**Annual Output**	**Price Per Tonne**	**Revenue (000's)**
- Bio- Oil	35	6,930	$400	$2,772
- Biochar	34	6,732	$2,600	$17,503
Total revenue				**$20,275**
Approx. Operational Expenses				$4,482
Depreciation				$386
Net Income (before taxes)				**CAD $15,407**

Note:
Based on 60 Tonnes Per Day for 300 Operating Days Per Year
Additional products may be produced that would both generate power and heat for the plant, and potentially produce additional revenue.

2.4.2 Livestock Manure

2.4.2.1 Livestock Manure - The Need[8]

Industrial agriculture is one of the leading causes of water pollution in the United States today. In the 2000 National Water Quality Inventory conducted by the Environmental Protection Agency (EPA), agricultural activity was identified as a source of pollution for 48% of stream and river water [I], and for 41% of lake water [II].

Water pollution from industrial farms not only damages the environment and kills wildlife it can also sicken and kill people. And since these farms exercise little restraint when it comes to water usage, they tend to waste large quantities of water, even when neighbouring communities are experiencing water shortages. Because small, sustainable farms are more integrated with their surrounding communities, they pay closer attention to the ways that they use water and how their practices affect local water supplies.

Sources of Pollutants

Most water pollution from industrial farms results from the storage and disposal of animal waste. Industrial livestock farms store manure and other farm wastes in gigantic tanks known as “lagoons” which can hold millions of gallons of manure and urine. Unfortunately, these lagoons often leak and—during large storms—they may rupture or simply overflow. When this happens, the environmental damage can be devastating as raw manure is up to 160 times more toxic than raw municipal sewage [III]. Leaking lagoons also release antibiotic residues and harmful bacteria that can leach into water supplies.

In order to dispose of manure after it’s been stored in lagoons, industrial farms spray the waste onto farm fields as fertilizer. Unfortunately, these farms produce far more waste than can be applied to fields and once the saturation point has been reached, the waste runs off into nearby water systems. The most common form of water pollution in the United States is excess levels of nitrogen or phosphorous, both of which are largely caused by fertilizer runoff [IV]. When manure is spread on fields as a fertilizer, it can also introduce some of the more toxic substances present in livestock excretions, such as pharmaceuticals [V] or bacteria [VI]. Water pollution from manure as well as synthetic fertilizers can lead to serious environmental damage and harm human health.

By polluting the nation’s waterways, a single factory farm has the ability to negatively affect whole regions, as was the case when manure spilled from a ruptured tank on a 3,000-head dairy farm in upstate New York in August 2005. Three million gallons of cow manure poured into the Black River, polluting an area one-fourth the size of the Exxon Valdez spill [VII]. The New York State Department of Environmental Conservation cited the farm for numerous environmental and permit violations and estimated that this spill killed around 200,000 to 250,000 fish [VIII].

Types and Effects of Pollutants

Agricultural water pollution can have variety of negative effects. Not only do substantial environmental problems result, but many of the pollutants produced by farms (minerals, chemicals and pathogens, to name a few) can make water unsafe for human consumption.

Nutrients

Nutrients such as nitrogen and phosphorous, are the minerals in fertilizer that promote plant growth. But due to the over-fertilization of cropland, far more nitrogen and phosphorous are applied to fields than are removed by crops [IX]. Excess nutrients in water cause harmful plant growth—commonly referred to as “algal bloom,” which can cause fish kills [X].

[8] See Appendix B for the references for this chapter.

"Nitrogen and Dead Zones"

Excess nutrients in bodies of water can contribute to the excessive growth of plant life, a process known as "eutrophication," which, in turn, can make water "hypoxic," or low in oxygen [XI]. The effects of eutrophication can be vast. According to the USDA, "as much as 15 percent of the nitrogen fertilizer applied to cropland in the Mississippi River Basin makes its way to the Gulf of Mexico [XII]." This pollution is one of the leading causes of the so-called Gulf "Dead Zone," an oxygen-deprived area as large as 8,000 square miles—almost the size of New Jersey—in which no fish can survive [XIII].

Ammonia and Nitrates

Livestock manure is high in ammonia concentrations, [XIV] and dissolved ammonia in water is not only highly toxic to fish, [XV] but can also be converted to dangerous nitrates [XVI]. Elevated nitrate levels in drinking water are highly poisonous to humans, causing potentially fatal oxygen levels in babies (known as "blue-baby syndrome"), spontaneous miscarriage, and possibly cancer [XVII]. In a sample of wells surveyed by the US Geological Survey from 1993 to 2000, 2 percent of public-supply and 9 percent of the domestic wells more common in rural areas were found to have nitrate concentrations higher than the EPA's maximum allowable level [XIX]. The EPA estimates that about 1.3 million households in counties with industrial livestock facilities get their water from wells with dangerously high nitrate levels [XIX].

Pathogens and other microorganisms

Manure contains a high level of pathogens (disease-causing micro-organisms). When the waste is applied to fields, those pathogens can be transferred to local water supplies during a run off from either irrigation or rainfall [XX]. The impact of pathogens from manure is severe: according to the Centres for Disease Control, in every waterborne disease outbreak in the United States from 1986 to 1998 where the pathogen could be identified, it most likely originated in livestock [XXI].

Some other waterborne micro-organisms do not originate on farms but develop as a result of eutrophication caused by high nutrient levels. Pfiesteria piscicida, for example, thrives in many areas where algal blooms grow, and causes lesions in fish and large-scale fish kills [XXII]. It can also cause a range of symptoms in humans, including respiratory and eye irritation, gastrointestinal problems, fatigue, as well as skin problems and cognitive symptoms such as memory loss and confusion [XXIII].

Antibiotics and Hormones

Antibiotics and artificial growth hormones are commonly used on industrial farms, either injected directly into the livestock or added to their feed. Large amounts of both substances end up being excreted by animals and can thus pollute water along with everything else in livestock waste. Some hormones can remain functional in manure up to 270 days after excretion, and there have been many documented cases of hormones discovered miles downstream of farms [XXIV]. Although it is unclear whether these hormone concentrations can be high enough to affect humans, they have been shown to compromise the reproductive processes of fish [XXV].

An estimated 75% of all antibiotics administered to livestock are excreted [XXVI], and for certain common antibiotics that figure can be as high as 90%[XXVII]. The overuse of antibiotics for livestock contributes to the development of antimicrobial-resistant bacteria, and some studies suggest that growth of these resistant bacteria may be promoted in waterways with high levels of antibiotics [XXVII]. Numerous studies have demonstrated that waterways are a prominent means of transmitting these dangerous types of bacteria to humans [XXIX].

Heavy Metals and Salts

Some heavy metals, such as copper and zinc are essential nutrients for animal growth—especially for cattle, swine, and poultry [XXX]. However, such elements are often present in animal feed in concentrations far higher than necessary for animal health, along with other heavy metals such as chromium, lead, arsenic and cadmium [XXXI]. Farm animals excrete excess heavy metals in their manure—which in turn gets spread as fertilizer, leading to soil and water pollution. The health hazards resulting from exposure to heavy metals in water include kidney problems from cadmium; nervous system disorders, kidney problems and headaches from lead; and both cardiovascular and nervous system problems from arsenic, which is also known to cause cancer [XXXII].

Many salts are also present in large quantities in manure, including sodium, calcium, magnesium, potassium, chloride, sulphate, bicarbonate, carbonate, and nitrate [XXXIII]. When introduced to the environment, these salts increase the salinity of waterways, leading to changes in aquatic ecosystems and making water brackish, and therefore unfit for drinking [XXXIV].

Organic Matter and Other Solids

In addition to the biodegradable organic matter naturally present in manure, animal bedding, wasted feed, soil, dust, hair and feathers are often mixed with manure in storage and can end up in waterways [XXXV]. The decomposition of organic matter can cause increased levels of bacteria, which in turn reduces oxygen levels in water and kills fish [XXXVI]. This decomposition can also negatively affect the colour, taste, and smell of water [XXXVII].

Wells and Groundwater

Although much of the water used in the U.S. is obtained from surface water sources, many families continue to use wells to draw water from the ground [XXXVIII]. In fact, groundwater is the source of drinking water for 46% of the U.S. population and for 99% of the population living in rural areas [XIL].

While public drinking water systems are regulated by the EPA, private drinking water wells are not regulated and are not required to meet EPA clean water standards [XI]. Furthermore, unlike public water systems, private wells aren't required to undergo routine testing by experts. As a result, families that rely upon private drinking water wells are especially vulnerable to the harmful effects of water pollution from factory farms. In U.S. counties that have industrial farms, approximately 13.5 million households depend on domestic drinking water wells [XII].

2.4.2.1.1 Livestock Manure – The solution

Table 9 - Market Size by Livestock Type

Livestock Required to Supply 110,231 lb./day of Manure Feedstock[9]

Livestock Type	Pounds Per Day Manure	% Moisture	Adjusted for Moisture	Required Number of Animals	Animals in Canada	Total Tonnes of Dry Manure	Number of Plants Required	Sales Revenue Potential * (000's)
Beef[1]	92	92.0%	7.36	14,977	721,440	2,408	48	$325,145
Dairy[2]	140	88.0%	16.80	6,561	1,400,000	10,668	213	$1,440,246
Hogs and Pigs[3]	9.5	89.0%	1.05	105,484	12,400,000	5,878	118	$793,482
Chickens (layers)	0.26	75.0%	0.07	1,695,864	25,000,000	737	15	$99,506
Chickens (broilers)	0.18	74.0%	0.05	2,355,366	539,697,400	11,457	229	$1,546,662
Turkeys	0.9	75.0%	0.23	122,479	10,500,000	1,072	21	$144,667
Total							**644**	**$4,349,712**

Notes:
[1]High Forage diet - Feedlot Cattle Only
[2]Lactating Cow
[3]Grower
*** Assuming gross revenue of $6.75 Million/Plant. The average number of cattle in a feedlot in Alberta is 6,591 - Only 9 lots out of a total 75 exceed the capacity of a single plant**

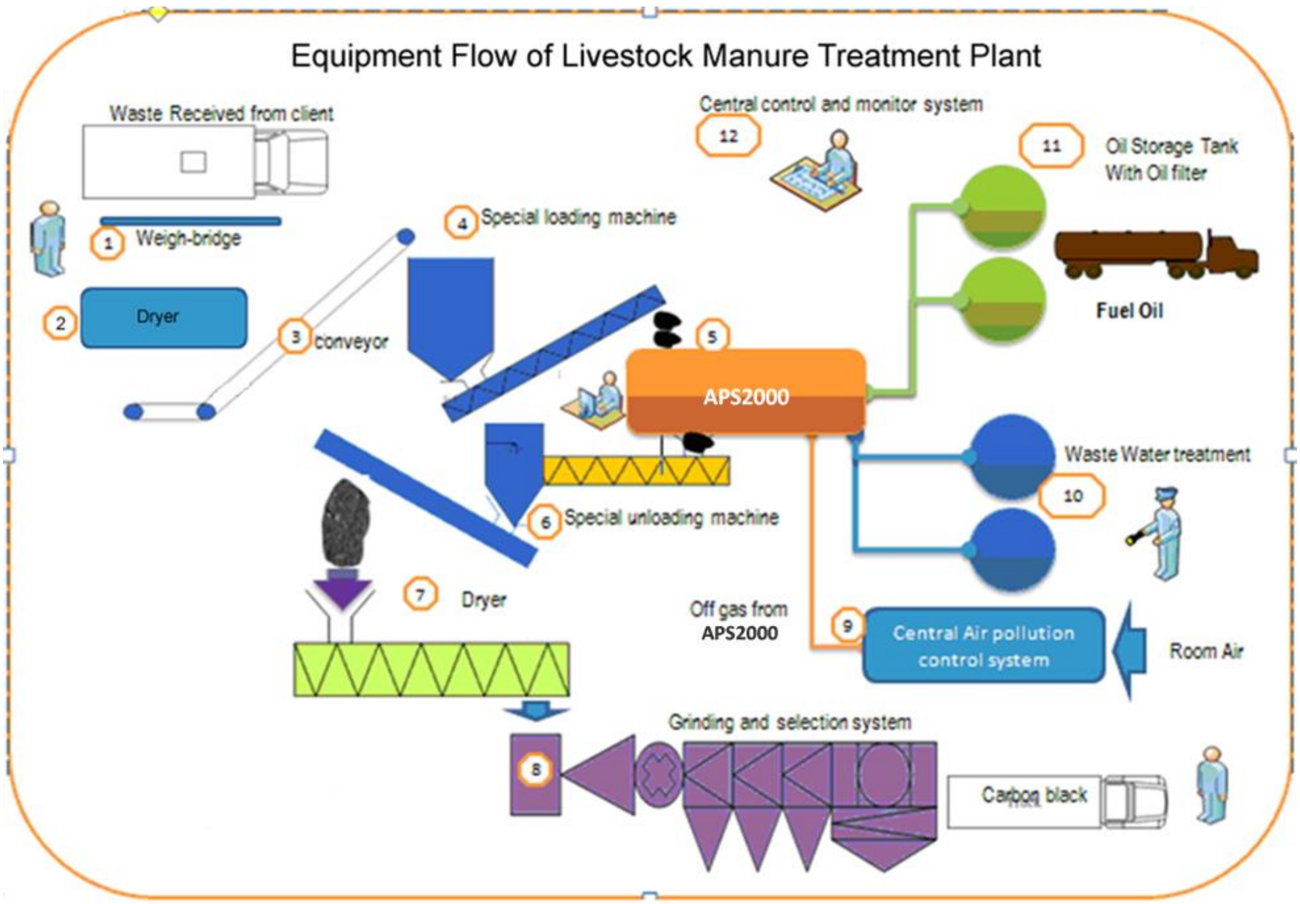
[9] Adapted from MWPS -18, unpublished OARDC data, Lawrence et al. (2004). Wm = daily weight of manure, Wa = average weight of animal during this stage of production, TS = total solids, VS = volatile solids, % wb = percent wet basis, and % db = percent dry basis. To convert manure weights to gallons, divide by 8.3. P_2O_5 = 2.273 x P and K_2O = 1.205 x K. a lbs of milk/day.

