CLIMATE CHANGE SOLUTIONS
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World Bio-trade Equity Fund Study

For IEA Task 40 Bio-trade
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Executive Summary

Biomass energy is a major plank in global strategies to achieve renewable energy objectives. While the EU may have sufficient local biomass sources, international trade is seen as necessary to getting large volumes of biomass to where they are needed, and at low-cost. Biomass trade between developed nations is increasing, such as Canadian pellets to the EU, but there are large biomass "potential" sources, such as Africa, South America and the Caribbean, that remain untapped due to lack of infrastructure, capital, risk, politics etc. Stand-alone bioenergy projects in many regions are simply considered too risky to invest in, and for banks are too risky to lend money. The creation of a Bio-trade Equity Fund, backed by guarantees from international bodies, biomass customers, and governments of developing nations can unlock sources of biomass and lay the groundwork for a major increase in biomass trade, provide a superior return to investors, generate socioeconomic benefits to needy regions, and lower biomass prices.

Investing in bioenergy is not generally well understood in the investment community. There are Green Energy Funds, but bioenergy investments are a miniscule part of these portfolios, and most deal with emerging technology stocks which are regarded to be very risky. There are World Bank based funds, but they are focused mainly on conveying money to developing nations for socioeconomic development, not so much for making a rate-of-return. The objective of a Bio-trade Equity Fund would be to invest in projects that promote world trade in biomass while yielding a rate of return commensurate with risk. Projects would include: improving ground-based biomass feedstock supply systems, such as advanced chipping systems and inland ships; building biomass conversion plants, such as for pellets, BioOil, 2nd generation ethanol and torrefied wood; and enhancing bio-product transportation systems, such as port improvements, purpose-built loaders, and specialized biofuel ships.

A targeted Bio-trade Equity Fund is particularly important at this time in the economic cycle. Even at the best of times lack of knowledge of bioenergy investment results in few projects that yield large amounts of biofuel. Now, at the tail end of financial crisis and worldwide recession, even less investment is directed toward commercial scale bioenergy. Yet massive amounts of biomass will be required to support achievement of challenging renewable fuel targets in the next 10 years. Due to confidence in a successful outcome, money is invested to export meaningful amounts of biomass in Canada, Brazil and Malaysia to Europe in the form of pellets, ethanol and palm oil. Millions more tonnes of biomass lay unused in regions such as Africa, Russia, and the Caribbean, but for any investor to fund a biomass densification plant in any of these regions with the object of export often would be considered too risky. However, with a large equity fund, investing a large densification plant combined with establishing efficient ground and sea supply chains, with guarantees of biomass supply and guarantees of purchase of final product, the stream of projects takes on a considerably reduced risk. Furthermore, a fund that invests in many such projects reduces the risk of any one failing to live up to expectations.

How would such a fund start? A brief business plan is required to summarize the basics of a Bio-trade Equity Fund including capital market gap, fund objectives, portfolio strategy, required rates of return, investment selection criteria, and financial projections for several years. With a concise plan, an experienced Fund Manager interested in the opportunity would be selected. The Fund Manager could expand the scope of the business plan according to his experience and knowledge of capital markets, and then test market the fund with capital placement firms. Ideally a deal would be struck with one placement firm. The Fund manager would build a team of perhaps 3-4 fund managers who would decide on projects and manage fund growth, and with them develop a full business plan. The team would acquire several project "finders" who would scour the world for biomass plant and supply chain opportunities, develop business cases, and present them for consideration and approval. The team would also acquire experienced project "developers" who take the best of these opportunities, and convert approved projects into functional cash-producing entities. It could take one year and perhaps €200,000 to find a Fund Manager, prepare a business plan and test market the fund to capital placement firms, and a second year and perhaps €1.8 million to set up the legal structure, build the teams and start investing.

A new fund such as this would have to build slowly, investing up to €20 million in low-risk projects including a demonstration supply chain to prove that the concept is both viable and lucrative. Only with proven success could the fund reach levels of €250,000-€1 billion that would be required. The fund would start by identifying 2-3 existing projects that were already generating cash flow, and 2-3 new low-risk projects in developed countries with well known products, markets and existing supply chains. An example would be to take a position in an existing pellet plant or build a new plant in BC Canada with guaranteed customers and feedstock supply, and investing in improvements to Prince Rupert and Vancouver port facilities to reduce supply chain costs. These projects would have a rate of return exceeding 20% and they would open up new volumes of biomass and deliver them at lower cost. Other examples include investing in fast growing plantations in Australia and then building pellet plants to use the feedstock.

In years 2-4, the fund would be generating cash flow, drawing more capital from interested investors, and gradually entertaining projects of increasing risk, such as new products in developed nations, or well-known products and technologies in developing nations, or new supply chains. Examples include a 50,000 tonne BioOil plant in Australia, a next-generation ethanol plant in Brazil using bagasse, an ultra-light freshwater transport in Finland, a "green coal" plant in South Africa using acacia feedstock and port enhancements to reduce transport costs, and a series of BioOil plants in Argentina combined with a barge program to bring BioOil to an ocean port. With continuing success in investment, finally larger or more risky projects can be considered that can open up large volumes of hitherto unused biomass, such as new production facilities and enhanced supply chains in developing nations. Examples include supply chain enhancements in Russia, Moringa plantations in Zambia, a position in an ethanol pipeline in Brazil, and purpose built biofuel tankers.

It is anticipated that this fund will result in meaningful volumes of biomass transported where they are needed most in the next 10 years to achieve renewable fuel targets. It will result in jobs in developing nations, commercialization of new technologies, and ultimately reduction in worldwide GHG emissions.

1. Introduction

The object of bioenergy is to convert renewable biomass to energy in a "conversion" plant, thereby replacing non-renewable fossil fuels. The reasons for doing this are many; energy security, GHG reduction, economics etc. Often biomass feedstock is a long distance from the conversion plant and it is uneconomic to transport the feedstock in raw form. One solution is to densify the biomass near the biomass source, such as into pellets, making transportation of the biomass to the conversion plant easier and less costly. Such business models work, but only in a very few exporting regions; such as ethanol from Brazil, pellets from Canada, and palm oil from Malaysia. What about all the other untouched biomass in the world?

From the outset IEA Bioenergy Task 40-Biotrade has presented estimates of biomass “potentials” by continent, yet biomass development and trade increase for existing biomass products and trading regions, while development and trade in other regions with great biomass potential continues to founder. The reasons are many; infrastructure, capital availability, risk, politics. Stand-alone bioenergy projects in many regions are simply considered too risky to invest in, and for banks they are too risky to lend money. 2nd generation biofuels will place new demands on biomass supply capability. EU targets for renewable energy will require massive biomass development in many regions to achieve. What can solve this problem?

It is proposed that creation of a new Bio-Trade Equity Fund, backed by international bodies, biomass customers, and developing regions, can unlock sources of biomass and lay the groundwork to meaningfully increase biomass trade, and provide a superior return to investors, while providing socioeconomic benefits to needy regions and lowering biomass prices. The bio-trade fund would exist to funnel investment to
- Build biomass densification plants near new, large biomass sources
- Develop efficient biomass supply chains to enable long distance transport at low cost.

2. Investing in Bioenergy

2.1. Debt and Equity

Companies are generally financed by debt and equity. Companies exist to provide a fair return to their shareholders, ie owners, and their investment in a company is called **equity**. Companies invest in projects that generate cash flow, and they often borrow money so that projects are funded both by the company's equity and **debt**. Debt lenders and equity investors have a very different risk tolerance, and accordingly receive different returns. Debt holders are more risk averse than equity holders and usually fashion loans to companies that provide assurance that the loan will be paid back on a timely basis, and that interest will be paid. Only after debt holders have received contracted payments do shareholders have a claim on remaining profits. Because a debt holder has reduced the risk of lending money, it is willing to accept a low rate of return. Because the shareholder is second in line to get returns from profits, his risk is much higher. The shareholder, or equity holder, demands higher return. A detailed discussion of financing of investments can be found in Appendix 1.

2.2. Company Financing vs Project Financing

There are two main options for financing new investments; corporate financing, and project financing. With corporate financing, shown in the example above, also known as **internal financing**, the general assets of the company itself are used as the basis of credit and collateral by the lenders. Irrespective of the cash flow generated by the project, it is the overall company cash flow that provides the principle and interest payments to the lender. With **project financing** it is the project itself that is weighed on its merits and it is from the project alone that interest and principle payments must come. As such, project financing is considered more risky than corporate financing and thus bears a higher interest rate. Although some biofuel projects are known to be funded thorough corporate financing, project finance is the route most often used to bring new technologies into the market[1].