Table 10 - Annual Gross Revenue and Income Projections for Livestock Manure

Beef & Dairy Cattle Manure – ATS2000				
Byproduct	**% of Output**	**Annual Output**	**Price per Tonne**	**Revenue (000's)**
- Bio-Oil	10	1,980	$400	$792
- Biochar	34	6,732	$1,850	$17,503
Total Revenue				**$18,295**
Approx. Operational Expenses				$3,483
Depreciation				$386
Net Income (before taxes)				**$14,426**

Notes:
Based on 60 Tonnes Per Day for 330 Operating Days Per Year
Additional products may be produced that would both generate power and heat for the plant, and potentially produce additional revenue.

2.4.2.2 Livestock Manure – Required Equipment



3. Marketing Plan

3.1 Target market and Size

Using an ATS1000 system, a typical JV will be focused on producing biochar and as such, this business plan will address the market for biochar, in Canada, USA, China, Hong Kong, Singapore, Philippines, India and South East Asia. Having said that, the Company believes that a brief investigation of the market potential for each of the primary waste-streams here in Canada and a market 10 times that size, in the USA, and each of the by-products that can be produced by an ATS plant, will be useful.

Magnum's target market is twofold. First of all, the input target market consisting of relationships with waste stream providers; companies, Governments and Municipal authorities that require a solution for their waste streams. The second target is the market for industrial/consumer products that may be produced at the plant.

The markets into which Magnum's Associates will be entering into JV Partnerships in the first phase are summarized in Table 11 below. The figures shown represent the total market size in Canada and are conservative. For both the recycled plastic and the waste wood biomass, the most recent figures available are several years old with both on an uptrend over the past number of years. The Markets in Asia, together with the associates we are negotiating with, are significantly larger, require immediate attention, and offer a very large and diverse market for the advanced ATS Technology.

Table 11 Market Size

Feedstock	Number of Potential Plants	Market Size of Potential JV Partnerships (1000s)
Livestock Manure	644	$8,993,460
Pulp Mills	114	$1,592,010
Used Rubber Tires	23	$320,980
Recycled Plastic	110	$1,536,150
Municipal Solid Waste	784	$10,948,268
Municipal Sewage Sludge	143	$1,997,418
Waste Wood Biomass	1,734	$24,215,310
Total	**3,552**	**$49,603,596**

The 7 areas identified in Table 11 are seen as providing the best potential starting points for homogenous feedstocks. As can clearly be seen, the size of the potential market for joint ventures is huge, even with this focus. To further enhance our chances of success, our sales efforts focus on industry organizations and geographically.

The second important market for the JV operation is the sales of the by-products being produced. These outputs are generic products for which domestic and world markets exist. A description of the market for the by-products is as follows:

Market	Size	Description
Syngas	Immediate area only can be serviced	Syngas can be used on site to power generators and dryers, and in nearby buildings for heating. Delivery offsite is not practical.
Liquid Fuel Products	Global Market in 2015 was *93.82 million barrels daily *Short-Term Energy Outlook	What is produced from biomass is bunker grade and would need additional refining to make it diesel quality. CAGR is approx. 7.1%. From tires and plastics, a #2 Home Heating Oil equivalent is produced while can be used without secondary processing.
Carbon Black	Approx. 8.1 Million metric tons	Carbon black is primarily used as reinforcement in vulcanized rubber goods, with two-thirds of the carbon black supply used in tires.
Biochar	Biochar has a variety of uses and can be treated as a component of fertilizer; it is valued at ~$2,600/Tonne. The fertilizer market in Canada is $2B annually.	Biochar is the carbon rich product produced by thermal decomposition of organic material such as wood, manure or leaves. It is produced under limited supply of oxygen at relatively low temperatures (<700°C).
Essential Oils	Market size is difficult to obtain, but approx. 2,600 tonnes of cedar wood essential oil were produced in the 1990s	Produced from waste bark and needles from the forest industry, these oils are expensive, retailing for $3-$9/ounce, or $135,000 per ton.

Table 12 Product market description

3.2 Industry Analysis

3.2.1 Industry Characterization

The industry can be summed up in one word: Dynamic. There are new products and rumours of new products almost daily. The field of waste to energy and waste management is experiencing huge investments from both government and private interests.

Consumers are justifiably cynical over new product claims as so many products have either failed to deliver or have proven to be extremely uneconomical. However, there is also a tremendous excitement for both industry players and watchers as new products become commercially viable.

3.2.2 Competitor Analysis

Characterized by R&D and pilot stage ventures, competitors are focused on designing & building very large plants using; gasification, thermal depolymerization, plasma arc gasification, anaerobic digestion, fermentation & mechanical biological treatment. Competitors include:

- Waste Management, in Houston, Texas
- Wheelabrator Technologies, Inc
- Covanta Energy Corporation
- AE&E – Von Roll, Inc.
- Alter Nrg Corporation
- Aquilini Renewable Energy.

The ATS Technology has an added selling advantage over competitive pyrolysis plants when comparing competitor plants such as the one recently completed in Cyprus at a cost exceeding $40 Million USD. In the USA, Carbolytic Materials Co. recently completed a tire pyrolysis plant capable of processing 15,000 Tons of waste tires with the assistance financing of $12.8 Million from the Missouri New Markets Development program.

As a result of the lower capital cost of the ATS System, the operating profit of an ATS Plant has an estimated return of capital in about 3 years. The return of capital for competitor plants is usually more than 6 years. Besides the comparative advantage that the ATS technology has over its competitors in terms of price and quality of product, below is a comparison chart setting out the advantages of the ATS System.

Pyrolysis Methodology (The process of using heat to break down complex substances into simpler substances by the use of heat)	**ATS Thermolysis System (using proprietary super-heated steam method)**	**Competitor Pyrolysis Systems**
1. Feedstock Inputs and methodology	The leading edge ATS system is a continuous feedstock system which operates under normal pressures making it easier to control the explosive fuel gas containing hydrogen and which is discharged during the pyrolysis process. This makes the ATS system much safer than the traditional systems used by ATS's competitors which operate under high pressures. Further since the ATS system is continuous, it does not have to shut down to cool the rising temperatures and reduce the high pressures incurred by the competitors who use the traditional pyrolysis systems. Also, since the ATS system operates continuously, it does not have to be shut down and therefore is much more energy efficient than the batch system used by some of ATS's competitors.	Most Competitors use a batch system (earliest developed pyrolysis system) or a different version of the continuous system which both operate under high pressures. This increases the danger of leakage in the explosive fuel gas created in the pyrolysis process, which increases the risk and danger of explosion. Further under the batch system the operator can only reload the feedstock once the pressures are reduced and the high temperature is cooled. This process of shutting down the pyrolysis operation to accommodate the cooling of temperatures and reducing of pressures the results in energy loss and operation time, thereby making it a much less efficient pyrolysis system.
2. Heat Sources	The ATS system uses a mixed heat source incorporating the uses of gas together with super-heated steam. By incorporating the use of super-heated steam, the feedstock materials are heated uniformly throughout as the super-heated steam penetrates into the center of the feedstock materials creating a more uniform heated feedstock rather than the single heat source used by ATS's competitors. Further, once the thermolysis process is initiated in the ATS system, fuel gas is created in the combustion chamber which is captured, and the dioxins, sulfur and other toxic materials are removed, and the clean fuel gas is reused as a fuel source for the combustion chamber. In essence the ATS system, once started, creates its own fuel,	The competitors use a single heat source which chars the surface of the feedstock but does not penetrate effectively below the surface of the feedstock material resulting in the internal portions of the feedstock materials remaining significantly cooler than the surface. This results in incomplete cracking (the breakdown of complex substances into smaller molecules using heat) of the feedstock material. This process results in a lower quality of carbon black, making it unsalable. The conventional competitor pyrolysis systems simply burn off the fuel gas released, thereby releasing dioxins and sulfur into the atmosphere, creating an environmental hazard.

	thereby eliminating the need for an external fuel source.	
3. Pyrolysis and Heating Process	The ATS System uses a Three stage process which is super-steam activated and uses an indirect heating system incorporating direct super-steam heating. This system results in a fast thermolysis, short processing time, minimal energy consumption, control of temperature variances during processing , complete treatment of the organic material, high quality by-products and a safer pyrolysis process through the use of super-heated steam. The ATS System can operate at a temperate up to 850C in its Third Stage. The reason a Three stage process is required is that different organic waste materials require different temperatures to treat them. It is impossible to treat a wide range of organic compounds in the stage One process. Although most organic compounds can be cracked between 350C and 420C and 95% of organic compounds will be decomposed to become fuel oil and fuel gas under 450C leaving 5% of the organic material unprocessed. To treat the remaining 5% of organic material a higher temperate is required, so a Three stage process is used which can operate at temperatures up to 850C. To crack used tires a suggested temperature of 500C is required and 600C for coal is required in the Third Stage. These are temperatures that the competitor's single heat source systems cannot achieve.	The competitors use indirect heating systems which operate at processing temperature less than 450C. As this method does not effectively penetrate heat into the internal feedstock materials, a longer processing time is required. Further, it often results in an incomplete treatment which results in a lower quality of by-products. Also, the poor thermal conductivity of this process requires more energy consumption and reduces the safety of pyrolysis process.
4. Cracking Time for Tire Chips	The ATS system takes approximately 2 minutes to completely decompose 10cm2 of used tire chips to fuel oil and fuel gas at 400C. The standard cracking time for tire chips is less than 10 – 15 minutes.	The traditional indirect heat system alone used by the competitors takes in excess of 8 minutes to decompose 10cm2 of used tire chips. The standard cracking time for the conventional batch system is greater than 1.2 hours and greater than 35 minutes for the conventional continuous system for each ton of feedstock inputs.
5. Energy Efficiency	The ATS system operates at an energy efficiency exceeding 85%	The competitor batch systems operate at an efficiency level of less than 30%. The traditional continuous competitor systems operate at an efficiency level of less than 50%.
6. Product Quality (a) Oil, sulfur content	The ATS system uses super-heated steam to produce a light fuel oil similar to diesel fuel containing less than 1% sulfur and can achieve sulfur content as low as 0.3% without the use of a catalyst. This lower sulfur content oil commands a higher selling price. Further the ATS system produces less Tar sand than	The competitors using the traditional pyrolysis systems cannot normally produce oil having a sulfur content of less than 2 % without the use of catalysts. Further the competitors' traditional pyrolysis systems cause a tar sand problem and produce dirty oil.

(b) Carbon Quality	the competitors' systems making ATS's products more attractive to the Buyers. The ATS system produces a carbon black with less than 0.1% oil content which meets the N220 or N330 carbon black specifications and has a BET rating of 120-800 ("Adsorption Surface Area"). The resulting carbon black has a high iodine absorption rate and high surface area making it a desirable by-product. The fact that there is indiscernible amount of oil is significant because carbon black cannot have oil content as the oil causes a chemical reaction which affects the process in plastic or rubber production. If carbon black contains an oil compound it will burn and cannot be sold.	The competitors using the traditional systems cannot produce a carbon black having less than 1% oil content which makes for a non-saleable carbon waste with a BET rating of less than 60. Further the iodine absorption and surface area are low.
7. Operating Efficiencies	The ATS system is a total cracking system producing a high-quality carbon black, biochar or activated carbon for sale, all of which are in high demand. Further the fast cracking time of less than 15 minutes increases the efficiency of operation over that of the competitors. Further the ATS system does not require a total vacuum like that of our competitors which makes the ATS system a safer operating system than that of our competitors.	The traditional pyrolysis systems used by the Competitors results in an incomplete cracking of feedstock. This produces a low quality of carbon black which contains an unacceptable level of oil, with a low iodine absorption surface area such that this product cannot be sold. Further the cracking times for the traditional systems are greater than 30 minutes and require a total vacuum during the cracking process. As a result, these systems have more safety concerns than the ATS system.
8. Application Range	The ATS system is multi-purpose that can process any kind of organic material, coal etc., and can remove mercury and other toxic substances.	The competition using the traditional pyrolysis systems are single purpose processing only, and lack the flexibility of the ATS system.
9. Environmental Impact	The ATS system requires no waste burning and is free of air-pollution and carcinogenic dioxins. There are no secondary pollutants.	The competition requires a landfill for the waste carbon and some traditional systems have a high degree of air and dioxin pollution. Further a secondary pollutant resulting from the traditional pyrolysis systems is slag-dust.
10. By Products	The by-products of the ATS system are fuel gas, fuel oil, steam recovery, power, carbon black, pryo or bio oil, biochar, activated carbon, fertilizer and metal recovery depending on the feedstock materials used.	The traditional pyrolysis systems only have Power and steam as by-products, and these are only generated from large scale pyrolysis systems.
11. Operating cost (US$/ton)	The operating cost of the ATS system is below 65 dollars per ton.	The competitors using the traditional pyrolysis systems have operating costs in excess of 150 dollars per ton.
12. Extra Environmental Costs	The thermolysis operations of the ATS system produce no air pollution and require no land fill for disposable of waste materials.	The competitors using the traditional pyrolysis systems incur high costs for air pollution control and land fill charges for disposal of waste materials.

13. Projected Pay Back on Investment	Less than 2 years after commencement of production.	The Competitors high capital cost (exceeding $20,000,000 USD) and higher operating costs result in a Pay-back period exceeding 7 years from the commencement of production.

Background: Technical Problems

Current pyrolysis methods consist of two systems: pyrolysis in batch technologies and continuous pyrolysis technologies.