2.3. Investment Funds

Often companies do not have sufficient equity to undertake major investments. They can raise equity by issuing new shares, but doing would dilute the value of the existing shares. Companies, especially small, young companies with emerging technologies, often turn to the capital market for equity funding. Capital investment Funds, or mutual funds, are professionally managed investment schemes that pool money from many investors. Fund managers invest the pooled money regularly, and distribute proceeds, usually annually, to participating investors. For individual investors the advantage of mutual funds is that they are managed by experts, and they invest in a number of opportunities enabling spreading the risk of loss by one or more investments. There are mutual funds along a whole spectrum of risk and return, for example;

- Very low risk money market funds
- Low risk government and utility bond funds
- Low risk money market and bond funds
- Middle risk balanced bond and equity funds
- Higher risk large cap equity funds (companies with large capital base)
- Very risky small cap equity funds
- Very high risk high tech, dot.com, next generation unproven technology funds

[1] Bole T. and Londo M- Improving the Climate for Second Generation Biofuels

Usually funds have a market niche that can satisfy the need of particular investors. For example, one fund may only invest in "green" companies, another in Asian equities, another in Utility bonds. A Green fund may be aesthetically pleasing to some investors, but may lack the superior returns demanded by others. Asian Equity funds may have tremendous upside potential, but may on the other hand collapse in value. Utility bond funds are considered safe, but have limited returns.

2.4. Biofuel Risks

There are many sources of risk when dealing with equity investments, for example; technology risk, market risk, regulatory and policy risk, geopolitical risk etc. In regulated environments utilities will usually have well known and understood technology, regulated prices to customers, regulated earnings, and often have a service monopoly, so investing in the utility is regarded to be low risk. A new company that has little cash flow that is about to launch a new product will have high risk.

Many biofuels are regarded to be high risk. For example, 2nd generation biofuel technologies are virtually new, and only a very few are becoming commercial. Some technologies will pan out and become standard over the next 5-15 years, while others will not make the leap successfully from pilot to commercialization. Investments in many new processes that produce biodiesel or ethanol have a high **technology** risk, but because the products are well known and governments worldwide are promoting their development with incentives and Renewable Portfolio Standards, these companies have lower market risk. Processes to make wood pellets are very well known and there is little technology risk, but other factors have made pellets remain risky. For example, worldwide closure of sawmills due to recession has drastically reduced the traditional supply of low-cost sawdust to make pellets, and pellet manufacturers have had to transition to more costly harvest residues as a feed stock. Also, the recent volatility in world maritime shipping prices has increased the landed price from Canada and the US to Europe, for example.

Another biofuel is BioOil (pyrolysis oil). There are two patented processes that successfully make BioOil and thus technology risk is declining, but it is a new product, and though the market potential is huge, customers generally do not know its characteristics, and governments have not dealt with this renewable fuel in incentive packages. As such, BioOil is still considered a relatively risk investment due to **market risk**, though perhaps not as risky as a 2nd generation ethanol technology barely at the pilot stage.

Regulatory risk is a major factor. For example, the Netherlands government provided feed-in-tariffs for power made from renewable biomass, and utilities invested heavily in machinery and equipment and supply chains to enable use of renewable fuels, such as pellets and palm oil. After 1-2 years, the government completely revised the incentive program, leaving utilities to scramble to adjust to the new regime.

Geopolitical risk comes into play when dealing with investment on a world scale, for example the unforeseen Russian implementation of an export tax on wood that drastically reduced wood imports to Finland. Any pulp mill in Finland that had a major portion of its wood supply from Russia was exposed to geopolitical risk. African countries are often sources of political instability, and many do not have the economic structures taken for granted in the West, thus investing in such countries is often with great risk. To promote development will require mechanisms to promote confidence and reduce risk

2.5. Difficulties in Investing in Bioenergy

Why are bioenergy activities particularly difficult to finance? It is a common observation that it is difficult to raise money for bioenergy projects and ventures, even for projects with good techno-economic prospects. Explanations to that difficulty may be found in the uncertainty about bioenergy among decision takers in the financial community.

The objective of the finance sector is get a positive margin between money submitted (loans, equity, etc.) and money received (interest, dividends, repayment of loans). Therefore, project evaluation is a key element in establishing priorities and recommendations for loans/equity to projects It is evident that some single accepted projects may fail to fulfill return objectives, but the total project portfolio would meet the targets. In that context it is important to distinguish between risk and uncertainty when evaluating basic information on projects. Risk means that it is possible to assess variations and deviations by statistics, time series, etc. Examples of risk evaluations are weather expectations and life expectancy assessment, for which comprehensive data normally are available, making it possible to calculate likely ranges of variations. Uncertainty, on the other hand, has to be evaluated by judgment and subjective analysis. Examples of uncertainty factor are political interventions, effects of new technology applications, actions by competitors, etc.

Projects that can be evaluated mainly by risk assessments would be regarded more favorably for loans than projects evaluated under uncertainty, all other things being equal. Thus, bioenergy projects, and in particular biomass trade projects, suffer from lack of long term statistical information and time series. Moreover, drivers for bioenergy are often based on political support, the details and structures of which have frequently been altered and changed in recent years. Therefore, evaluation criteria for bioenergy trade projects fall mainly in the category of uncertainty.

In the evaluation process it is common to apply standard models and formulae to rate projects against established policy directives and other projects. When data are weak or missing or when many factors are uncertain, such as for bio-trade projects, bioenergy projects often are evaluated as unreliable. Moreover, employees evaluating projects may feel uncomfortable making judgments instead of applying standard models, as project failures would be blamed on their personal judgment, not on weakness in the standard models. Thus, bio-energy projects may be downgraded in the early phases of the evaluation.

Banks and other financial institutions can handle uncertainty by hiring professional industry experts and include their advice in the evaluation process before decisions are taken. Agro-business, forest industry, mining, medical technology are examples of professions from which banks hire experts to take part in project evaluations. For bio-trade projects this has not been generally applied, as the number of project applications still are quite few, and no or only few available experts exist in the bioenergy profession with adequate experience for this type of work. A general problem for bioenergy and bio- trade is the lack of formal hand-books, text-books, and courses for training and education. One result is observed ignorance, and sometimes lack of basic knowledge, regarding bio-energy, in financial institutions.

2.6. Consequences of 2007-09 Financial Crisis

Bioenergy projects are driven by three mechanisms: legal and regulatory drivers, such as the 1997 Kyoto protocol; economic drivers, such as commodity prices and subsidies; and financial and institutional costs, such as investment cost, financing, counterparty, and performance risks. The Kyoto protocol is the basis for all sustainable development in renewable fuel globally. The protocol is so powerful that most countries have adopted sustainability or climate change policy as one of the most important factors in politics and policies. The Kyoto protocol legally commits and binds many countries to reduce the GHG emissions. The impact that climate change activities will have on development and economics is significant. The protocol goes beyond the main target of climate change reduction. It is creating a new economic wave that will change the dependency on conventional energy carriers as well as create millions of jobs globally. There will be a focus on trying to develop bioenergy as well as developing or increasing efficiency of supply chains. Less developed countries that are identified as biomass suppliers will benefit and increase their political and economical position. Countries and dominant global players recognize this and believe that this fast growing business cannot be reversed.

In the middle of this tide of change, in 2007-08 a major financial crisis occurred that resulted in a deep and lengthy world-wide recession that had a major impact on availability of capital. The collapse in US housing prices and accompanying foreclosures left banks undercapitalized, without sufficient equity to support existing loans. Banks became reluctant to lend, not only due to the risk of lending in an economically difficult time, but due to lack of equity to support new loans. Similarly, investors became skittish, making it extremely difficult to raise new capital. Not only did debt funding became scarce, but equity funding also. For every 100 bioenergy projects that were under consideration by capital funds, perhaps 3-4 would be accepted, and only the least risky projects with iron-clad contracts for biomass supply and similar contracts for long term purchase of biomass energy.

Many other unforeseen effects and chain reactions occurred due to the financial crisis. Plants produced less due to lower demand and product prices. Consequently, CO_2 emissions decreased and did the CO_2 price. Demand for coal decreased, as did shipping costs. The spread between coal+CO_2 and biofuels fell, reducing the attractiveness of sustainability projects. However, in Europe for example, Kyoto commitments stayed in place making it harder and more expensive to undertake sustainability investments. The climate change business will be negatively impacted in the short term but will grow in the mid to long term.

Regarding the post-Kyoto period, a new global agreement was to be negotiated at the UN Conference of the Parties in Copenhagen in December 2009. Using two basic models for energy growth, the IEA analysis supports a hybrid policy approach, comprising a combination of cap-and-trade systems, sectoral agreements and national measures that will be needed to keep GHG emissions, and corresponding global temperature increases, at acceptable levels. A proposed cap is to reduce the GHG emissions in 2050 by 50% vs the 1990 level, projected to limit a world-wide temperature increase to 2 °C.

Despite the crisis, countries recognize the importance of the Kyoto protocol, not only for the reduction of GHG emissions but also for energy security and economic growth. This was clearly stated by Obama, Brown, Sarkozy and Ban Ki-Moon , that the crisis is a call to speed up the creation of a new energy economy. The US, a non-Kyoto member, plans to implement measures as well. US President Obama has promised the Americans will invest $150 billion over the next 10 years to catalyze private efforts to build a clean energy future. On a macro scale, there is an attitude of looking forward and the outcome of COP 15 in Copenhagen is expected to reflect this new green-economy thinking. On a micro scale, the economics of biofuel co-firing as a stand-alone project remain very positive.

3. Green Funds

It is proposed to create a Bio-trade Equity Fund to develop biomass densification plants in regions of large biomass potential, and to invest in supply chains to transport this biomass at low cost to regions that require it to enable achieving climate change objectives. The object is to invest in "projects" that will provide future cash flow and in "shares" of companies that can boost biomass trade. Is this a viable niche? Are there other funds that fill this need? What is their performance?

3.1. Existing Green Funds

New Alternatives Fund (NAF):

Like other funds, this fund seeks long-term capital gains by investing in common stocks of companies that provide a contribution to a clean and sustainable environment with at least 25% of the portfolio in alternative energy, including production and conservation of energy. In 2008, 64% of the portfolio was invested in securities of foreign companies. The largest holding was in wind energy, the next largest was energy conservation (18%) and the distribution of clean water. In 2008 it reduced holdings in solar due to abysmal performance of pure play solar energy companies. Only one company was in biomass, Abengoa, which the fund regarded to be in the “difficult” biofuel and ethanol market. In 2008 NAF sold shares in Sunopta, a cellulosic ethanol company. On performance, despite a collapse in value in the fund in 4Q 2008, total fund expenses rose 39.5% since the investment advisors are paid based on overall asset value in the year. NAF is not a direct competitor to the proposed Bio-trade Fund because it has almost no biomass investments, does not invest in trade supply chains, only invests in equities and in general seems to have poor performance.

Calvert Global Alternative Energy Fund (CGAEX):

Calvert has 31 different mutual funds along a spectrum of risk and return, from very low risk money market and bond funds, through middle risk balanced bond and equity funds, higher risk large cap equity funds, very risky small cap equity funds, and finally two sector funds that are at the extreme end of risk and return, the Global Water Fund and Global Alternative Energy Fund (CGAEX). CGAEX seeks long term growth in capital and invests at least 80% of its assets in equity securities whose main business is alternative energy or that are significantly involved in that sector. In Aug 2009 the fund was invested 34% in wind power companies, 23% in solar companies, 14% utilities, and only 6% in biomass energy companies and 3% in biofuel companies. There were 51 companies in the CGAEX equity portfolio. The Fund has lost 44% of share value in one year and 19% since inception, compared with the Large Cap Growth Fund that lost 26% in one year and gained 7% from inception. CGAEX is not a competitor to the Bio-trade Fund since it has only a small position in biomass, invests in risky equities on the expectation of "star" performance by a small portion of its holdings, does not generally have cash flow, and has poor performance.

Powershares Wilderhill Clean Energy Portfolio:
This is a fund that invests 90% of its assets in equities in green energy. Its goal is capital appreciation, and recognizes that the fund is high risk with the prospect of high return. The top 30 equities in the fund have only 2-3% of the assets in the fund, ie it targets small cap and medium cap growth stocks. Examples include Sociedad Quimica y Minera de Chile, Cosan (Brazil), American Superconductor, Evergreen Solar and China BAK Battery. The fund gained 58% on assets in 2007 compared with 10% for NASDAQ, but lost 70% of its asset value in 2008 compared with the NASDAQ at 40%. This is a high-risk green equity fund, but is not positioned in the niche contemplated for the Bio-trade Equity Fund.

Global Sustainable Biomass Fund (GSBF):
The GSBF is a grant program under the responsibility of the Minister for Development Cooperation in the Netherlands to promote development of sustainable biomass in developing countries. It´s geographic focus is projects in Indonesia, Vietnam, Mali, Columbia, Nicaragua, Ethiopia, Tanzania, Mozambique and South Africa. It is a pool of government funds to enhance sustainability, while also providing for objectives of GHG reduction, social well-being, biodiversity etc. The fund has a budget of €12.5 million with subsidies in the range of €100,000 to €1 million per project, and because of its small size it is meant more to promote demonstrations of what is possible rather than intending to meaningfully impact achievement of EU targets. It is NOT a fund in which investors can participate, and as such it is not a competitor fund to the Bio-trade fund.

World Bank Climate Investment Fund:
This fund consists of two financing instruments designed to promote low-carbon and climate resilient development in developing countries: the Clean Technology fund (CTF); and Strategic Climate Fund (SCF). CTF promotes financing for demonstration, deployment and transfer of low-carbon technologies. SCF supports developing country efforts to reduce deforestation, to put climate risk into planning, and to scale up renewable energy. Financing is channelled through the African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank, and World Bank Group. These funds are primarily debt instruments meant to supply loans where banks normally would not, and but are also equity seed money to strengthen long-term financial packages and mitigate perceived risk by commercial lenders. These funds appear to be directed at financing technology utilization in developing countries, but do not apparently demand or even expect a rate of return, and are not focused on bioenergy trade and thus are not in the niche of a Bio-trade fund.

Copenhagen Climate Fund:
This is a proposal for a $100 billion fund, emanating from the Dec 2009 Climate talks in Copenhagen that is targeted to help poor nations combat global warming. There has been no agreement on how this money should be managed and where and how it should be channelled. The developing nations want more control in accessing money, but donor nations are just as adamant that they will not allow money to be distributed without knowing exactly where it is going, and for what. While intentions are good, it appears that such a fund will be years in the making, and that money will be targeted at helping the poor in developing nations rather than making a return on investment and promoting trade.

In short, there are green funds that have a miniscule proportion of their portfolio in bioenergy, but these are stock plays anticipating major technology breakthroughs. There are debt funds with the objective to improve climate change factors in developing nations. There are virtually no funds that have a full understanding of the scope of bioenergy projects and none that even consider supply chain logistics. This is a capital market gap. If a bioenergy fund would fill this gap, what would it look like? How would it have to be structured to be successful?

3.2. Characteristics of Successful Fund

3.2.1. Fund

Existing equity funds that invest in shares of bioenergy companies in general have a portfolio of many companies across a range of risks and returns, ideally some that are moving forward to commercialization and are projected to have steady growth in share value commensurate with growing cash flow, others that have that undervalued shares that have tremendous upside should their technologies pan out. The hope is that 1-2 "stars" will exceed losses from poorly performing equities. A Bio-trade Equity Fund would want to spread risk, but the basis of the fund would be to participate in projects that will generate cash flow. Funds should have a portfolio of projects at various stages of completion; some earning cash flow, some under construction, others with an excellent technology or business opportunity that is on the verge of entering the market. There should always be 3-4 deals in the pipeline. A successful fund has an apparent “endless” supply of good projects from which to choose.

“First time” funds are problematic in industry since they don’t have a track record. It is essential to adopt management that has had previous successful performance. Risk is the most important factor in fund strategy. Management should strip out as much risk as possible. It would be easier to invest in low-risk projects first to establish a fund track record for performance, and then later move on to higher-risk projects. Funds usually have an “investment period” like 3-4 years, or 10-15 years. Large pension funds like to invest in longer-term funds so they don’t have to keep looking for new funds in which to invest. Since bioenergy projects tend to have cash flows stretching over several years, the time horizon should be long, for example 10 years.

3.2.2. Management

A fund should have a strong, seasoned management team, preferably that work together well. Absolutely everything about management must be transparent; who makes the investing decisions, who are the backing companies, who is paid and for what.

As a departure from existing green funds, management should be familiar with bioenergy technologies, such as pellets, wood-chips, torrefied wood, BioOil, ethanol, methanol and bio-chemicals, and biomass feedstocks including agricultural residues, energy crops, forest residues, fast growing ligno-cellulosic crops and plantations. Another necessary skill is an understanding of ground supply chains, and maritime shipping options.

Management should always put some of its own money at risk in the fund. They must have something to lose or gain by their decisions. In addition, their remuneration must be aligned with what the investors want.

Each country has a local bank that backs international investments. To reduce risk it is anticipated that project proponents will secure the support of such banks, and also secure supply guarantees of biomass suppliers and purchase guarantees of customers.

4. Types of Bioenergy Investments

What are viable investment categories for the Bio-trade Fund? The prime objectives of the Fund are to make superior rate of return while promoting trade in existing and future products at lowest cost. To do this will require investment not only in conversion facilities, but all aspects of the inland and ocean supply chain.