For the pyrolysis in batch technologies, feedstock materials of various types such as organic biomass, used plastics and used tires are placed in a pyrolysis furnace which is then heated to activate a pyrolysis reaction. Upon completion of the pyrolysis reaction, the furnace is cooled, depressurized and the pyro-products are removed. This prior approach has the following disadvantages:

(1) The pyrolysis furnace must be subjected to a repetitive heating and cooling cycle for each batch which limits the production capacity of the process and is an inefficient use of the energy required.

(2) That because of the loading and unloading it is difficult of make effective use of the pyro-gases generated from the pyrolysis process.

(3) During the unloading process a release of dust and pyro-gasses results which is a hazard to the environment.

To overcome the above disadvantages, the current method of pyrolyzing feedstock is through the use of continuous pyrolysis methods. One of these methods is the continuous batch system which involves a series of reaction chambers being connected together. In spite of this, there are still distinct disadvantages of this system, and they are as follows :

(4) Each reaction furnace has to be cooled and repeatedly heated.

(5) Each reaction chamber must be unloaded and loaded repeatedly which incurs the disadvantages of a batch system referred to above.

(6) The use of a series of reactors makes for a bulky plant configuration.

(7) The individual operation of each furnace complicates the pyrolysis operation.

The second improved method being used is a continuous pyrolysis system which does not incorporate the plurality of parallel pyrolysis furnaces. This system is a dry pyrolysis method which uses a dry inert gas to carry the resultant pyro-gas out. However, there are still disadvantages by using this system, and they are as follows :

(8) There is a danger of explosion in the furnace as a significant of combustible gases are generated during the high temperature process.

(9) Sulfurous components in the feedstock materials will be released, leaving a high sulfur content in the pyrolysis by products produced, thereby lowering the quality and merchantability of the resultant by products.

(10) There is not readily-available a cost effective inert gas in the pyrolysis industry having the capability of carrying the pyro-gas out or a method of self-generating an inert gas having the capabilities required and it must be either specially produced or the supply of an inert gas has to be outsourced, thereby significantly increasing the operating costs of the system.

The ATS super-heated steam pyrolysis systems provides a system to address ALL the disadvantages of the previous pyrolysis methods and allows for a continuous pyrolysis without the requirement of multiple pyrolysis furnaces. The advantages of the ATS super heated steam thermolysis system are:

(11) Less Environmental impact as there is a minimal amount of Non-combustible waste produced.

(12) No burning and no landfill requirements as there is a more complete cracking of feedstock.

(13) Less tar produced than competitive batch systems.

(14) More efficient re-use of gases produced from the super-heated steam pyrolysis system by using these gases for fuel for heating the furnace.

(15) Minimal vacuum required ensuring safer operation.

(16) Ability of super-heated Steam system pyrolysis to process variable feedstocks.

(17) Ability of super-heated Steam system pyrolysis to operate on a Continuous basis.

(18) The ATS system incorporates a Gravitational Separator to remove the large particulates from the pyrogas leaving the reactors and an innovative Venturi condenser incorporating both steam injection and small water droplets to remove both small particulates and gaseous pollutants.

Summarizing the problems found in pyrolysis systems and methods:

(19) Experience has shown that there is a buildup of soot in the water-cooled condensers resulting in a tar buildup in the condensers and piping system. This occurs because of the formation of tar and contamination upon the cooling surface of such condensers, including the steam condensate. This resulting pyrolysis fuel representing a mixture of water with light and heavy mazut is not suitable for burning in a standard light diesel fuel burner.

(20) Experience has shown that the steam condensate is impure containing water-soluble benzenes, benzynes and other light rubber factions which condense with the steam including minor hydro-suspensions of insoluble fractions. In the boiler and in the condensers this organic matter is condensed and upon repetition of the process increases the yield to 9%-10% of the material feedstock. The operation of steam boilers currently available in industry are unable to handle a condensate having this quantity of organic impurities. The ATS system also avoids the boiler problems by eliminating the boiler and incorporating an innovative coiled piping apparatus in the Thermal chamber to produce super-heated steam.

(21) The quality of carbon black or activated carbon under the steam pyrolysis system used by competitors may achieve only 95% purity which makes the carbon black or activated carbon produced less marketable.

(22) Experience has shown that the flash point of fuel oil produced when using used tires as feedstock material is less than 40̊ C. This results from the use of water-cooled condensers by the existing steam pyrolysis systems and their lower condensing temperature which produces a less marketable fuel oil.

(23) The current system pyrolysis systems used by competitors incorporate an auger or conveyor system which do not provide for a thorough mixing of the feedstock with the super-heated steam, thereby lessening decomposition of the feedstock and the purity of the by-products produced.

(24) The current competitor steam pyrolysis systems, which through experience have shown, are capable of producing a carbon black having a relatively high purity, however as they incorporate only one or two reactors in the reaction chamber, the length of time for processing the feedstock material in these systems is not sufficient for decomposing all the volatiles from the material to be pyrolyzed or the carbon by- products produced making it difficult, if not impossible, to produce a purity of carbon black or activated carbon approaching 99%.

(25) The current competitor steam pyrolysis systems do not incorporate an emergency system to safely remove pyro-gas from the reaction chamber in the event of a shutdown of the pyrolysis system due to a power failure.

(26) Many of the current competitor steam pyrolysis systems use a dual blade gate valve system at the entry to the reactor and a dual blade gate valve at the discharge exit in the reactor to reduce access of air into the reactor which experience has shown that such gate valves start to leak air into the reactor during continuous use due to a build of particulate matter on the blade gate valves creating an improper seal.

(27) The current competitor steam pyrolysis systems do not generate a sufficient amount of super- heated steam thereby causing an insufficient pressure in the reactors to ensure that no air enters thereby increasing the risk of explosion of the pyrogas produced therein and reducing the effectiveness of the pyrolysis system as a whole.

(28) The various embodiments of the ATS system contribute to improved quality for outputs such as carbon black and/or improved reliability by removing the potential for tar buildup and/or removing the possibility of dioxin contamination as a form of pollution.

(29) The ATS processor may be adapted to generate carbon black from used tires, biochar or activated carbon from human or animal wastes, wood or agricultural biomass, silage and/or other carbon rich materials.

(30) Current competitor systems produce a low complexity hydrocarbon gas, may include benzene, benzyne and/or other molecules with less than 30 atoms that are mostly hydrogen and carbon. These low complexity hydrocarbon gases are responsible for reacting with air to form various dioxin compounds that are very dangerous pollutants as unwanted byproducts of many chemical processes including the burning of wastes. Various embodiments of the ATS system can be operated to remove the possibility of generating these pollutants. The furnace includes an orifice adapted to ignite the furnace using a high BTU fuel and as the ATS chemical processor stabilizes into normal operation, uses a return gas with a low BTU turbulently mixed with air to create a high BTU fuel in the furnace, without requiring an external source.

(31) The orifice of the furnace is adapted to act as an inlet for a return gas including low complexity hydrocarbon gases, as well as steam, and to burn the low complexity hydrocarbon gases of the return gas as a low BTU fuel to remove the low complexity hydrocarbon gases from a low BTU resulting gas, and act as an inlet for a high BTU gas to be burned and combine with the low BTU resulting gas.

(32) The condenser may be implemented as any one, or a combination of three embodiments, which will be referred to as the first, second and third condenser.

The innovative state of the art ATS venturi condenser is adapted to: (30-3) Avoid condensing the low complexity hydrocarbon gases with the gases that form fuel oil and

(33) Maintain the condensing temperature above 100 degrees C Generate a steam mixture including the low complexity hydrocarbon gases for output from the condenser as the return gas to the furnace

(34) Contain an injector adapted to spray water droplets to interact with carbon particulates to remove the carbon particulates from the syngas.

(35) Introduce a steam output where the steam output reduces a build-up of tar in pipes receiving the steam output and/or a scrubbed product of the steam output.

Various embodiments may reduce the danger of explosion caused by the pyrogas produced during the pyrolyis operations and the poor quality of by-products produced from traditional pyrolysis systems while incorporating the advantages that the continuous steam pyrolysis systems have over batch pyrolysis systems.

To prevent the leakage of air into the reactors, a number of devices may be used such as sluices, valves or seals to isolate the loading and unloading of reactors from outside air, all of which have proven to have some deficiencies, which in the case of failure may lead to ignition and explosive inflammation of pyrolysis fragments and products. The ATS system uses a duel drop box method for loading the feedstock into the reactor tubes and unloading the carbon products which dramatically reduces the above events from occurring. Operating the hopper valves by using hinged dual flap air lock gates instead of dual blade gates eliminates particulate buildup of material to be pyrolyzed occurring in the sliding blade gates.

The ATS reaction chamber housing is engineered to reduce the open space inside the reaction chamber housing thereby maximizing the heat flow velocity and the efficiency of convective heating in the reaction chamber.

The unique ATS system of condensing steam outside of the oil condensers used by competitors, creates a steam condensate free of organic particulates and eliminates the problem of a repetitive build-up of organic soot, thereby permitting reuse of the condensate in the boiler.

The ATS system enables extending the time for removal of volatiles from the residual carbon black or biochar produced from the pyrolyzing of the feedstock materials through the operation of a second and third reactor each having a separate motor and may be operated for a different time period in the thermal chamber which increases the purity of the carbon black produced from crumb rubber up to 99%. Further, the time and temperature for each reactor tube may be set separate and apart from the other reactor tubes so as to produce the various portions of bio char, carbon black, bio oil or fuel oil and syngas that the operator may desire.

(36) The ATS system incorporates an Alfa Laval separator for cleaning the condensed fuel oil or bio oil separating the combustible light fuel from the heavy mazut, oil fractions and pyrolitic carbon. After separation there remains up to 2% to 3% of mazut-carbon sludge. The heavy oil fractions remain and form a mazut-carbon-slime, which can be subsequently added to the feedstock material and reprocessed through the system.

The ATS system by ensuring that at least 30% of super-heated steam by weight in relation to the weight of the feedstock material is injected into the thermolysis reactors, reduces the possibility of air entering into the reactors and creates a more thorough heat penetration into the feedstock material during the thermolysis process.

The ATS system incorporates an auger system which includes one or more blending zones, the total length of the blending zones ranging from 5% to 35% of the total length of the proceeding zones which ensures that a thorough mixing of the various feedstocks happen and that a consistent heat and steam penetration occurs.

3.2.3 Industry Attractiveness

The industry attractiveness is evaluated using the five forces model described by Porter in Competitive Advantage, 1985.

- Industry rivalry:
  The waste to energy and waste management industries are characterised by R&D and pilot projects at this time. There are relatively few competitors market ready at this time and virtually none with a product comparable to ours. Given the time it takes to develop products, plan manufacturing capacity and penetrate the market price competition is virtually non-existent. (++)

- Buyers:
  The buyers are very diverse, easy to identify and often desperate. The ATS by-product is relatively opaque in quality, performance and pricing. As well, in this price range the buyer does not have any other choices. Providing financing and grant options will lower the cost to adopt the new product. (+)

- Substitutes:
  There are several substitutes for our by-product, however they all have major shortcomings and/or are significantly more expensive. For instance, incineration produces air pollution and incineration plants are at least a factor 2 more expensive, while producing poor economic benefits in the form of sellable products. The threat of substitutes is therefore low. (++)

- Potential Entrants:
  There is a low risk of new entrants in the near term. The cost of developing new technology while not contravening our pending patents will be very high. New entrants will also have to secure bio-feed sources, some of which will have been tied up by MGI already. (++)

- Suppliers:
  Magnum is the world rights owner of the patent pending ATS Technology.

Complementors:

Financing is a complementary product. The financing option decreases the threat of entrants, as providing financing requires contacts in a different industry. It also decreases buyer power as it decreases switching cost to the product and increases it to another product. Our work in securing government assistance within the disparate industries will be a key to giving us a tremendous marketing advantage. (++)

Based on this analysis we believe the industry to be a very favourable one. Our challenge is to break through buyer cynicism resulting from so many past industry failures. Our key strategy will be to focus on the severe repercussions of not employing a solution to today's serious waste stream challenges while emphasising the relative low price of Pricing Policy

The Board and executives of Magnum's Associates have experience in emerging markets and as such are well qualified to create a pricing strategy for the products. A central core of our strategy is to not make price a component of our sales rationale; we will compete on product quality, reliability of supply and professional advice.

In the early stages of an emerging market, irresponsible entities will compete on price and drive the market down to a point where companies are not able to generate enough revenue to stay in business. As this happens in a new market, it hurts all players and casts the entire industry in a bad light; financiers grow sceptical, investors suspicious, and ultimately buyers that enjoyed a low product price for a time are unable to source product.

Furthermore, as companies subsist on slimmer and slimmer margins, corners are cut to save money and the result is unhappy workers, an unsafe working environment, poor product quality and poor service. Consumers may benefit for a brief time in an emerging market where irresponsible companies drive the prices down, but they will be disappointed in the long-term.

Magnum's Associates have already created a value-added product such that it can maintain a high price for its biochar. They have formulated and manufactured a line of unique Grow Mediums for the North American market that have a 10% biochar foundation. This enables us to maintain a price on our biochar of $2,000 - $2,600 per tonne as we sell our high-quality biochar to soil substrates that Magnum's Associates have scientifically developed or to other soil substrate blenders who have developed their own Grow Mediums but do not manufacture their own supply of high quality biochar.

At this point the Company's Associates has just begun work on developing several other specialty products for the consumer/industrial markets that will allow us to maintain high prices for our biochar.

3.3 Sales and Promotional Activities

Magnum's Associates have made connections with professionals in the biochar marketplace here in Canada and worldwide who are able to make connections to people who can facilitate the success of our sales/marketing efforts.

MGI's marketing partner has designed a new website that focusses on the biochar and grow medium products. Search engine optimization will shortly ensure that potential consumers are able to find our products as there are few producers of biochar in North America (and especially Canada). This one simple step will bring significant results.

Magnum's marketing partner has signed up a distributor for its raw biochar and Grow Medium products to service the retail sector here in Western Canada and are in discussions to secure representation in Eastern Canada and the USA. Our marketing partner has also secured the services of two agents who are representing our products to the LPs (licensed producers of medicinal cannabis) in Canada. We are currently running tests in conjunction with an LP in Montreal that has agreed to use our Cannabis Grow Mix for one crop rotation. They are documenting the process and have agreed to stand as a testimonial for our product. To this point, we have run smaller tests here in Western Canada and the results can be summarized with one quote, from a BC LP, "I've been growing marijuana for 20 years and I've never seen plants come up this fast, this healthy and vital." This is significant as the LP in Quebec has the attention (through our Agents) of 10 other LPs there; a very successful result to the test we're currently running will bring a good deal of business our way.

Magnum's Associates have attended Industry Trade Shows in the past, and they will be expanding on this with floor display participation in select shows and attendance to others. Due to the multiple applications for biochar over the next couple of years, Magnum's marketing partner will be attending a wide variety of shows; from industrial, to health & beauty, to industrial. Joining Industry Associations and advertising in Trade Journals is also part of our marketing strategy. Magnum's Associates will use wide Canadian dissemination for news releases. Once Magnum's Associates enters a new market with biochar they will use the media to draw attention from other entities in that market; our green story and the uniqueness of biochar will make us attractive to media with an environmental slant.

4. The Organization and its Management

4.1 Business Systems

To ensure focus on its core values and future success the Magnum will:

Continue to be an expert on industry needs: The Company is an expert on industry needs in Canada and worldwide and will maintain its business intelligence in order to keep abreast of changes in the marketplace. As resources become available, market research firms will be used to canvas industry players to enhance our direct knowledge of our target market to complement in-house expertise.

Capable and motivated personnel: Good personnel are very expensive. However, Canada has a relatively high immigration ratio and a fair number of well-educated and experienced immigrants have a hard time finding decent jobs. According to Statistics Canada, in 2008, 42 percent of all immigrants to Canada aged 25 to 54 had higher levels of education than their jobs require. In November 2009 Statistics Canada reported that between October 2008 and October 2009, employment among immigrants declined 12.9 percent due to the impact of the recession. Over the same period, employment for Canadian-born workers only declined 2.2 percent.[10] MGI will endeavour to empower this pool of talent and hire well qualified immigrants while supporting the transitory time where re-certification of skills is completed. Magnum sees this as part of its strategy to increase quality at lower than average cost while also creating a win-win situation for all. Magnum believes this will strengthen its strategic advantage.

Selecting personnel with demonstrated abilities to build and manage relationships: As we are looking to build Joint Venture Partnerships, it is imperative that we start off on the right foot. The relationship created during the sales process will set the tone for the ongoing Joint Venture relationship. Personnel will be excellent listeners, educators, and facilitators. Where possible, the interpersonal skills will be complimented by technical ability, otherwise new employees will be educated by the Company. Magnum is a Technology company and will be actively seeking joint venture partners to perform the operation of the ATS systems.

Full and broad use of online business systems: As a Company focussed on the sustainability market, Magnum has an obligation to look at its own systems and ensure they are as sustainable as possible. Through the use of online business systems like CRM packages, web-conferencing, online collaboration tools, server applications and others Magnum will be able to manage a geographically spread team while saving on travel costs and the need for a large central office for its employees. The Company will provide a small core office with flexible workspaces, so people that need to work at the office can, but the focus of the Company will be to travel for client purposes as much as possible to propagate the ATS Technology. This focus will therefore both strengthen the Company's green credentials as well as save costs.

4.2 Legal Structure

While there are several ways in which the Joint Venture may be designed, the preferred structures are quite simple, being an incorporated legal corporation that is owned a certain portion by Magnum and the rest by our operating JV partner. The JV entity financed by the JV partner, will take on the capital costs required including some ancillary equipment for the operation of the ATS plant.

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10 - http://www.straight.com/article-271917/vancouver/many-depressions-part-life-canada;
- Various Stats Canada reports like LSIC 2003. www.statscan.gc.ca

4.3 Organizational Structure

The JV entity structure will consist of a Board of Directors and a management team. The Board may consist of representatives from each of the two founding partners. With respect to the management team, standard practice would see Magnum's technical personnel in overseeing the technical matters of the operation.

Function	ATS-BC1700 JV
Plant Manager	1
Operators	7
Bookkeeper	1
Engineer/Foreman	1

Table 13 Personnel requirements for and ATS2000 Joint Venture

4.4 Corporate Culture and Ethics

The corporate culture and business ethics are summed up by our values, values that reflect a sense of purpose beyond making a profit.

People, Planet, Profit – focus is on achieving economic, social, environmental returns. Every product and service that we sell will have a positive effect on the community (employees included), the planet and the economic value.

Sustainability – Besides working on creating a more sustainable economy through the implementation of cutting-edge energy technologies, Magnum also strives to make its operations as sustainable as possible. Examples are minimizing commuting through the use of a virtual office environment, using public transport as much as possible, participating in recycling programs and use of recycled paper.

Embrace change and new ways of thinking – This world and especially this industry requires us to be continuously looking for the latest developments.

Respect – people deserve to be treated with respect and listened to.

Teamwork – everyone has a role in creating success and should benefit from it.

Prudence – Although we embrace change, critical evaluation and thoughtful action is required, especially in relation to money and investments.

Lead by example – be aware that we walk the talk, both inside and outside of the company.

Corporate Citizenship – do the right thing.

Magnum believes that these values strengthen the core business functions of the Company and will add to the Company's underlying strengths.

4.5 Recruitment of staff

Recruiting skilled labour

- ✓ Risk management strategy: Canada has a highly educated immigrant population that has difficulty finding work at the right level. By offering market salaries, Magnum believes it can recruit well educated and motivated staff in the immigrant population.

5. Financial Forecasts

5.1 Proforma

Based on the business case presented Magnum's Associates have prepared financial forecasts shown in Appendix A.

5.2 Financing

Magnum welcomes all interested qualified parties to Joint Venture. Magnum will contribute the ATS Technology and the Joint Venture party will contribute the required funding that will achieve a return on investment on capital invested on the ATS system estimated to be about 3 years after commercial operations commence.

Carbon Savings

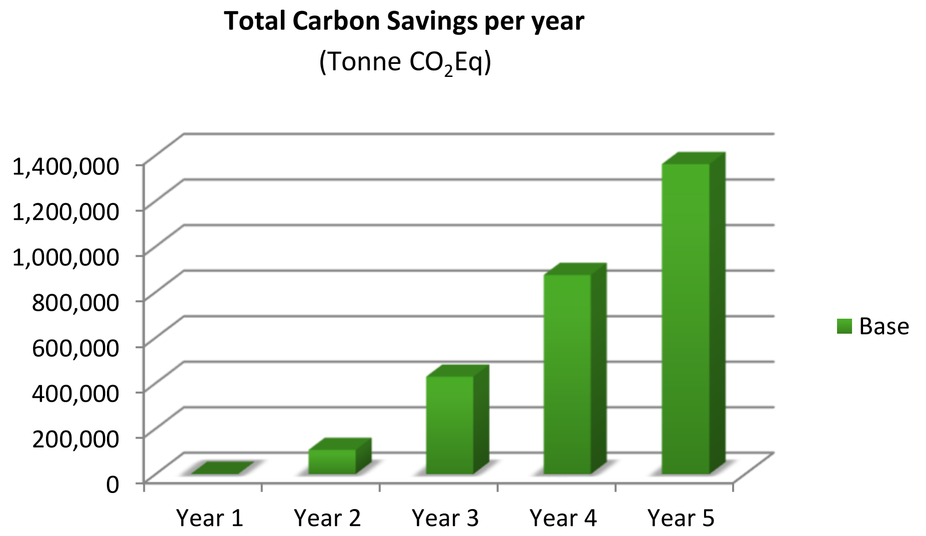
The Company is focused on the triple bottom line. Not only are we interested in the important aspect of financial return on investment, the Company is also interested in environmental sustainability of the business. There are many ways to measure sustainability for the Company it is focusing on re-using materials considered waste and displacing the use of fossil fuels. Greenhouse gas savings (Carbon Dioxide) are therefore considered an important part of the return on investment.

In the table below the amount of carbon dioxide saved from being added to the environment for the first phase waste streams is provided. Further details to the Carbon savings calculations are provided in Appendix G.

Feedstock	CO_2 savings
Used Tires	2.7 tonnes
Plastics	2.5 tonnes
Manure	1.8 tonnes
Wood	2.4 tonnes

Table 14 Carbon dioxide savings per tonne of feedstock using the ATS technology

Based on the numbers provided in Table 14 the total CO_2 savings per year of the base case scenario is provided in the graph below.



The carbon savings achieved through re-using waste materials is considerable. Besides the positive impact on the environment, with future developments around carbon trading there is a considerable impact on the financial bottom line. This impact has not been modelled in the financials above due to the uncertainty surrounding carbon trading and the volatile nature of valuing a tonne of CO_2Eq. However, with a tonne of CO_2 valued at around $17[11], the financial impact in year 5 would be $22M added to the bottom line.

The Company's Associates are currently in contact with carbon trading specialists how to best take advantage of the opportunities provided by carbon trading.
As well, it should be noted that all the ProForma Financials are prepared by personnel of MGI Thermolysis Systems Inc., the manufacturing partner of Magnum, with input from Emergent Waste Solutions Inc., Magnum's Licensee for Canada.

[11] https://www.theice.com/productguide/ProductGroupHierarchy.shtml?groupDetail=&group.groupId=19. Price was Eur 13.19 on 24 Aug 2011

Appendix A.1 – ATS1000 to produce biochar

For the New ATS1000 Destined for Canada (in CAD$)

REVENUE	Assumptions	Sale Price per Ton	% of Biochar	Total Tonnes	1st Year Ended	2nd Year Ended	3rd Year Ended
Bio Oil	1	n/a					
Biochar - Export	2a	2,099	34%	14,256	10,174,482	10,174,482	10,174,482
Biochar - Domestic	2b	2,600	34%	0	-	-	-
Total Revenue					**10,174,482**	**10,174,482**	**10,174,482**
Sales Commission for USA	3a		7%		712,214	712,214	712,214
Royalty % of Total Revenue	3b		5%		508,724	508,724	508,724
Feedstock - $40/ ton.bone dry	4	40		13,464	538,560	538,560	538,560
Total Cost of Goods Sold					**1,759,498**	**1,759,498**	**1,759,498**
Gross Profit					**8,414,984**	**8,414,984**	**8,414,984**
Operational Expense							
Electricity Equipment	5				15,000	15,750	16,538
Shipping from Vegreville	5a		0		-	-	-
Diesel or Natural Gas	6				500	525	551
Water	7				2,176	2,285	2,399
Maintenance Equipment	8				60,000	63,000	66,150
Water Sewage Treatment	9				572	601	631
Landfill waste disposal fee	10				2,000	2,100	2,205
Chemical Catalyst	11				-	-	-
Filter & Gasket Replacement	12				-	-	-
Electricity Plant Office	13				4,000	4,200	4,410
Waste Discharge	14				-	-	-
Cleaning	15				18,000	18,900	19,845
Water -Coffee Misc Office	16				3,000	3,150	3,308
Plant Rental ($5.50/sq ft)	17				44,000	44,000	44,000
Triple net expenses ($2.90 sq ft)	18				23,200	23,200	23,200
Total					**172,448**	**177,711**	**183,236**
Employee Expense			**No.**	**Salary**			
Foreman / Asst. Plant manager	19		1	50,000	50,000	51,000	52,020
Equipment Operators			10	36,000	360,000	367,200	374,544
Engineer / Plant Manager	19(a)		1	60,000	60,000	61,200	62,424
Technical Consultant			1	60,000	60,000	61,200	62,424
Book keeper			1	40,000	40,000	40,800	41,616
Total					**570,000**	**581,400**	**593,028**
CPP & EI	20		7.23%		41,222	42,047	42,888
Employee Benefits	21		6.50%		37,050	37,791	38,547
Total					**648,272**	**661,238**	**674,463**
Liability and Insurance							
Liablity & Property	22				42,000	42,840	43,697
Auto	23		1		3,000	3,060	3,121
Worker's Comp	24		0.97%		5,529	5,640	5,752
Total					**50,529**	**51,540**	**52,570**
Office & Yard Expense							
Office & Lab supplies	25				5,000	5,250	5,513
Yard Maintence	26				12,000	12,600	13,230
Postage & Courier					2,000	2,100	2,205
Cell Phones	27		3		1,800	1,890	1,985
Office phone & fax	28				4,500	4,725	4,961
Security system	29				12,000	12,600	13,230
Total					**37,300**	**39,165**	**41,123**
Adminstrative Expenses							
Testing	30				12,000	12,600	13,230
Fees & Licenses	31				7,500	3,750	1,875
Head Office	31				80,000	81,600	83,232
Total					**99,500**	**97,950**	**98,337**
Total Operating Expenses					**1,008,050**	**1,027,603**	**1,049,730**
Amortization							
AATS1000 Plant	32	$7,716,000	- Starting Value		385,800	385,800	385,800
Total Expenses					**1,393,850**	**1,413,403**	**1,435,530**
Net Profit Before Tax (NPBT) (CAD					**7,021,134**	**7,001,581**	**6,979,454**
Net Profit Before Tax (USD)	33				**5,280,319**	**5,265,613**	**5,248,973**