4.1. Existing Technologies

4.1.1. Sources of Tradable Biomass

Sources of biomass that can be densified have traditionally included forest, agricultural and post-industrial waste. Forest biomass includes sawdust, shavings and bark from sawmills, pulp mills, and other wood product mills, and now includes harvest residues from forest operations, standing timber, and plantations of fast-growing tree species. Agricultural biomass includes crop residues such as corn stalks, bagasse (cane stalks at sugar plants) and trash (cane material left in the field), and also covers energy crops, such as miscanthus. Post industrial wood includes construction waste. Investments from the bio-trade fund could include acquiring the rights to large tracts of ag waste, or planting of biomass crops, either agricultural (such as miscanthus), or wood (such as fast-growing willow).

4.1.2. Ground-based Supply Systems

Systems to supply forest biomass include chippers (that chip standing timber or harvest residues), grinders (that grind wood, usually larger and more robust than chippers), bundlers (that bundle harvest waste for transport), loaders (that load biomass onto trucks), harvesting equipment (that fells trees). Woody biomass is transported from the bush by trucks of various kinds, some are multi-use, and some are purpose-built. Biomass sometimes is transported directly to the biomass heat plant or pellet plant, and sometimes is transported to a depot for further handling, such as grinding and/or storing. Bio-trade Fund investments could be supplying or enhancing existing supply chain technology to new or existing markets.

4.1.3. Conversion Systems

Biomass can be converted to energy using several conversion technologies including;
- Direct combustion for heat, power or combined heat and power (CHP)
- Gasification for transportation biofuels, heat and power
- Pyrolysis for BioOil and Bio-char
- Hydrolysis for sugars and subsequent fermentation to liquid transportation fuel like ethanol
- Densification for pellets, biocarbon or torrefied wood

<u>Direct combustion</u> of biomass for heat has been practised for millenia. Following the steep rise in oil prices over the last 35 years, technologies have improved to maximize efficiency and minimize emissions. Biomass can be combusted in boilers of various sizes for the distribution of heat, from single residences, to large district heating systems, to industrial applications. It can also be combusted to produce high-pressure steam which can be fed into a turbine to produce power. Efficiency in converting biomass to energy can be increased by combining the production of heat and power.

Gasifiers operate by turning biomass into a flammable gas that can be cleaned and filtered to eliminate chemical compounds. The gas can be used more efficiently than simple combustion to produce heat or power. Gasification technology has been used in industrial applications for years, but only recently are commercial/residential applications becoming commercial. Gasification is also an intermediate step to the production of ethanol, methanol, and other chemical compounds, a process just becoming commercial in 2008-09.

Pyrolysis is burning biomass at high temperature in the absence of oxygen to produce a liquid BioOil, that can be burned in place of fossil fuels in stationary engines. The by-product char, a black powder, is also a fuel. This technology has been commercial for 20 years, but essentially all world production is made by two companies in Canada; Ensyn and Dynamotive Energy. Several fast pyrolysis processes have been tried in Europe over the years without success, though a demo is now operating in Finland and a commercial-scale-plant is being built in the Netherlands. BioOil is not generally known in the marketplace and a market remains to be built. BioOil is not yet a transportation fuel.

The term biofuels is often mistakenly used to reference only bio-ethanol and bio-diesel, both transportation fuels. Most of the world's bio-ethanol is manufactured in Brazil from sugar cane and in the US from corn in processes categorized as 1st generation technology, and it has been practised for decades. In Brazil manufacturers have been producing ethanol for over 25 years and in that time have reduced the cost of manufacturing by 75%. Bio-diesel is made from animal fats and vegetable oils, and manufacturing of this product is also mature.

Densifying biomass into pellets has been practiced for many years, but only since the Kyoto Protocol and implementation of policies to reduce GHG emissions has production and trade shown tremendous growth. Canada is the world's largest exporter of pellets, shipping 1.2 million tonnes offshore in 2008. Pellets have energy value of 18 GJ/t. Another type of pellet is biocarbon, a black carbon pellet that has energy value of 30 GJ/t, but this process has only been practiced commercially in South Africa. Conversion facilities are viable candidates for Fund investments, but only if meant for trade.

4.1.4. Transportation Systems

Biomass can be transported overland by truck, rail or pipeline, and in the last 10 years across oceans by ships. Ships are categorize by size; Handysize (20-35,000dwt), Handymax (35-50,000dwt), Panamax (50-80,000dwt) and Capesize (100-300,000dwt). The larger the vessel, the lower the cost per unit shipped[2]. Most ocean ports cannot handle Capesize, and many cannot handle Panamax sized ships. Most solid biomass is shipped on bulk carriers that have several holds covered by hatches and on-board equipment for loading and unloading. Solid biomass is often shipped locally from small harbours with Handysize and Handymax ships. Tanker ships are designed to carry bulk liquids. Crude oil is generally carried in massive oil tankers, and LNG in large LNG tankers. Biofuels, such as ethanol and biodiesel, and also chemicals and vegetable oils are usually carried in smaller chemical tankers 5-45,000dwt. Carriage of chemicals in bulk are covered by regulations in SOLAS Chapter VII and Marpol Annex II, which provide guidelines on issues such as tank coating requirements, side-hull

[2] World Biofuel Maritime Shipping Study- Bradley D., Diesenreiter F., Trømborg E.- 2009- IEA Bioenergy Task 40

protection, double bottoming, and maximum tank-size. Shipping by chemical tankers is costly because of their limited size. A Bio-trade Fund might invest in multi-purpose trucks, rail cars, pipelines or ships that promote trade.

Biomass is often shipped from ports that can only handle smaller ships. Some ports can handle large ships, but port handling and storage facilities are often inefficient and thus make biomass more costly. Some ports are undersized, which require ships to only partially fill and proceed to another port for additional cargo, all of which add to costs. Viable projects for a Bio-trade Fund are port storage enhancement, loading equipment, docking facilities, and rail marshalling facilities.

4.2. New Technologies and systems

4.2.1. Supply Systems

While trucks for transporting woody fibre have been used for decades, Scandinavian countries have continually been building and testing new purpose-made trucks to maximize transport volumes and reduce costs. Supply chain research in Scandinavia has resulted in a 2% per annum reduction in unit supply costs over 25 years. Lately the Swedes have been testing rail options and the Finns inland waterway systems to further reduce supply chain costs. The biomass bundler has been in operation for several years, but there are only 25-30 in operation world-wide since advances in chipping supply systems have undercut the cost of bundlers. However, a Finnish study has projected that there are several ways in which the current bundler can be reconfigured to reduce costs, even below chipping. Improving ground supply systems does not always involve new technology. Sometimes it is just a matter of improving existing road and rail systems to today's standard. A Bio-trade fund could invest in rail supply chain reductions, inland ships, or bundler improvements, for example.

4.2.2. Conversion Systems

1st generation biofuels have drawbacks. Since they use food as feedstock they contribute to higher food prices, are an expensive option for energy security, provide only limited GHG benefits, and feedstocks are not always produced sustainably[3]. Research is ongoing on 2nd generation biofuel technologies that use ligno-cellulosic non-food feedstocks, such as forest and agricultural residues. Many processes are at various stages of development, from basic research to demo and commercial stages. Commercialization of these technologies is expected to take place over the next 20 years. There are 5 operational **thermo-chemical** biofuel plants worldwide; Cutec (Germany), Enerkem (Canada), U. of Vienna (Austria), Southern Research (US), Tembec (Canada). Several companies have demo or commercial plants under construction including; Enerkem, CHOREN, GTI Gas Technology Institute, Range Fuels, ECN, and Forschungzentrum Karlsruhe. Six more plants are planned before 2016. There are 9 operational **bio-chemical** biofuel facilities world-wide including Abengoa (US), Iogen (Canada), Inbicon (Denmark), KL Energy (US), AE Biofuels(US), Lignol (Canada). There are 8 more demo or commercial plants under construction and 10 more planned before 2016. The Bio-trade Fund can invest in demo projects or in commercial scale plants that will result in biofuel trade.

[3] From 1st to 2nd Generation Biofuel Technologies- Sims R., Taylor M., Saddler J., Mabee W. 2008 IEA Bioenergy Task 39

Separate research by Ensyn and Dynamotive in the last year has shown that by using a hydrogenation process BioOil can be mixed with fossil fuel in existing refineries to make green gasoline. BioOil can also be a feedstock for a myriad of bio-chemicals. The Bio-trade Fund can invest in BioOil plants that will result in biofuel trade.

Processes are being developed to further densify pellets by 15-20% to reduce the cost of transportation, and also to make pellets waterproof to further save on transportation and storage costs. Torrefied wood is another technology that when commercial will be a transportable, waterproof, dense energy product. The Bio-trade fund can invest in new densification processes.

4.2.3. Transportation Systems

Size of ship is critical to economies of scale. For example, to ship cargo from SE Asia to the EU would cost $89/ton on a 30,000dwt vessel, but only $41.20/ton on a 95,000dwt vessel. It makes sense to ship fuels on large ships, but the costs to refit a standard Panamax ship to comply with bulk chemical transport guidelines is prohibitive. Ship designs are being considered that would enable a basic Panamax-sized tanker ship to be converted to chemical-ship guidelines at reasonable cost. From the start the ship would have a double bottom of height 2.15m, side-protection of 2m, and 7 cargo tanks per side instead of the normal 6, enabling easy future modification to 3000m^3 tanks, the current maximum size for Type 2 ships. The Bio-trade fund could invest in or take a position in Panamax ships of this sort, or invest in the modifications only, and be paid by the ship-owner or transporter for the cost reduction resulting from the modification.

Improving port systems can involve installation of purpose-built loading equipment such as cranes and conveyors, sufficient storage containers, upgrading rail and truck delivery systems, and enhancing docks to accommodate larger ships.

5. Biomass Availability

As seen above there are many prospective investments in biomass conversion and supply chain enhancements, and many may make the difference between transporting biomass cost effectively and not. Where are the large sources of biomass? What funds are needed and how risky will it be to invest in freeing up biomass from these sources?

5.1. EU

Table 5.1 shows availability of ligno-cellulosic residues in 8 European countries[4]. France, Germany, Poland and Spain have considerable agricultural residue, Sweden and Finland are endowed with forest processing residue. Residues total 4200 PJ. Agricultural and wood processing residues provide 79% of the available residues at relatively low cost. The amount of construction residue is small, but it has a negative cost. Wood from chipping trees and logs comprises only 13% of available residues, and most will be at high cost. The European study VIEWLS concluded that there is sufficient biomass potential for biofuels and bioenergy heat and power, but only if most of available residues were allocated to energy, and only if energy crops are included, since potential residues are insufficient to meet demand.

[4] Impact of 2nd Generation Biofuels on Trade- IEA Task 40 Biotrade- Bradley D., Pelkmans L.

Table 5.1 Residue Availability in Europe (PJ)[5]

	Ag	Forest Processing	Logging Chips	Tree Chips	Roadside Hay	Construction	Total
France	343.9	251.6	68.5	35.7	17.4	19.1	736.2
Germany	206.9	221.0	60.1	29.8	24.0	32.1	573.9
Sweden	24.3	256.8	69.9	41.5	2.6	0.1	395.2
Poland	165.7	127.8	24.6		11.3	15.0	344.4
Finland	20.1	211.7	57.6	36.0	1.5	3.0	329.9
Romania	146.4	52.0	4.2		6.5	8.7	217.8
Spain	141.5	36.7	10.0	13.9	11.9	2.7	216.7
UK	113.8	34.7	9.4	5.1	17.3	1.8	182.1
Other EU27	491.1	456.4	120.6	43.3	51.6	41.9	1,204.7
Total	1,653.7	1,648.7	424.9	205.3	144.1	124.4	4,200.9
Cost (€/GJ)	1.1-3.9	1.1-2.6	1.4-6.7	4.2-8.1	2.0	-4.6	

How much will it cost to access this biomass? Table 5.1 also estimates the cost. The lowest cost is likely to be forest processing and agricultural residues that are already at centralized plants, as low as 1.1€/GJ, since no further transport is required. Roadside hay is also projected to be only 2€/GJ on average, depending on the country and volume. Construction waste is deemed to have a negative cost, since the cost of land filling is eliminated. The highest cost will be logging chips and whole tree chips.

It has been shown[6] that € billions can be saved by importing lower-cost biofuels to the EU instead of supplying biomass locally. But where to get biomass? What if there are not enough low-cost biomass sources in the EU? What are other sources of biomass and how likely is it that these can be sources of feedstock for power plants, heating and 2nd generation biofuels that will be traded over long distances?

5.2. North America

With one of the world's largest forestry sectors, **Canada** is regarded as a storehouse of biomass. Before the 2007-8 world financial meltdown, Canada produced 21 million BDt[7] of mill residue (sawdust, bark etc) annually, and in 2007 had a surplus of 1.8 million BDt[8]. As a result of the US housing crisis, residue production fell and there was no surplus in 2009. When lumber markets recover, Canada will have a surplus of 3-5 million BDt (52 PJ). There are 21 million BDt of bark in old mill piles, much of it in Quebec and Ontario. Provinces are releasing 22 million BDt (379 PJ) annually of harvest residue for energy, mostly already at roadside. There is 9.8 million BDt of urban wood waste and agricultural biomass is estimated at 17.3 BDt annually. In total, the surplus is estimated at 779 PJ with an average cost of 1.67€/GJ (0.18-2.7€/GJ), shown in Table 5.2. Canada has a modern industrial economy and a good transportation/port system. The forest industry is declining due to global competition, and is looking increasingly to divert wood resources to energy, both for domestic use and

[5] Biofuel and Bioenergy Implementations Scenarios- Final Report of VIEWLS WP5
[6] 2nd Generation Biofuel Impact on Trade- 2010- IEA Task 40- Bradley D,, Pelkmans L.
[7] Bone Dry tonnes = Oven Dry tonnes
[8] Canada Report on Bioenergy 2009- Climate Change Solutions, July 7, 2009

export. Although Canada has renewable targets, growth in domestic demand for pellets and CHP is slow, and therefore there is an excellent opportunity for export.

Table 5.2 Canada Residue Surplus

Canada	PJ	Cost €/GJ
Ag Res	293	0.72
Mill Res	52	0.90
Hog Res	34	0.18
Forest Res	379	1.54
Forest chips	146	2.69
Urban	168	0.36
	779	1.67

The **US** has increased production of 1st generation ethanol from corn exponentially in the last decade, largely for energy security reasons. With the potential for biomass to replace imported oil, the USDA determined the technical feasibility of supplying 1 billion tons annually of agricultural biomass[9]. USDA estimated current sustainably removable biomass at 194 Mt annually, including 113 Mt crop residues and 6 Mt corn fibre. This level can be increased to 600 Mt through a combination of technological changes: higher crop yields, improved residue collection technology, and adoption of no-till cultivation. Further, adding perennial crops targeted to biomass production would result in almost 1 billion tons biomass. Except for export-driven pellet plants in the South East, much US biomass could be destined for domestic biofuels and bioenergy for energy security rather than for exports.

5.3. South America & Caribbean

Brazil is both a major producer of forest products and sugar cane. In 2008 Brazil produced 219 million tonnes of cane and 19.5 million litres ethanol (1st generation). Most sugar cane bagasse is burned inefficiently in sugar and ethanol plants for heat, however steam saving actions, minor investments and new cane production can yield 25 million BDt of surplus bagasse at 50% moisture. In addition, there is 31 million BDt of trash (leaves and stalks) available in the field. The forest industry had an estimated 65 million BDt of surplus biomass in 2005, projected at 70 million BDt in 2010, including inefficiently used sawmill residues and rarely used field residues. Biomass transportation costs are high, and conversion to energy-dense biofuels is best done in Brazil. Currently, the focus of Brazil is on expansion of first generation ethanol production from sugar cane, yet there is a huge amount of other biomass waste available to convert to other biofuel products for export.

In 2002 **Argentina** had 2,230 sawmills producing 94 million m^3 of wood[10] yielding 4-5 million tonnes of unused wood waste. Recently it was estimated that there were several million tonnes of waste forestry biomass on rivers within barging distance of major ports[11]. **Chile** has a major forestry industry, about 1/3 the size of Brazil. In 2007 Chile manufactured 60,000 tonnes wood pellets, exporting about 20,000 tonnes. The distances to markets and older port facilities make pellet exports a challenge, however with current low shipping rates and a lower cost per GJ of shipping liquid biofuels, Chile could be a biofuels exporter.

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[9] Biomass as a Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion Ton Annual Supply- April 2005, USDAi

[10] The First Hewsaw to Argentina, Dario Rodriguez

[11] World Maritime Biofuel Shipping Study- IEA Bioenergy Task 40, July 2009

5.4. South Asia & Oceania

South-East Asia has been identified as a major source of biomass from forests, plantations, and processing facilities, as shown in Table 5.3. The lowest cost feedstock would be residues from palm oil and other processing plants, most prominent in **Indonesia** and **Thailand.** A slightly more costly but abundant source is agro-residues, again with Indonesia and Thailand having the greatest potential.

Table 5.3 Residual Potential Asian Countries (TJ)[12]

	Indonesia	Malaysia	Philippines	Thailand
Forest residues	250	250	20	20
Agro-based wood residues	750	200	350	150
Field-based agro-residues	1,850	80	600	1,000
Agro processing residues	600	150	300	450
	3,450	680	1,270	1,620

5.5. Africa

A study on global study on bioenergy potentials[13] projected that sub-Saharan Africa had great potential for exportable biomass. Estimates were largely theoretical and based on quantum leaps in arable land utilization and full utilization of modern production techniques. Estimates of production scenarios varied from 58 EJ/y to 252 EJ/y in 2050. Regional technical biomass potentials for Africa were estimated by VTT in 2007 at 165 Mtoe (1EJ/y), of which half were energy crops, 40% were agricultural residues, and 10 % was bagasse. Though only "technical" potentials rather than realistically achievable volumes, with the support of World Bank and other funding sources, potentials can be turned into reality, one piece at a time.