3

1	No revenue projected for bio oil production although may be a revenue generator in the future
2	Feedstock is delivered chipped, mixed & dried to a level below 10% moisture
	The wood fibre being processed is: homogenous, bone dry and the particle size is between 0.8 and 10mm
2a	Per Green Earthology PO US$550/2m^3
2b	0% of production is for the domestic retail market & direct to growers at $2,600 per tonne. Revenue is projected to be increased by 6% in year 2 and by 7% in year 3, as new products are being developed that are being charged a higher price..
3a	Sales commission for supplying California contract @ 7%
3b	Royalty as per contract with Licensor (5%)
4	Feedstock is delivered to factory bone dry for $40/tonne
5	Electricity is based on existing plant using 500,000 kwh @$0.02/kwh
5a	Shipping cannot be exactly ascertained until a shipping date is presented - it applies only to domestic sales
6	Diesel projected for startup operations
7	Water projection of 600,000 gallons @commercial rate of $0.39/m3
8	Projected cost of $50,000 based upon plant size and equipment
9	Water & sewage treatment based on 70% of water cost & usuage-($4.70/17m3)
10	Landfill waste disposal fee- based on research
11	Chemical catalyst (if necessary to create activated carbon) based on existing plant costs
12	Filter, gasket & sealant- based on Vegreville plant in Alberta, Canada (accounted for under assumption 8)
13	Electricity for Office and Lab including equipment usage
14	Projected waste disposal fee of $4,000 based on research data (see assumption 9)
15	Projected cleaning costs of Lab, Office and Staff room (shared with ATS500)
16	Projected Office, water, coffee & incidental office supplies
17	Plant Rental
18	Triple Net Rental charges
19/19(a)	For this small plant, there is no need to have a full time Plant Manager. Instead, the Engineer will act as the Plant Manager and the Foreman will also serve as the Assistant Plant Manager.
20	Employers portion of payroll taxes (includes CPP & EI totals 7.23%)
21	Employee benefits - employers portion - estimated to be 6.5% (Canadian average)
22	Insurance costs for public liability and property
23	Projected auto insurance (estimated)
24	Projected Workmens compensation- based on Alberta assessments (1.9%)
25	Projected Office and Lab supplies (based on research)
26	Yard maintenance
27	For the provision of one cell phone per shift
28	These costs are shared with the ATS500 entity in the adjoining building
29	Cost is estimated at $12,000 and is shared equally with the adjoinging ATS500
30	Lab testing and certification testing
31	CFIA certification and IBI Membership fees will be paid in 2018. Subsequently there will be few new fees & licenses
32	Purchase cost of the AATS1000 system is CAD$7,716,000 (US$6,000,000) and exchange rate used as at May 25, 2018 = 1.286). Flat rate of 5% amortization is used starting Year 1.
33	As at June 29, 2018. the conversion rate is US$ 1 = CAD $ 1.32968

Calculating Feedstock Required (in tonnes)

Kg per hour required	1,800
Kg per year required	14,256,000
Tonnes per year	14,256

Appendix A.2 – Wood Waste Proforma for Biochar

For ATS2000 Producing Biochar (in CAD$)

REVENUE	Assumptions	Sale Price per Ton	% of Biochar	Total Tonnes	1st Year Ended	2nd Year Ended	3rd Year Ended
Bio Oil	1	n/a					
Biochar - Export	2a	2,099	34%	27,720	19,783,715	19,783,715	19,783,715
Biochar - Domestic	2b	2,600	34%	0	-	-	-
Total Revenue					**19,783,715**	**19,783,715**	**19,783,715**
Sales Commission for USA	3a		7%		1,384,860	1,384,860	1,384,860
Royalty % of Total Revenue	3b		5%		989,186	989,186	989,186
Feedstock - $40/ ton.bone dry	4	40		27,720	1,108,800	1,108,800	1,108,800
Total Cost of Goods Sold					**3,482,846**	**3,482,846**	**3,482,846**
Gross Profit					**16,300,869**	**16,300,869**	**16,300,869**
Operational Expense							
Electricity Equipment	5				18,000	18,900	19,845
Shipping from Vegreville	5a		0		-	-	-
Diesel or Natural Gas	6				700	735	772
Water	7				2,418	2,539	2,666
Maintenance Equipment	8				60,000	63,000	66,150
Water Sewage Treatment	9				608	638	670
Landfill waste disposal fee	10				2,000	2,100	2,205
Chemical Catalyst	11				-	-	-
Filter & Gasket Replacement	12				-	-	-
Electricity Plant Office	13				4,000	4,200	4,410
Waste Discharge	14				-	-	-
Cleaning	15				9,000	9,450	9,923
Water -Coffee Misc Office	16				1,500	1,575	1,654
Plant Rental ($5.50/sq ft)	17				44,000	44,000	44,000
Triple net expenses ($2.90 sq ft)	18				23,200	23,200	23,200
Total					**165,426**	**170,337**	**175,494**
Employee Expense			**No.**	**Salary**			
Foreman / Asst. Plant manager	19		1	50,000	50,000	51,000	52,020
Equipment Operators			10	36,000	360,000	367,200	374,544
Engineer / Plant Manager	19(a)		1	60,000	60,000	61,200	62,424
Technical Consultant			1	60,000	60,000	61,200	62,424
Book keeper			1	40,000	40,000	40,800	41,616
Total					**570,000**	**581,400**	**593,028**
CPP & EI	20		7.23%		41,222	42,047	42,888
Employee Benefits	21		6.50%		37,050	37,791	38,547
Total					**648,272**	**661,238**	**674,463**
Liability and Insurance							
Liablity & Property	22				42,000	42,840	43,697
Auto	23		1		1,500	1,530	1,561
Worker's Comp	24		0.97%		5,529	5,640	5,752
Total					**49,029**	**50,010**	**51,010**
Office & Yard Expense							
Office & Lab supplies	25				5,000	5,250	5,513
Yard Maintence	26				12,000	12,600	13,230
Postage & Courier					2,000	2,100	2,205
Cell Phones	27		3		1,800	1,890	1,985
Office phone & fax	28				4,500	4,725	4,961
Security system	29				12,000	12,600	13,230
Total					**37,300**	**39,165**	**41,123**
Adminstrative Expenses							
Testing	30				12,000	12,600	13,230
Fees & Licenses	31				7,500	3,750	1,875
Head Office	31				80,000	81,600	83,232
Total					**99,500**	**97,950**	**98,337**
Total Operating Expenses					**999,527**	**1,018,700**	**1,040,427**
Amortization							
AATS2000 Plant	32	$13,650,000	- Starting Value		682,500	682,500	682,500
Total Expenses					**1,682,027**	**1,701,200**	**1,722,927**
Net Profit Before Tax (NPBT) (CAD					**14,618,842**	**14,599,669**	**14,577,942**
Net Profit Before Tax (USD)	33				**10,994,255**	**10,979,837**	**10,963,497**

Appendix A.3 – Wood Waste Proforma for Activated Carbon

ATS2000 Producing Activated Carbon in Philippines (in CAD$)

REVENUE	Assumptions	Sale Price per Tonne	% of Prod.	Total Ton Production	Revenue	1st year	2nd year	3rd year
Bio Oil	1	300	30%	7,425	2,227,500	2,227,500	2,294,325	2,363,155
Activated Carbon	1	1,500	25%	6,188	9,281,250	9,281,250	9,559,688	9,846,478
Total Revenue					**11,508,750**	**11,508,750**	**11,854,013**	**12,209,633**
Operational Expense								
Electricity Equipment	2				190,000	190,000	193,800	197,676
Diesel or Natural Gas	3				48,000	48,000	48,960	49,939
Water	4				7,310	7,310	7,456	7,605
Maintenance Equipment	5				60,000	60,000	61,200	62,424
Water Treatment	6				2,000	2,000	2,040	2,081
AC Packaging	7				464,100	464,100	473,382	482,850
Chemical Catalyst	8				30,000	30,000	30,600	31,212
Filter Replacement	9				33,000	33,000	33,660	34,333
Plant Rental	10				36,000	36,000	36,720	37,454
Property Taxes	11				7,500	7,500	7,650	7,803
Electricity Plant Office	12				18,000	18,000	18,360	18,727
Cleaning	13				2,400	2,400	2,448	2,497
Total					**898,310**	**898,310**	**916,276**	**934,602**
Employee Expense			**No.**	**Salary**				
Plant Manager			1	36,000	36,000	36,000	37,080	38,934
Marketing and Product Manager			1	24,000	24,000	24,000	24,720	25,956
Asst Plant Manager			1	24,000	24,000	24,000	24,720	25,956
Foreman			3	12,000	36,000	36,000	37,080	38,934
Equipment Operators			12	36,000	432,000	432,000	444,960	467,208
Engineers			2	18,000	36,000	36,000	37,080	38,934
Chemist			1	18,000	18,000	18,000	18,540	19,467
Adminstrative Assistants			2	3,600	7,200	7,200	7,416	7,787
Marketing & Sales Staff			1	24,000	24,000	24,000	24,720	25,956
Accounting Dept			1	18,000	18,000	18,000	18,540	19,467
Total					**655,200**	**655,200**	**674,856**	**708,599**
Liability and Insurance								
Liablity	14				30,000	30,000	30,000	30,000
Worker's Comp			0.97%		6,355	6,355	6,546	6,873
Total					**36,355**	**36,355**	**36,546**	**36,873**
Office & Yard Expense								
Office & Lab supplies	15				24,000	24,000	24,480	24,970
Yard Maintence	16				2,400	2,400	2,448	2,497
Postage & Courier					12,000	12,000	12,240	12,485
Cell Phones			9		9,000	9,000	9,180	9,364
Office phone & fax					1,500	1,500	1,530	1,561
Security system					3,600	3,600	3,672	3,745
Total					**52,500**	**52,500**	**53,550**	**54,621**
Adminstrative Expenses								
Marketing/Advertising	17		1.5%		172,631	172,631	176,084	179,606
Legal					12,000	12,000	12,240	12,485
Public Relations					60,000	60,000	61,200	62,424
Testing					60,000	60,000	61,200	62,424
Fees & Licenses					12,000	12,000	12,240	12,485
Commission	18		**3%**		345,263	345,263	352,168	359,211
Total					**661,894**	**661,894**	**675,132**	**688,634**
Total Operating Expenses					**2,304,259**	**2,304,259**	**2,356,360**	**2,423,329**
Amortization @5%-10.5M	19		5%		525,000	525,000	498,750	473,813
Royalty % of gross revenue	20		**5%**		**575,438**	**575,438**	**592,701**	**610,482**
Net Profit Before Tax (NPBT)					**8,629,053**	**8,629,053**	**8,904,952**	**9,175,822**

Appendix A.4 – Plastics Proforma

For ATS2000 Converting Plastics to Diesel Fuel (in CAD$)

REVENUE	Assumptions	Sale Price per Ton	% of Prod.	Total Ton Production	Revenue	1st year	2nd year	3rd year
Fuel Oil/$500/T		500	75%	17,820	8,910,000	8,910,000	9,177,300	9,452,619
N grade CB		500	2%	475	237,600	237,600	244,728	252,070
Tipping fees		0						
Total Revenue					**9,147,600**	**9,147,600**	**9,422,028**	**9,704,689**
Royalty % of gross revenue	28		5%		457,380	457,380	471,101	485,234
Cost of used Plastics	1	0%			-	-	-	-
Gross Profit					**8,690,220**	**8,690,220**	**8,950,927**	**9,219,454**
Operational Expense								
Diesel or natural gas	29				2,400	2,400	2,448	2,497
Electricity Equipment	2				66,700	66,700	68,034	69,395
Water	3				9,500	9,500	9,690	9,884
Maintenance Equipment	4				75,000	75,000	76,500	78,030
Water Sewage Treatment	5				6,650	6,650	6,783	6,919
Landfill waste disposal fee	6				33,000	33,000	33,660	34,333
CB Packaging	7				23,760	23,760	24,235	24,720
Chemical Catalyst	8				12,000	12,000	12,240	12,485
Filter, Gasket Replacements	8				33,000	33,000	33,660	34,333
Plant Rental	10				72,000	72,000	73,440	74,909
Triple net expenses	11				20,000	20,000	20,400	20,808
Electricity Plant Office	12				18,000	18,000	18,360	18,727
Misc. Waste Disposal	13				8,400	8,400	8,568	8,739
Cleaning	14				18,000	18,000	18,360	18,727
Water, Coffee ect. - Office	15				3,000	3,000	3,060	3,121
Total					**401,410**	**401,410**	**409,438**	**417,627**
Employee Expense			**No.**	**Salary**				
Plant Manager			1	66,000	66,000	66,000	67,320	68,666
Marketing and Product Manager			1	54,000	54,000	54,000	55,080	56,182
Asst Plant Manager			1	48,000	48,000	48,000	48,960	49,939
Foreman			3	42,000	126,000	126,000	128,520	131,090
Equipment Operators			22	36,000	792,000	792,000	807,840	823,997
Engineers			1	60,000	60,000	60,000	61,200	62,424
Chemist			1	60,000	60,000	60,000	61,200	62,424
Adminstrative Assistants			2	24,000	48,000	48,000	48,960	49,939
Marketing & Sales Staff			1	48,000	48,000	48,000	48,960	49,939
Accounting Dept			1	48,000	48,000	48,000	48,960	49,939
Total			34		**1,350,000**	**1,350,000**	**1,377,000**	**1,404,540**
Payroll Taxes	16		10%		135,000	135,000	137,700	140,454
Medical	17		37	11,000	407,000	407,000	415,140	423,443
401 K	18		5%		67,500	67,500	68,850	70,227
Total					**1,959,500**	**1,959,500**	**1,998,690**	**2,038,664**
Liability and Insurance								
Liablity	19				31,502	31,502	32,132	32,775
T&E	20				24,000	24,000	24,480	24,970
Property	21				30,000	30,000	30,600	31,212
Auto	22		3		7,488	7,488	7,638	7,791
Umbrella	23				15,000	15,000	15,300	15,606
Worker's Comp			3%		40,500	40,500	41,310	42,136
Total					**148,490**	**148,490**	**151,460**	**154,489**
Office & Yard Expense								
Office & Lab supplies	24				48,000	48,000	48,960	49,939
Yard Maintence	25				24,000	24,000	24,480	24,970
Postage & Courier					24,000	24,000	24,480	24,970
Cell Phones			15		9,000	9,000	9,180	9,364
Office phone & fax					4,500	4,500	4,590	4,682
Security system					12,000	12,000	12,240	12,485
Total					**121,500**	**121,500**	**123,930**	**126,409**
Adminstrative Expenses								
Marketing/Advertising	26		1.5%		137,214	137,214	137,214	137,214
Legal					12,000	12,000	12,000	12,000
Public Relations					60,000	60,000	60,000	60,000
Testing					48,000	48,000	48,000	48,000
Fees & Licenses					36,000	36,000	36,000	36,000
Commission	27		**5%**		457,380	457,380	457,380	457,380
Total					**750,594**	**750,594**	**750,594**	**750,594**
Total Operating Expenses					**3,381,494**	**3,381,494**	**3,434,112**	**3,487,782**
Net Profit Before Tax (NPBT)					**5,308,726**	**5,308,726**	**5,516,815**	**5,731,672**

Appendix A.5 – Waste Tires Proforma

For ATS2000 Converting Tires to Carbon Black & Fuel (in CAD$)

REVENUE	Assumptions	Sale Price per Ton	% of Prod.	Total Ton Production	Revenue	1st year	2nd year	3rd year
Fuel Oil/$400/T		400	40%	6,192	2,476,800	2,476,800	2,551,104	2,627,637
N grade CB		2,000	38%	5,882	11,764,800	11,764,800	12,117,744	12,481,276
Steel		300	7%	1,109	332,640	332,640	342,619	352,898
Tire recycling $3.00/tire	1	300		15,890	4,767,000	4,767,000	4,910,010	5,057,310
Total Revenue					**19,341,240**	**19,341,240**	**19,921,477**	**20,519,122**
Operational Expense								
Electricity Equipment	2				11,340	11,340	11,567	11,798
Diesel or Natural Gas	3				48,000	48,000	48,960	49,939
Water	4				7,310	7,310	7,456	7,605
Maintenance Equipment	5				50,000	50,000	51,000	52,020
Water Treatment	6				2,000	2,000	2,040	2,081
Landfill waste disposal fee	7				33,000	33,000	33,660	34,333
CB Packaging	8				330,000	330,000	336,600	343,332
Chemical Catalyst	9				60,000	60,000	61,200	62,424
Filter Replacement	10				33,000	33,000	33,660	34,333
Plant Rental	11				72,000	72,000	73,440	74,909
Property Taxes	12				15,000	15,000	15,300	15,606
Electricity Plan Office	13				18,000	18,000	18,360	18,727
Waste Discharge	14				8,400	8,400	8,568	8,739
Cleaning	15				18,000	18,000	18,360	18,727
Water - Office	16				3,000	3,000	3,060	3,121
Total					**709,050**	**709,050**	**723,231**	**737,696**
Employee Expense			**No.**	**Salary**				
Plant Manager			1	66,000	66,000	66,000	69,300	72,765
Marketing and Product Manager			1	54,000	54,000	54,000	56,700	59,535
Asst Plant Manager			1	48,000	48,000	48,000	50,400	52,920
Foreman			3	42,000	126,000	126,000	132,300	138,915
Equipment Operators			12	36,000	432,000	432,000	453,600	476,280
Engineers			2	60,000	120,000	120,000	126,000	132,300
Chemist			1	60,000	60,000	60,000	63,000	66,150
Adminstrative Assistants			2	24,000	48,000	48,000	50,400	52,920
Marketing & Sales Staff			2	48,000	96,000	96,000	100,800	105,840
Accounting Dept			1	48,000	48,000	48,000	50,400	52,920
Total					**1,098,000**	**1,098,000**	**1,152,900**	**1,210,545**
CPP & EI	17		7.23%		79,385	79,385	83,355	87,522
Benefits			6.50%		71,370	71,370	74,939	78,685
Total					**1,248,755**	**1,248,755**	**1,311,193**	**1,376,753**
Liability and Insurance								
Liablity	18				60,000	60,000	61,200	62,424
Worker's Comp			0.97%		10,651	10,651	11,183	11,742
Total					**70,651**	**70,651**	**72,383**	**74,166**
Office & Yard Expense								
Office & Lab supplies	19				48,000	48,000	48,960	49,939
Yard Maintence	20				24,000	24,000	24,480	24,970
Postage & Courier					24,000	24,000	24,480	24,970
Cell Phones			15		9,000	9,000	9,180	9,364
Office phone & fax					4,500	4,500	4,590	4,682
Security system					12,000	12,000	12,240	12,485
Total					**121,500**	**121,500**	**123,930**	**126,409**
Adminstrative Expenses								
Marketing/Advertising	21		1.5%		290,119	290,119	295,921	301,839
Legal					12,000	12,000	12,240	12,485
Public Relations					60,000	60,000	61,200	62,424
Testing					48,000	48,000	48,960	49,939
Fees & Licenses					24,000	24,000	24,480	24,970
Commission	22		**5%**		967,062	967,062	986,403	1,006,131
Total					**1,401,181**	**1,401,181**	**1,429,204**	**1,457,788**
Total Operating Expenses					**3,551,137**	**3,551,137**	**3,659,942**	**3,772,812**
Amortization @5%-10.5M	23		5%		525,000	525,000	498,750	473,813
Royalty % of gross revenue	24		**5%**		**967,062**	**967,062**	**996,074**	**1,025,956**
Net Profit Before Tax (NPBT)					**14,823,041**	**14,823,041**	**15,265,462**	**15,720,354**
Net Profit Before Tax (USD)	25				**11,147,826**	**11,147,826**	**11,480,553**	**11,822,659**

Appendix A.6 – MSW Proforma

For ATS5000 Converting MSW to Biochar (in CAD$)

REVENUE	Assumptions Conversion %	Sale Price per Ton	% post sorting prod.	Total Ton Production/yr	1st year	2nd year	3rd year
From pre sorting	Steel	300	10.50%	4,158	1,247,400	1,247,400	1,247,400
	Glass	100	5.80%	2,297	229,700	229,700	229,700
Biomass & yard Trimmings	Biochar 25%	1,500	33%	13,068	19,602,000	19,602,000	19,602,000
Cardboard & paper	Biochar 35%	1,500	31%	12,276	18,414,000	18,414,000	18,414,000
Wood	Biochar 30%	1,500	7%	2,772	4,158,000	4,158,000	4,158,000
Ash Soil Misc carbon base	Biochar 15%	1,500	3%	1,188	1,782,000	1,782,000	1,782,000
TOTAL	**Total**			**29,304**	**45,433,100**	**45,433,100**	**45,433,100**
Plastics	Fuel Oil 70%	400	15%	5,940	2,376,000	2,376,000	2,376,000
Textile ,rubber & leather	Fuel oil 50%	400	10%	3,960	1,584,000	1,584,000	1,584,000
TOTAL	**Total**				**3,960,000**	**3,960,000**	**3,960,000**
Tipping Fee	1	100		58,000	5,800,000	5,800,000	5,800,000
GROSS REVENUE					**55,193,100**	**55,193,100**	**55,193,100**
Royalty % of gross revenue	28	5%			2,759,655	2,759,655	2,759,655
GROSS REVENUE LESS ROYALTY					**52,433,445**	**52,433,445**	**52,433,445**
Operational Expense							
Diesel or natural gas	29				48,000	48,000	48,000
Electricity Equipment	2				175,000	175,000	175,000
Water	3				20,000	20,000	20,000
Maintenance Equipment	4				260,000	260,000	260,000
Water Sewage Treatment	5				20,000	20,000	20,000
Landfill waste disposal fee	6				120,000	120,000	120,000
CB Packaging	7				1,465,200	1,465,200	1,465,200
Chemical Catalyst	8				72,600	72,600	72,600
Filter, Gasket Replacements	9				96,000	96,000	96,000
Plant Rental	10				600,000	600,000	600,000
Triple Net costs	11				200,000	200,000	200,000
Electricity Plant Office	12				18,000	18,000	18,000
Misc. Waste Disposal	13				14,000	14,000	14,000
Cleaning	14				36,000	36,000	36,000
Water, Coffee ect. - Office	15				10,000	10,000	10,000
Total					**3,154,800**	**3,154,800**	**3,154,800**
Employee Expense			**No.**	**Salary**			
Plant Manager			1	66,000	66,000	66,000	66,000
Marketing and Product Manager			1	54,000	54,000	54,000	54,000
Asst Plant Manager			1	48,000	48,000	48,000	48,000
Foreman			2	42,000	84,000	84,000	84,000
Equipment Operators			28	36,000	1,008,000	1,008,000	1,008,000
Engineers			2	60,000	120,000	120,000	120,000
Chemist			1	60,000	60,000	60,000	60,000
Adminstrative Assistants			2	24,000	48,000	48,000	48,000
Marketing & Sales Staff			3	48,000	144,000	144,000	144,000
Accounting Dept			1	48,000	48,000	48,000	48,000
Total			42		**1,680,000**	**1,680,000**	**1,680,000**
Payroll Taxes	16		10%		168,000	168,000	168,000
Medical	17		42	11,000	462,000	462,000	462,000
401 K	18		5%		84,000	84,000	84,000
Total					**2,394,000**	**2,394,000**	**2,394,000**
Liability and Insurance							
Liablity	19				31,500	31,500	31,500
Transport and cargo	20				24,000	24,000	24,000
Property	21				48,000	48,000	48,000
Auto	22				7,500	7,500	7,500
Umbrella	23				30,000	30,000	30,000
Worker's Comp			3%		50,400	50,400	50,400
Total					**191,400**	**191,400**	**191,400**
Office & Yard Expense							
Office & Lab supplies	24				96,000	96,000	96,000
Yard Maintence	25				48,000	48,000	48,000
Postage & Courier					48,000	48,000	48,000
Cell Phones			15		9,000	9,000	9,000
Office phone & fax					4,500	4,500	4,500
Security system					24,000	24,000	24,000
Total					**229,500**	**229,500**	**229,500**
Adminstrative Expenses							
Marketing/Advertising	26		1.5%		827,897	827,897	827,897
Legal					12,000	12,000	12,000
Testing					144,000	144,000	144,000
Fees & Licenses					30,000	30,000	30,000
Commission	27		**5%**		2,759,655	2,759,655	2,759,655
					3,773,552	**3,773,552**	**3,773,552**
Total Operating Expenses					**9,743,252**	**9,743,252**	**9,743,252**
Net Profit Before Tax					**42,690,194**	**42,690,194**	**42,690,194**

Appendix B - **Proposed installation of the ATS-1000 in Canada.**

WOOD BIOMASS & ESSENTIAL OILS – THE NEED

In recent years, the young and dense pine forests of Canada have suffered extreme insect outbreaks. To restore these forests to an ecologically sustainable condition a large number of small-diameter pine trees must be felled. Whether the operation is for salvage or fuel reduction, large volumes of timber and slash would be generated. The economic value of small-diameter pine as timber, however, does not offset capital and operation costs of handling and processing. Options for overcoming this constraint include recovering more value from the biomass as energy, wood products from larger diameter trees, and chemicals. Advanced timber manufacturing processes can produce engineered lumber, beams, and sheets from small dimension stock. Heat and power can be generated by combustion; hydrocarbons can be produced in a reformer; and other chemicals produced with Thermolysis. An often-overlooked opportunity of integration with wood and energy production is the steam distillation of volatile, essential oils—specifically pine oil and pine needle oil.

Renewable energy is of growing importance in satisfying environmental concerns. Wood and other forms of biomass including energy crops and agricultural and forestry wastes are some of the main renewable energy resources. These can provide the source of renewable liquid, gaseous and solid fuels. Biomass is considered the renewable energy source with the highest potential to contribute to the energy needs of modern society for both the developed and developing economies worldwide. Energy from biomass based on short rotation forestry and other energy crops can contribute significantly towards the objectives of the Kyoto Agreement in reducing the greenhouse gases emissions and to the problems related to climate.

WOOD BIOMASS & ESSENTIAL OILS – THE SOLUTION

Properties of biomass Thermolysis oils

Pyrolytic liquid is referred to by many names including pyrolytic oil, bio-oil, bio-crude-oil, bio-fuel-oil, wood liquids, wood oil, liquid smoke, wood distillates, pyrolytic tar, pyrolytic acid, and liquid wood. The crude pyrolytic liquid from an indirect-heat pyrolysis process is usually dark brown and free flowing with a distinctive smoky smell. Chemically, it is closely related to biomass in elemental composition and is composed of a very complex mixture of oxygenated hydrocarbons.

Solid char may also be present. The physical properties of bio-oils are described in several publications. These properties result from the chemical composition of the oils, which are significantly different from that of petroleum derived oils. Bio-oils are multi-component mixtures comprised of different size molecules derived primarily from de-polymerization and fragmentation reaction of three key biomass building blocks, cellulose, hemicelluloses, and lignin.

Therefore, the elemental composition of bio-oil resembles that of biomass rather than that of petroleum oils. Basic data for bio-oils and conventional petroleum fuels are compared and those most important for combustion are discussed below. More detail on fuel-related characteristics is provided. Below is the content of bio-mass from indirect-heat Thermolysis process.

ATS system in distillation mode:

The ATS System can be adjusted to work as a distillation system. To operate in this mode, the temperature of the stage I and stage II processing must be set below 200°C. The ATS System will use steam to maintain this temperature. This process is suitable for essential oil production.

The advantage:

- The wood still contains the organic compounds. It is burnable. It can be retreated to produce bio-oil.

The disadvantage:

- The wood will not completely de-compose and production of carbon black is impossible in this process.