In Namibia, neighbouring South Africa, there are 10-12 million hectares of land infested by invasive acacia thorn bush and the government is trying to reverse this encroachment and restore wild life habitat and ranch land productivity. Each infested hectare has 10-11 tons of standing Acacia, therefore there are over 100 million tons of Acacia wood that can be used as biomass feedstock.

5.6. CIS

The CIS and Baltic states are major sources of woody biomass. A study on Regional Biomass Potential in 2050 projects woody crop potential at 45 EJ in 2050, 5 EJ in residues, and 33 EJ in forest surplus, however these estimates are highly conjectural. A less theoretical study indicated that the annual supply from North West Russia was 3.5 million m^3. That amount could increase 53% to 5.1 million m^3 if the annual allowable cut could be used completely, and 106% higher to 7.2 million m^3 if thinnings could be used at a full scale. However, the lack of a business culture, the bureaucracy, six month winters, language difficulties, and even personal safety, all together create seemingly insurmountable barriers to doing business in Russia.

[12] FAO Regional Wood Energy Development Program in Asia
[13] A Quickscan of Global bioenergy potentials to 2050- Smeets E, Faaij A, Lewandowski I- 2004

6. Example Projects to Promote Bio-trade

A Bio-trade Equity Fund would target new biomass conversion plants, and projects that either build new supply chains or enhance existing ones. The fund should start by investing in some projects that were already running and delivering positive cash flow. Subsequently, to ensure success, the fund would invest in the low-risk, lowest cost projects to build credibility, and gradually expand the scope of projects and increase risk over time. For example, project choices may be categorized as follows;

Phase 1 Investments:
- New conversion plants with known and widely used technologies in a safe country that has some supply chains already in place
- A supply chain enhancement that would significantly reduce supply costs for an existing conversion plant, with existing markets
- A low-cost expansion of an existing conversion plant that had markets confirmed

Phase 2 Investments:
- Conversion plant in a riskier country, with supply chains in place
- Conversion plant with a new technology in a safe country, with safe existing markets
- Port enhancement in a riskier country, but with existing densification plant

Phase 3 Investments:
- Conversion plant AND new supply chains in a riskier country with great biomass benefits
- Major investment in any new large conversion plant
- Building a special-built Panamax biomass ship
- First commercial plant for a new technology

What are some specific examples?

6.1. Phase 1 Low-risk Examples

6.1.1. Canada- Prince Rupert Port Upgrade

BC currently has production capacity of 1.5 million tonnes wood pellets and exports most of it to Europe. In 2008, due to a slowdown in the lumber industry, pellet plants were limited in the amount of mill residue available for pellets, so producers began using more expensive harvest residue. Despite the change in feedstock, pellet plant expansions of 2-3 million tonnes are planned in central British Columbia to take advantage of the Mountain Pine Beetle wood that is being released for energy by the province. These expansions would triple BC's pellet capacity. Pellets are exported primarily through the port of Vancouver, with some now going through the port of Prince Rupert 800 km north of Vancouver. It is a deep-water port, is well positioned to move pellets, and has more parking for rail cars and better marshalling areas than Vancouver. The port was built for the export of coal, grain, and pulp, not pellets, but it can accommodate Panamax ships of 80,000 tonnes. Pellet manufacturers now use the coal loading terminal on Ridley Island, where existing loading equipment has a 4,000 tonne per hour loading capacity, compared to 500-tph in Vancouver. However, the faster Port Rupert equipment is harsh on pellets. A new pellet loading facility would cost $5-8 million and increase loading efficiency, reduce costs, and not damage pellets. The greater problem however is storage. There is only one pellet silo with 14,000 tonne storage. The design is good, but could be better. Ships like to load 40,000 tonnes and get on their way.

Currently 20-25,000 tonne Handysize ships load a partial shipment of 10-14,000 tonnes. The size of the ship and load very much affect supply chain costs. Ridley Terminal envisions 5 silos of new design with capacity 50-60,000 tonnes. The capital cost would be $20-30 million Cdn (€13-19 million). Additional projects could be changing the assembly to limit dust and preserve pellet integrity, expand the rail siding, and putting in a new dumper. The cost of these investments would be an additional $20-30 million Cdn. The rate-of-return on these projects would be approximately 23%. The Bio-trade fund could partner with the terminal owner to develop these projects. Return would be enhanced and risk reduced with long-term supply contracts from 3-4 pellet producers in the BC interior, long-term rail contracts with CN rail, long-term loading and port contracts, and long-term purchase contracts with specified prices from European or Asian buyers.

While long-term pellet sales to Europe are envisioned, the port of Prince Rupert currently loads coal destined for China, Korea and Japan. Ships could load both coal and pellets in the same terminal, same ship, and sell both to the same buyer in Asia.

6.1.2. Canada- Port of Vancouver Upgrade

The port of Vancouver has two pellet terminals; Fibreco and Kinder Morgan. Handymax vessels like to load 40,000 tonnes. Kinder Morgan has storage capacity of 21,000 tonnes and room to double that. The loading system has a fixed conveyor, which requires a ship to move back and forth to fill. A flexible loader would allow faster filling of the holds thus reducing dock time, and would also protect pellet damage with a reduced fall distance. The cost would be $20 million and would save $400,000 annually in tug costs alone. An on-site Euro silo originally built for potash can be converted to pellets increasing storage to 40,000 tonnes, sufficient to entirely fill a Handymax ship, thus enabling better shipping rates.

A third port is Squamish, 50 km north of Vancouver and much closer to the southern pellet mills than Prince Rupert. It was formerly used as a port by the pulp industry. Squamish does not have the congestion experienced in Vancouver, and $5-8 million in loading and port facilities would enable “Star” ships to load pellets from nearby producers.

The Bio-trade Fund could partner with any of the terminal owners for a share of these lucrative projects.

6.1.3. Australia- Softwood Plantation

XXX Forests has established 50,000 ha of softwood plantations to supply timber for domestic and international markets, and 3,000 of short-rotation coppice for local cogen plants. They have potential to establish in excess of 20,000 ha annually of new plantations, and for this initiative they need external funding. XXX can also contract for residues from up to 450,000 ha of third party plantations. While they currently export roundwood, they do not export bioenergy products.

6.1.4. Australia- Pellet Plant

With already existing plantations and prospects for significant growth, there is the potential to develop large densification plants near to low-cost biomass; either pellet plants, BioOil plants or 2nd generation ethanol plants. There are many locations near deep-water ports, and Australia has already begun to export pellets to the European market.

6.1.5. Canada- Vancouver Rail Bottleneck removal

The Vancouver terminals are congested. Limited rail capacity east of Vancouver sometimes keep cars filled with pellets waiting days, unable to reach the terminals and often causing ships to either wait offshore or depart partially filled. An expanded rail system would improve efficiency, reduce cost of volumes shipped, and enable the smooth expansion of exports from new pellet mills in the interior. The Bio-trade fund could partner with CN-Rail to remove bottlenecks and share in profits.

6.2. Phase 2 Medium Risk Examples

6.2.1. Finland- Ultra-light Freshwater Vessel Concept

Finland is in the forefront in biomass supply chain management research and has built and tested many purpose-made machines for low-cost handling and road transportation of woody biomass. Finland is covered with lakes, and the Finnish forest research organization, Metla, has been studying the concept of moving forest chips using inland waterways instead of by truck or rail. It is believed that such transport would considerably reduce the cost of getting wood fibre to coastal conversion plants, for example on Lake Saimaa, and also to move product in other inland waterways, such as in the Netherlands and Belgium. The proposed concept is to build ultra-light freshwater vessels, as shown in Fig 6.1. The design length would be 110m, width 14m, and height to keel 8.5m. The operational depth would be .45-2.4m and the carrying capacity 2,920 tonnes. The fuel-efficient operational speed would be 8-10 knots. It would have the ability to manoeuvre sideways and the sub-surface parts would be designed to withstand ice conditions. The capital cost is €22 million, and potential government support of up to €9.9 million has already been identified. The ship would eliminate the need for €35-45 million in truck costs over the 25-30 year ship lifetime.

Fig. 6.1 Ultralight Freshwater Vessel

6.2.2. Canada- Quebec Biorefinery

Quebec has the second largest forestry industry in Canada. The industry is foundering due to migration of pulp production to the southern hemisphere, and closure of sawmills following the sub-prime housing crisis in the US. Quebec has 5.3 million BDt of dry bark in heritage piles and 5-7 million BDt annually of harvest residues for energy. The Province has delegated power to allocate fibre to 18 regional development groups, and many communities are interested in developing biomass for heat and power and pellets. Quebec has year-round ports: Saguenay has a 13-metre deep port on the Saguenay River used by the pulp & paper industry that can handle 100,000 tonne vessels; ports of Quebec and Montreal; and smaller ports at Trois-Rivières and Rageneau. With such large biomass resources and a major economy, Quebec is a prime location for integrated bio-refinery operations that can supply heat and power locally, as well as pellets, BioOil, ethanol and bio-chemicals world-wide.

6.2.3. South Africa- Green coal (torrefied briquettes)

It is generally uneconomic to ship raw wood long distances for energy. Wood is now densified into pellets and transported economically over 14,000 km to Europe. Torrefication is a densification process that results in a 30-40% loss of mass but only a 10% loss in energy. Torrefied wood at 26 GJ/tonne is more energy dense than wood pellets at 18 GJ/tonne, and thus it can be cheaper to transport. Torrefied wood is also water-proof, and therefore does not require the same storage and handling restrictions as pellets. Logistically torrefied wood can be handled in the same way as coal for bulk distribution. In coal power plants torrefied wood can be added directly to coal without restriction and without added capital, while pellets are limited to 10% of feedstock without capital enhancements. Green Coal is a business venture to produce torrefied wood briquettes to substitute for coal in coal power plants. It is a community-based project that provides considerable local employment.

In neighbouring Namibia there are over 100 million tons of Acacia wood that can be used as a feedstock to make torrified wood. A $3 million pilot plant is already successfully operating. A 60,000 tonne per year plant could be built for $8 million. Harvest activity for 60,000 tons would cost $1.9US million in capital and result in EBITDA of $700,000. Product could be trucked or railed to the deep-water Port of Walvis Bay, the largest port in Namibia with 3000 vessel calls per year.

6.2.4. Brazil- Ethanol pipeline

In recent years the sugar cane crop in Brazil grew 6% per year, but to meet international and domestic demand it is estimated to grow 16% in 2009 to 550 million tonnes. 58% of the main south-centre crop is destined for 1st generation ethanol. However, Brazil’s shipping ports are already under pressure. In 2007 ships waited 3.15 days on average for a berth at Santos Alamoa ethanol terminal, responsible for 80% of Brazil’s exports. The wait rose to 5.37 days in 2008, and was projected to be over 14 days in 2009[14]. Ships often cost $10,000 per day, so a 14 day wait costs $140,000. Ethanol must compete with soybeans, steel and iron ore for rail space in the Sao Paulo-Santos corridor, and there are not enough trucks to substitute. Three investor groups have tabled plans to build ethanol pipelines through the corridor. Petrobras plans two pipelines costing US$1.1 billion to connect the western-central sugar cane region to the ports of Santos (Sao Paulo State) and Paranagua (Parana State). Cosan announced plans to invest $1billion in a 386-mile pipeline. A third private investor group also plans to build pipeline capacity. All pipeline proposals need investment partners, and all should have after-tax rates-of-return in the 20-25% range. A Bio-trade fund would not be able to fund any of these entirely, but could take a 10-20% stake. The Fund would take its share of pipeline profits, but to ensure success of the Fund, international buyers should provide guaranteed volumes and prices for ethanol that used this pipeline, and the Brazilian government should consider a preferred tax rate for offshore investors.

6.2.5. Brazil- 2nd Generation Ethanol

Brazil's is focused on 1st generation cane ethanol, and financial resources will continue to be directed at expansion in this business. However, due to the sheer size of the sugar cane crop

[14] Fabio Abrahao- International Logistics and Supply Chain Consultants

Brazil has one of the largest concentrations of non-food biomass feed stock in the world, sugar cane bagasse. Brazil also has one of the world's largest pulp industries. Pulp and forest operations leave millions of tonnes of wood waste unused. These biomass resources can be feedstock for 2nd generation ethanol plants. Iogen, Enerkem and other companies have proven technologies that convert agricultural and forest biomass to 2nd generation ethanol; Ensyn and Dynamotive have proven technologies that convert this biomass to BioOil. The Bio-trade Fund could invest in 2nd gen ethanol and BioOil plants. An economic 2nd gen ethanol plant would produce 35 million litres annually and cost $75US million. An economic BioOil plant would be 200-400 tpd (66,000-132,000 tonnes BioOil p.a.) and cost $50US million. Rates-of-return should be on the order of 25-30%. The projects could be led by the Bio-trade Fund, but should have partners in Brazil to be successful. International buyers should guarantee ethanol volumes and also provide for superior pricing owing to the non-food aspect of its feedstock. BioOil should have contracted volumes with Brazilian pulp mills for their lime kilns, and contracted volumes and prices for BioOil export to EU power plants.

6.2.6. Argentina BioOil plant and Barge program

Argentina has a sizable sawmilling industry. In 2002 there were 1.1 million hectares of plantation forest and 32 million ha of native forest, with 2,230 sawmills processing 94 million m^3 of wood[15]. Using industry conversion factors, this processing volume yields approximately 4-5 million tonnes of wood waste, completely unused in 2002. It has been recently estimated that there are several million tonnes of waste forestry biomass on rivers within barging distance of major ports. It is possible that Argentina can become a major exporter of wood pellets, bio-oil or ethanol using commercially available technologies.

As noted in 4.1.3, BioOil, or pyrolysis oil, is a relatively new biofuel that can be used to replace heavy or light oil in stationary engines or in boilers. It can also replace coal in large power plants by using dedicated burners. It is also a good feedstock for bio-refineries to make bio-chemicals, and recent research has proved its use as a feedstock to make green gasoline. It is twice as energy dense as wood pellets, easier to handle, and may be a better low-cost renewable fuel to ship long distances than wood pellets. There is an opportunity to build several modular 200-tpd BioOil plants on the Paranó River upstream from Buenos Aires in Argentina. There is plentiful dedicated mill residue available. Capital cost for each 50,000 tonne BioOil plant would be approximately $37 million, 25% less than in North America. Operating cost would be 25-30% of equivalent costs in North America. 10-15 plants are envisioned, sufficient to produce 500-750,000 tonnes. Some BioOil could be sold into Argentina, Brazil, and Uruguay, but it is envisioned that most of the production would be available for export. Barges would enable the large-scale, low-cost transport of BioOil to ocean ports such as Monte Video, and shipped to world markets.

6.2.7. Phase 3- More Risky Examples

6.2.8. Zambia- Biomass

The Moringa Oleifera plant has been identified as an inexpensive way to increase nutrition in African countries, and also provide medical benefits. It is fast-growing and drought resistant, and grows even in marginal soils. Zambia has 44 million hectares of arable land, of which only 14% are being cultivated. In 2010-11, the Zambian Bioenergy Association will target

[15] World Biofuel Maritime Shipping Study- Task 40

60,000 farmers in three provinces (10,000 initially) with a campaign to grow Moringa. The Moringa plant produces oil and leaves for cooking and food, and Moringa stalks that can be used as a feedstock in the production of ethanol or biodiesel. Moringa plants yield 50-70 tonnes/ha of biomass if on non-irrigated land, or 100-120 tonnes/ha if on irrigated land. Initial plans are to build a small demo biodiesel plant for local use and three biomass densification plants for possible exports. It is planned that funds such as the World Bank Climate Fund and Copenhagen Fund can support the growth of Moringa plantations, by conducting awareness meetings, purchasing trucks and other equipment, etc. The Bio-trade fund could subsequently support the building of an ethanol or biodiesel complex, with much of the production being exported.

7. Bio-trade Fund

7.1. Principles and Objectives

The principle of a Bio-trade fund is to guide equity funding into projects that will enable development and transportation over long distance of meaningful amounts of biomass within the next 10-15 years in order that GHG and biofuels targets can be better achieved. The impact will be reduction in world GHG emissions, and socio-economic development in regions that may not otherwise achieve it.

The objectives of the fund are;

- To make an acceptable rate of return based on the risk of the project portfolio, either by way of dividends or capital appreciation. The return will be in the area of 20%.
- To generate projects in regions with large volumes of underutilized biomass that
  - Develop biomass conversion facilities, or
  - Enhance ground supply chains to move biomass to port, or
  - Expand or improve efficiency of port facilities, or
  - Enable low cost shipping of biomass
- To enable investment money to flow to projects
- To enable over a 10 year period the low-cost supply of 50 million tonnes biomass to regions that need this biomass to achieve climate change objectives

Owing to the environmental and socioeconomic ideals of the fund, it is recommended that governments provide incentives that will enable the Fund to yield a superior return for the risk of the investment portfolio.

7.2. Structure

Capital funds normally invest in stocks of companies that have significant upside stock appreciation potential, often due to a promising technology or a pending government production contract for example. Funds generally try to buy stocks low, and then sell high when the technology is proved and moving into production. Many equity investment funds prefer to ride share value upward and then sell rather than wait for the company to pay dividends. The summation of the value of company stocks that the fund owns is the "value" of the fund. Investors can buy shares in the fund itself and sell when the value of their shares appreciates.