ATS System in dual mode:

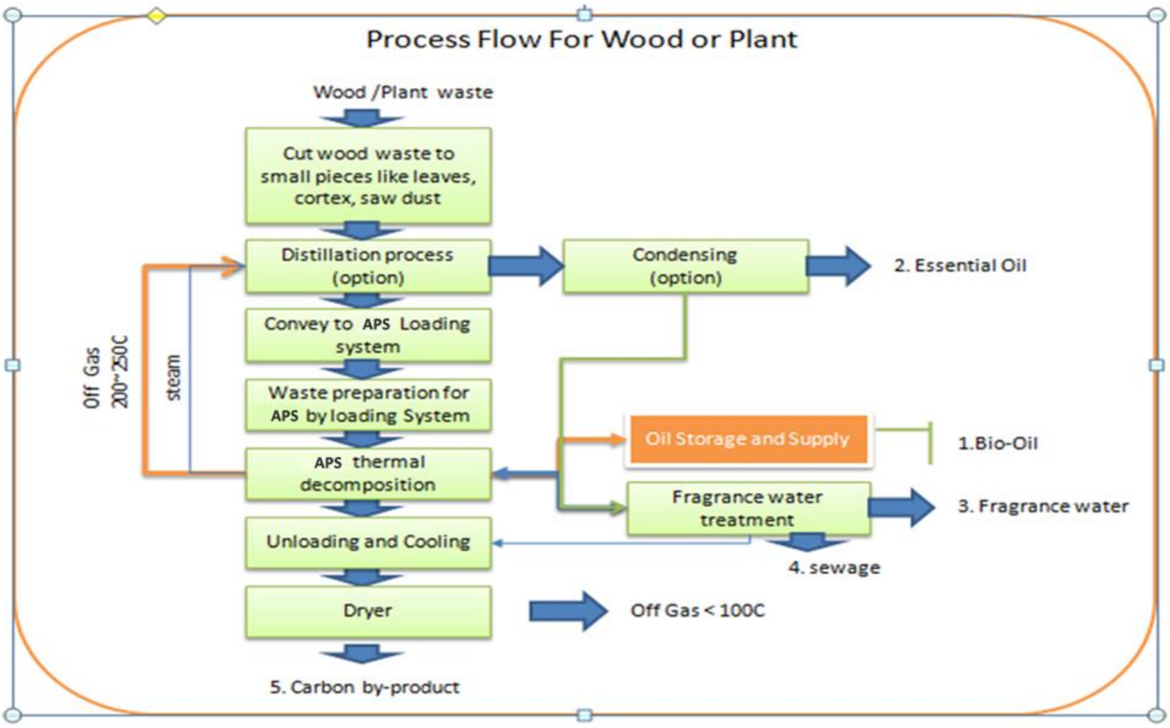
ATS also can work in a distillation mode and Thermolysis mode at the same time, a so called "dual mode". We can initial the stage I as a distillation process, the stage II is the Thermolysis process. After processing, the oils are blended together. The problem is how to separate the essential oil from bio-oil. The solution may be to adjust the condensing temperature to separate the bio-oil and essential oil.

1. Process flow:

ATS can adjust the processing temperature of stage I to produce different kinds of oil products. To produce essential oil, the temperature must be under 200C. To produce the Bio-Oil, the temperature must be under 410C.

The flow chart does not indicate what kind of product the process produces. The customer can determine that by himself.

i. Process Flow:



ii. Description of Process flow chart

a. Pine wood, wood waste, or plant waste has to be cut into small pieces. The smaller the size the better it is. After cutting, the waste will be sent to the distillation process.

b. Distillation process is optional. ATS can work in a distillation mode. The second stage process of ATS will crack the waste to biofuel. The essential oil will blend with Bio-Oil. So, we suggest adding a distillation process. The steam and heat source can come from the ATS System's off-gas and extra steam sources.

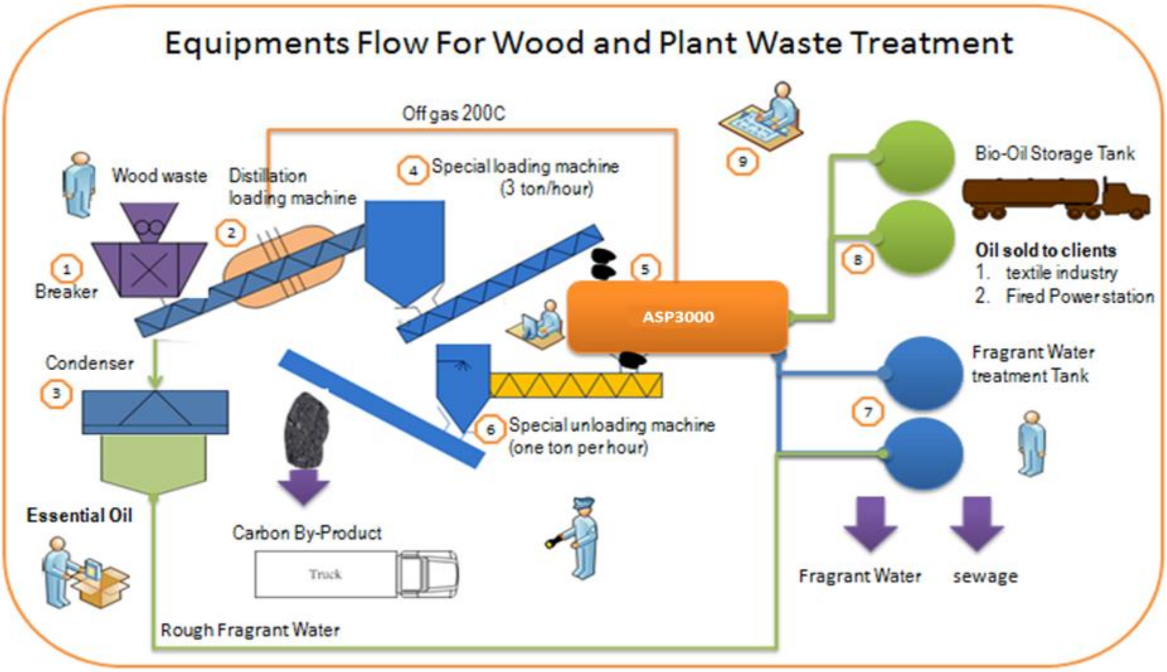
   After distillation, the vapour will be condensed and produce the essential oil and fragrance water. If the fragrance water does not meet the concentration levels required, it will be recycled until the concentration reaches the level required for sale.

c. The waste will be sent to the loading system of ATS after the distillation process.

d. ATS system will crack the wood to produce the bio-oil by the Thermolysis process. The bio-oil will be sent to the bio-oil tank for storage.

e. After ATS cracking, the carbon products will be unloaded with cooling. The carbon product can be carbon black or activated carbon. To sell the carbon black in industries, the carbon black has to be ground under 300mesh and formed like ball or cylinder. It needs a grinder system in the process. This process is optional.

f. The condensing water from ATS is similar to fragrance water and after refinement can be sold as such.



2. **Equipment:**

a. The proposal for the plant for treatment of wood waste is with one ATS System, which we assume can handle approximately 50 tons per day (assuming moisture is removed by centrifugal moisture removal equipment) because the density of wood is about 0.34 ton/m^3.

b. The wood waste transported by truck to the plant shall be cut into small pieces by a breaker machine (1).

c. The residue will be sent to distillation loading system (2). The system will distill and vaporize the essential oil by steam. The steam vapour will be sent to condensers (3) to produce the essential oil. The condensing water is similar to fragrance water and sent to fragrance water treatment (7)

d. The residue will be sent to the loading system (4) of ATS. The loading system is a semi-vacuum machine. It will prevent air leaking into the ATS system. The loading system also acts as a mixing machine to blend the waste with special chemical material.

e. ATS2000 (5) will crack the organic composition to produce bio-oil. The bio-oil will be sent to bio-oil tank for storage.

f. The carbon product will be unloaded and cooled by the unloading system (6).

List of required Equipment:

Table 15 - List of Equipment for Converting Wood Waste to Essential Oils

Equipment List	Qty	Energy Used (KWH)	Specification
(1) breaker machine	1	30	2 ton per hour
(2) distillation loading machine	1	4	1 ton/hr (Airtight and deodorizer)
(3) condenser	1	2	100 kg per hour
(4) ATS loading system	1	5	2 ton per hour
(5) ATS2000	1	25	2 ton / hr
(6) Unloading system	1	3	3 ton/hr (Airtight and deodorize)
(7) Fragrance water treatment system	1	2	2 ton/hr
(8) Bio-oil tank and filter system	1	1	10 ton
(9) Central control system	1	0.1	50 ton/day
(10) Planning and Installation of equipment	1	0	Cost of travel, room and board for engineer and installation crew
(11) Testing (plant and equipment)	1	0	Cost of travel, room and board for 5 crew members

The table is a reference only.

Plant Requirement: Based on equipment list and processing workflow, estimated size of plant 25M x 20M x 7M (L x W x H), not including office and waste separation and storage area.

3. **Operation income prediction**: operation income prediction depends on content of wood waste, based on conservative figures.

Table 16 - Conversion Rate & Daily Production Tonnage[12]

Pine wood	Percentage	Quantity (Ton/day)
Density	0.34	50
Essential Oil	2%	1.0
Bio-oil	15.0%	7.5
Activated carbon (depends on feedstock)	30.0-55.0%	27.5
Fragrance water	16.67%	8.33

Table 17 - Wood Waste Income Analysis

Wood Waste Including Essential Oils			
Products	**Annual production**	**Sales or per tonne (US$)**	**Annual Sales (US$)**
Essential oil	330	$70,560	$23,284,800
Biochar	6,600	$1,500	$9,900,000
Fragrance water	2,751	$500	$1,375,275
Bio-oil	2,475	$500	$1,237,500
Revenue			**$35,797,575**
Approx. Operational Expenses			$3,250,000
Depreciation			$500,000
Net Income (before taxes)			**$32,047,575**
Notes: **50 tonnes per day at 330working days comes to 16,500 tonnes per year in input**			

The market price of essential pine oil is between US$ 3-9 per ounce. Cedar essential oil commands a higher price-market for the essential oil is in Asia. We are assuming $5.00 per ounce. These projections are subject to contingencies such as quality and type of feedstock, moisture content of the feedstock.

CONCLUSION

Integrating recovery of essential oils by steam distillation and ATS technology into a program of forest thinning and biomass utilization may be an attractive option for improving forest and economic health in Canada. Although data presented in this note are preliminary and economic values assume unlimited market entry, they are sufficient to identify several important information and research needs and to justify a more detailed assessment and continued development of the proposal.

12 Figures are estimates

Appendix C - **Sources for Text on Livestock Manure**

- Main Source – www.sustainabletable.com

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XXXVI. U.S. Environmental Protection Agency, Office of Water Standards and Applied Sciences Division. "Environmental Impacts of Animal Feeding Operations." U.S. EPA. December 1998.

XXXVII. U.S. Department of Agriculture, Soil Conservation Service. *Agricultural Waste Management Field Handbook*. USDA, April 1992: p. 3-3.

Appendix D – Biochar Prices Across North America

Table 18 Biochar prices across North America

Source	Product	Amount	Price	US$/Lb	Where	Notes
	typical activated charcoal			~$2-$4		
SunGro "Black Gold"	Horticultural Charcoal	2qt.	~$3	$3.45	"Western US"	
Quarter Acre Orchids	Horticultural Charcoal	1 gal.	$6.50	$3.75	Alexandria, VA	
RhizoChar Group	RhizoChar™	50 lb.	$150 (Incl. Shipping)	$3	Hillsborough, NJ	"inoculated with soil food web microbes and nutrients"
BuyActivatedCharcoal	Charcoal GREEN™ Biochar	50 lb	$141	$2.82	Crawford, NE?	"inoculated with beneficial soil microbes and enriched substrates"
Energy Anew, Inc.	Biocharm™	15 quarts (~5lb dry weight?)	$11 retail, $28.75-34 postpaid	~$2.20 - $6.80	San Rafael, CA	sold by volume. pre-charged with something; site doesn't say what
Landscape Ecology		1 cu. ft (~10lb dry weight)	$15/$22.50 retail	~$1.50- $2.50	Hilo, HI	sold by volume (damp) not by weight
e.g. Real Montana or Cowboy Charcoal	typical cooking charcoal			~$1	throughout the USA, e.g. Lowes	
Biochar Engineering		1 lb	$1 + S/H etc.	$1	Golden, CO	
Vee-Go	Biochar Xtra (VBX)	14 lb (10 qt.)	$12.95 +shipping	$0.92	Easthampton, MA	($1.63/lb. w/shipping) is also 7-3-7 fertilizer
Burt's Greenhouses	Biochar	90 L (~18.7kg, 41.2 lb)	CAN$25 ($23.43)	~$0.57	Odessa, ON Canada	
Dynamotive	CQuest™ BioChar	122 lb drums		$0.50	West Lorne, ON Canada	"the brand the USDA is shipping to test sites around the country"
Black Earth Products	Biochar	4kg (8.8lb)	AUS$4	$0.40	Australia	"This Product is not yet available."
Chip Energy	to be announced? not on website	metric ton	$400	$0.20	Goodfield, IL	price reported on biochar list

Appendix E - **Manufacturing Schedule for Construction of ATS Systems**

	Months	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1	**Process and equipment soft calculation**													
1.1	Furnace with heat balance soft calculation													
1.2	Thermolysis reactor thermal soft calculation													
1.3	Screw reactor mechanical soft calculation													
1.4	Calculation on the reactor box refractory													
1.5	Calculation on the inner steam boiler													
1.6	Calculation on the super-heating steam coil													
1.7	Hydraulic steam pressure calculation													
1.8	Calculation on the oil Venturi condenser													
1.9	Thermal calculation on exhaust scrubber													
1.10.	Scrubber SO2 absorption calculation													
2	**Standard Units, facilities (fans& pumps)**													
	and control-monitor system specifications													
2.1	Conveyor and double-damp loading valves													
2.2	Tube-in-water coil for pyrolysis cooling													
2.3	Water screw jacket for cooling carbon black													
2.4	Auto burning gun for start-up of reactor heating													
2.5	Air for air blowers, off-gas and smoke fans													
2.6	All oil-water pumps and storage tanks													
2.7	All sensors for control systems													
3	**Equipment Assembly and detail design**													
3.1	Triple-screw tube Thermolysis reactor unit with													
	super heating steam coil													
3.2	Heat utilizing steam boiler													
3.3	Furnace-reactor-boiler (total thermal housing)													
3.4	Assembly of furnace-reactor-boiler unit													
3.5	Venturi condenser for liquid Thermolysis oil													
3.6	Exhaust scrubber for washing of smoke gas													
3.7	Assembly of frame for unit installation													
3.8	Design and installation of unit pumps													
3.9	Design of air, gas, water and oil piping systems													
3.10	Design of control system and panel box													
4	**Equipment purchase and Manufacturing**													
4.1	Furnace-reactor-boiler assembly unit													
	with thermal block castable lining													
4.2	Venturi condenser for liquid Thermolysis oil													

4.3	Exhaust scrubber for washing smoke gas													
4.4	Assembly of frame for unit installation													
4.5	Manufacturing of all piping parts													
4.6	Purchasing of oil-gas burner with safety sensor													
	and oil-temperature control valves													
4.7	Purchasing of all other standard units and facilities													
4.8	Purchasing of the control panel box													
5	**Purchasing of Carbon Black Processing equipmen**t													
5.1	Tire wire removal equipment													
5.2	Tire shredder after wire removed													
5.3	Bucket elevator													
5.4	Roll machine for crushing carbon char (max 5mm)													
5.5	Vibro-screening and loop recycling equipment													
	for carbon char >5mm for re-crushing													
5.6	Magnetic separator for steel wires (20-25 kg/hr)													
5.7	Grinding Machine for carbon (max 50 micron)													
5.8	Air blower and cyclone for CB powder and piping													
5.9	Small bag impulse -recycling filter for cyclone													
5.10	Large bag impulse-recycling filter for air aspiration													
5.11	air compressor for filters for impulse recycling													
5.12	screw conveyers for carbon filter discharge													
5.13	collection standpipe for lowering CB to 1st floor													
5.14	Mixer for CB powder-liquid paste formation													
5.15	Extruder for CB powder-liquid paste granulation													
5.16	Packing Machine for CB granular product													
5.17	All conveyors for material relocation													
5.18	Thermal drying													
5.19	Acid washing and drying equipment for CB													
	removal of ash													
6	**Machine Installation and testing-adjusting**													
6.1	Machine installation and piping on platform													
6.2	Reactor loading and unloading system													
6.3	Testing-adjusting operation of equipment													
7	**Thermolysis Process technology specifications**													
7.1	Process specification testing results													

Appendix F - **The Best Organic Waste Solution**

To appreciate why the Advanced Thermolysis System (ATS) is the best and to date the only system incorporating a solution for the organic waste problems that earlier and current pyrolysis systems encounter. To illustrate this new Technology, we will trace the development of earlier pyrolysis systems and the disadvantages each and the current pyrolysis systems encounter.

1) First Traditional Pyrolysis system (whether a batch system and its loading and unloading problems or a continuing system) just applied external heat into a sealed thermal chamber. This resulted in an extremely poor grade of bio char resulting from a poor penetration of biomass. Other problems encountered were a tar build up in the piping system and poor heat control.
2) Subsequently, an upgraded Traditional Pyrolysis System (second Pyrolysis System) was required, which used a catalyst such as N2 to create a more thorough penetration of the bio mass feedstock, thereby releasing more of the volatiles from the biochar which created a purer carbon biochar with a higher surface area. But this had the following disadvantages: (a) Catalysts are expensive (b) did not solve the problem of tar build up in the piping (c) insertion of N2 into the thermal chamber lowered the processing temperature in the thermal chamber.
3) To overcome the difficulties encountered above, a further upgraded system was required. Some of the difficulties incurred in 2 were overcome by physical activation using steam injection into the thermal chamber at 100C+. This avoided the use of expensive catalysts and provided a more thorough penetration of the feedstock thereby releasing more of the volatile, and addressing the problem of tar buildup, the quality of the by-products was not addressed. To overcome all of the technical difficulties incurred in the Pyrolysis systems referred to above, our Technical team headed by our Chief Scientist, developed the Advanced Thermolysis System (ATS), which addressed all the above problems.

This was accomplished by incorporating a more advanced physical activation system incorporating the use of super-heated steam (temperature approx. 500C). Not only did our Technical team address this issue but they also engineered a novel way of creating this super-heated steam using the heated thermal chamber as a source for super heating the steam. Subsequently, further improvements were developed involving a thermal chamber containing 3 reactor tubes, each containing a rotating auger to ensure a thorough mixing of the feedstock. This new design significantly creates much more heat efficiency than the traditional large single tubular reactors.

The advantage of incorporating super-heated steam, since it was near the processing temperature of the thermal chamber, ensured that there was only a small drop in the processing temperature. This resulted in a temperature, near the equivalent, to what is required to create activated carbon, a high quality/price by-product from wood biomass. With the required and adjustable temperature, the ATS system can partially activate the biochar produced so that it approaches the quality of the desired grade of activated carbon (having a surface area approaching 140 to 500 square meters per gram of biochar depending upon the activation time).

Our technical team recognized that there was no singular process in the industry for activating bio char into activated carbon. To introduce such a revolutionary method, our technical team invented a state of the art energy efficient design for an activation reactor for inclusion in our modified ATS system, and thereby, utilizing the extra heat generated (approx. 1000C), to transform biochar into activated carbon, a product that has a high value in the market.

We believe the Advanced Thermolysis System (ATS) and its innovative design incorporating other features such as a modified Venturi condenser, gravitational dust separator, 3 phase furnace, activation chamber (none of which are present in other current pyrolysis systems), delivers the best quality of biochar or activated carbon achievable in the present market.

Subsequently, further improvements were developed by our Chief Scientist involving a thermal chamber containing not 1 but 3 reactor tubes, each containing a rotating auger to ensure a thorough mixing of the feedstock. This new design technology significantly creates much more heat efficiency than the traditional large single tubular reactors used in the Traditional Pyrolysis Systems.

The advantage of incorporating super-heated steam, since it was near the processing temperature of the thermal chamber, ensured that there will only be a small drop in the processing temperature. This resulted in a temperature, near the equivalent, to what is required to create activated carbon, a high quality/price by-product from wood biomass. With the required adjustable temperature, the ATS system can partially activate the biochar produced so that it approaches the quality of the desired grade of activated carbon (having a surface area approaching 140 to 500 square meters per gram of biochar depending upon the activation time).

Our technical team also recognized that there was no singular process in the industry for activating bio char into activated carbon. To introduce such a revolutionary method, our Technical team invented a state of the art, energy efficient design, of an activation reactor for inclusion in our latest enhanced ATS system, thereby utilizing the extra heat generated in the ATS system (approx. 1000C), to transform biochar into activated carbon, a product that has a high value in the market.

2. Highlights of the State-of-the-Art ATS System

- The State of the art ATS system utilizes super-heated steam to decompose the organic feedstock to create valuable end products having a much higher quality than any other competitor pyrolysis systems.
- The ATS system is a continuous system requiring virtually no additional fuel once the system commences operation, resulting in a much higher production rate than any other similarly sized system. Earlier, and some current pyrolysis systems, are only batch systems which create the difficulties of a stop and go operation.
- The ATS system is the only unique multi-purpose waste conversion system available today.
- The ATS system is an innovative three stage process in one system thereby maximizing the energy efficiency of the whole system.
- The ATS system produces no measurable pollution.
- The ATS system enable a Return on Investment on capital invested in equipment, estimated to be about 3 years.

3. The advantages of the ATS Technology over Traditional Pyrolysis Systems

- A thermal chamber housing design incorporating 3 reactor tubes which maximizes heated air flow and efficiency of heat transfer to the tubular reactors.
- A method of separating steam from the fuel oil during condensation thereby producing steam free of soot and eliminating the problem of tar build-up in the condensers and piping system.
- A method of creating steam, free of organic particulates, thereby eliminating the problem of a repetitive buildup of organic soot.
- A method whereby the time is extended for removal of volatiles from the residual carbon black produced from the pyrolyzing of the feed stock materials by adding a 3rd tubular reactor in the reactor chamber, thereby increasing the purity of the carbon black from 95% to 99%
- A method of increasing the flash point temperature of the fuel oil from 40°C to not less than 75°C by incorporating the use of a proprietary Venturi condenser, thereby enhancing the merchantability of the fuel oil and providing a sufficient quantity of residual off-gas for heating purposes.
- A method for cleaning the fuel oil by incorporating a Laval separator which separates the combustible light liquid fuel oil fractions (highly desired by the market) from the heavy fuel oil fractions. The heavy oil fractions (approx.2-3%) remain and are added to feedstock material and reprocessed through the ATS system.
- A method providing for a vortex pre-mixing chamber for the low heat value syngas thereby increasing its heat value for burning in the furnace.
- A special oil burner for starting and lighting the increased - heat value syngas during the operation mode of the ATS system.
- A method of ensuring that at least 30% of superheated steam by weight in relation to the weight of the feedstock material is injected into the tubular reactors, thereby causing a more thorough release of

volatiles contained in the feedstock material while reducing the possibility of ambient air entering into the reactor tubes.

- A method using hinged dual flap air lock gates instead of dual blade gates, thereby eliminating a particulate build-up in the sliding gate blades and eliminating the risk of ambient air entering into the tubular reactors.
- A method of extracting outside air from the first loading hopper bin prior to the feedstock material being pyrolyzed, thereby eliminating the ambient air from entering into the first tubular reactor and assisting in eliminating odours during the Thermolysis operations.
- A method of connecting an emergency nitrogen fire suppression system to the reactor to extinguish any fires in the reactors and thermal chamber.
- A method of dispersing explosive pyro-gas safely in the event of a shut down due to a power failure.
- A method for providing access to the piping system for the purpose of removing any build-up of soot.
- A method whereby the auger system contained in the tubular reactors incorporates one or more blending zones, enabling a more thorough mixing and penetration of the superheated steam into the feedstock materials.

So, the combination of the above unique advantages together with the innovative and proprietary design containing 3 reactors in the thermal chamber, each having its own motor, allows the ATS system to regulate the time of decomposition of feedstock in each reactor, and therefore, allowing the system operator to optimize the various quantities and qualities of manufactured products he wishes to produce.

4. ATS System - the Environmentally Friendly Technology

- Approval from the Canadian Govt. stating that our ATS system presently operating in the Province of Alberta, Canada, is in full compliance with all environmental issues.
- The ATS system is fully supported by Alberta Innovates, a govt. body, after they did a comprehensive study on the ATS system. As the ATS system emits no measurable pollution (in other word, no hazardous emissions), it passed the strict compliance procedures.

The biochar produced by our ATS system has been certified by the Organic Materials Review Institute (OMRI) of Canada and the USA. This certification designates that the products produced by our ATS Systems are now certified, that they meet the strict organic standards of OMRI and that they do not have chemicals or toxins or anything else that could hurt a person by their use. The products produced by our ATS System, are only a few approved products that has certification by OMRI. This certification now makes the biochar markets in Canada and the USA wide open for customers that desire organic biochar. Magnum is now the certified leader in the production of high quality organic biochar in a booming market in North America which is projected to grow exponentially in the future.

5. Waste Management Applications

For application in the waste management field where there is a variety of waste feedstock materials, the composition of which may vary from season to season, a one stage process will have difficulty in processing such mixed waste of un-predictable composition. To deal with a variety of waste materials such as used tires, manure, waste plastics and MSW, etc., only the ATS System can effectively and efficiently process them by incorporating our patent pending three stage Thermolysis Technology.

a. Using super heated steam as opposed to direct heat solely, the first stage acts as a Thermolysis mode. It converts most of the organic composition to fuel at the critical cracking stage. The most important function in this stage is to obtain the greatest amount of fuel oil. The temperature in the first stage is under 450C.

b. The second stage involves gasification, deep Thermolysis, carbon activated, and fuel gas synthesis modes. The purpose of the second stage is to completely de-compose the organic compounds. The processing temperature in the second stage is adjustable between 450C ~ 550C.

c. The third stage completes the breakdown by releasing the remaining volatiles in the bio char and together with the super heated steam injected into this reactor, creates a partial activation of the biochar to create a much purer form of carbon product, operating at a temperature range of 550C-650C.

With this state of the art three-stage Technology, the ATS System is able to process efficiently, different types of organic wastes. Table 1 shows some of the major organic wastes that the ATS System is capable of processing :

Table 1- Waste Streams

Used tires or waste rubber	Organic sludge	Manure
Waste plastic PP, PE, HDPE, PVC	Coal and oil waste	MSW*
Agricultural waste/ biomass	Wood biomass	Other organic waste

The ATS System should not be considered as only an energy converting system, but also the top leading-edge waste management system that can be used in many major waste applications such as recovery of landfills, removal of oil and coal waste, deal with manure problems and retreatment of activated carbon. It can be applied by industries to produce carbon black and fuel oil. This ATS Technology is also able to reduce CO2 emissions when treating waste and is the best solution to replace incineration while at the same time maximizing revenues.

We believe the Advanced Thermolysis System (ATS) and its innovative design incorporating other features such as a modified Venturi condenser, gravitational dust separator, 3 phase furnace, activation chamber (none of which is present in other current pyrolysis systems) delivers the best quality of biochar, carbon black or activated carbon, that is achievable in the present market.