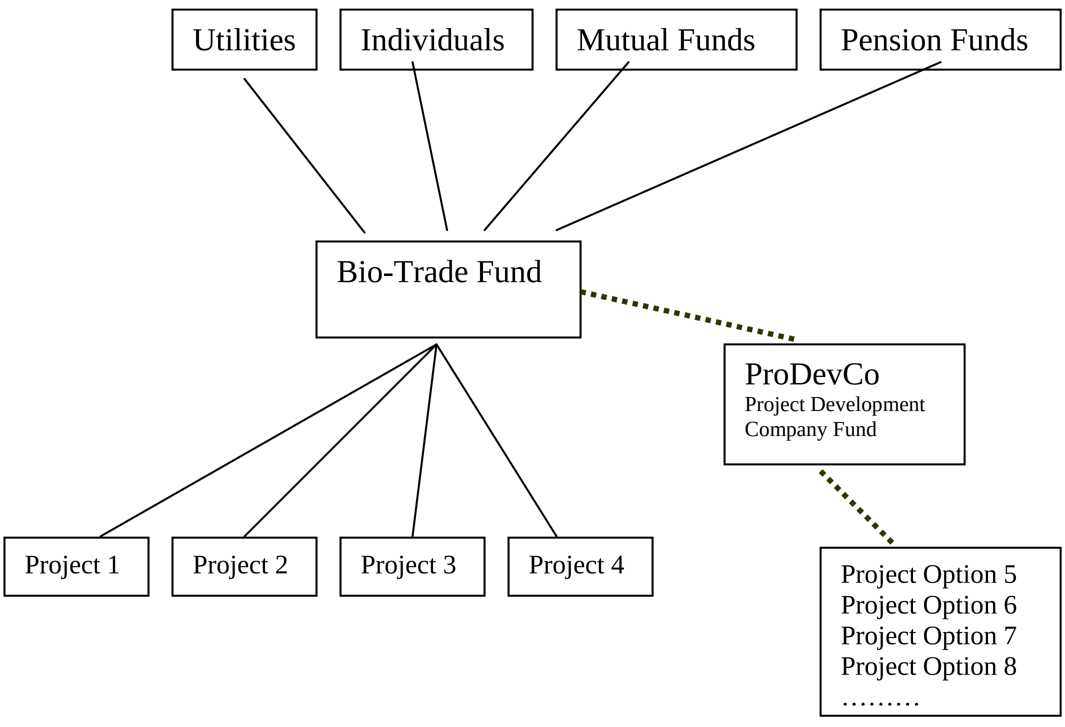
The Bio-trade Equity Fund is not based on buying stocks of bioenergy companies, but on developing projects that will provide cash flow. The Bio-trade Fund would be composed of two basic entities as illustrated on Fig 7.1;

- The Bio-trade Fund itself, which is sole or part owner in several projects and managed by a small management team
- ProDevCo- A team of project developers to examine project opportunities, propose promising projects to the Bio-trade Fund management team for approval, develop projects that are approved to proceed, and transfer the project into the fund

It is anticipated that initial investors in the Bio-trade Fund will be venture cap companies, since that is the business they are in. Utilities are obvious candidates as initial investors since many must procure large volumes of biomass over several years for either co-firing or burning in 100% biomass power plants. However, utilities are risk averse, usually only invest with iron clad contracts for biomass supply and power sales, and many hold the mistaken impression that all bioenergy investments are inherently risky. To change this will require education and demonstration projects. Utility participation in the Fund may provide them with the long term supply contracts needed to build a 100% biomass power plant. Examples include Drax, EON-UK, Essent, and Electrabel. Individual speculators may also invest in the fund. Over time, as projects enter the fund and generate cash flow, and the Bio-trade Fund establishes a track record, mutual funds and pension funds will also be drawn in as investors.

Initially investors would provide seed money to set up the Bio-trade Fund legal entity and ProDevCo entity, on the order of €1.8 million in year 1. A Fund management team of 3-4 proven managers and a project development team of perhaps 4-5 would be formed.

Fig 7.1 Structure of Bio-trade Fund



In ProDevCo, 2-3 project "finders" would be tasked with finding investment opportunities. They can solicit such projects through organizations such as IEA Bioenergy Task 40-Biotrade, the World Bioenergy Association, domestic bioenergy associations or other networks.

Projects may be already operating and generating cash flow, or they may be very low risk projects that are projected to achieve early cash flow and an acceptable return, or be riskier projects worthy of analysis. The "finders" would develop business case proposals on projects they find and present them to the Fund management team for approval to invest. They would also approach governments and stakeholders of each project to solicit guarantees on supply or price to reduce risks of investment.

ProDevCo would also need experienced project "developers". The developer would deal with all parties related to each project; equipment manufacturers, banks, biomass suppliers, local stakeholders, etc, and be responsible for signing contracts and getting projects started. The developer would also create project entities that will enable transferring cash to the projects, and back into the funds as returns.

It is expected that in a short time there would be a funnel of hundreds of project opportunities, from the lowest risk to the highest. The "finders" would evaluate projects according to specified selection criteria including rate-of-return, volume of biomass, timing of cash flows, risk etc. Initially only the lowest risk projects will be preferred. As the Fund developed a steady cash flow, more risky projects may be accepted. Project selection criteria would be weighted by importance, and reflect the following:

1. Rate of return
2. Volume of biomass
3. Proximity of cash flow
4. Risk of project
5. Partners
6. Socio-economic benefits to locality

7.3. Management

While the Bio-trade Fund could operate in any continent, the demand for biomass by the EU and legally binding renewable targets there make Europe a favoured centre for the fund. Managers should have knowledge of the biomass/bioenergy industry including technologies, a thorough understanding of the workings of financial markets, experience in offshore investing, and an understanding of the underlying risk of investing in foreign countries. Management must have a portion of their compensation tied to the success of the fund.

In ProDevCo project "finders" must have a thorough understanding of all aspects of capital investment evaluation, and considerable knowledge in bioenergy business. Finders would be responsible for preliminary evaluation of investment opportunities, presenting opportunities to Fund Management, and drawing up the capital investment plan and business plan.

Project "developers" must have experience in all aspects of getting projects off the ground, including setting up legal entities, negotiating with prospective partners, lobbying for government incentives, arranging contractors, and overall delivery of projects.

7.4. Timeline

To get an equity fund up and running might take 1-2 years. A reasonable yet conjectural time frame for start-up, and an example time frame for project investment follows.

Start-up Fund
Year 1:
- Prepare a conceptual 3-5 page business plan
- Find an experienced, successful fund manager that likes the concept
- Prepare a more-detailed a 10-20 page business plan and test market the concept with capital placement funds
- If significant interest from investors is found, develop a full business plan, design legal structure, develop investment criteria
- Build the management team, those that have worked well in the past
- Acquire bioenergy expertise-

Year 2:
- Hire project developers and bioenergy project finders
- Find 4-5 investment opportunities, develop capital plans and partnership proposals
- Estimate cash flows for the Fund and project Fund value for 1-2 years
- Employ capital placement firm to raise on the order of €20 million
- Management to approve 3-4 projects, at least two of which are supplying cash flow
- One project should be a demonstration, a low risk project including densification plant and supply chain

Fund Operating
Year 3-4:
- Invest in 2-3 operating projects that are generating income. For example;
    - 30% of 150,000 t pellet plant in BC. €3.4 million.
    - 45% of 80,000 t operating pellet plant in low-risk location. €4.2 million.
- Begin development of new low-risk supply chain projects. For example;
    - 51% of new 150,000 t pellet plant in low-risk location. €5.7 million.
    - 49% of Prince Rupert Port loading facilities. €1.5 million
    - 49% Prince Rupert Port silos. €5.7 million.
- Finders to propose 3-4 more projects and solicit projects worldwide

Year 4:
- Management begins to market Fund to other investors worldwide
- New projects added to portfolio, some low risk, some medium risk. For example;
    - 49% of new 150,000 t pellet plant near plantations in west Australia. €5.5 million.
    - 49% of Port Rupert rail dumpers. €1.5 million
    - 49% of Ultra-light Freshwater ship in Finland. €8.6 million.

Year 4:
- Fund beginning to draw non-utility investors
- More biomass being imported to EU at lower cost
- Some fund cash is reinvested in new projects, some returned to shareholders as dividends
- Fund adds more low-risk and some more risky investments. For example;
    - 10% of €0.66 billion ethanol pipeline in Brazil. €53 million.
    - 51% of a €30 million BioOil plant in Argentina. €11.8 million.
    - 100% of a €5.3 million barge program in Argentina. €4.3 million.
    - 49% of a €53 million 2nd generation ethanol plant in Australia. €21 million.
    - 100% of flex-loader at Kinder Morgan terminal Vancouver.

Year 5, 6, 7:
- Fund expands into higher risk category, such as more risky regions, or simply larger projects. For example;
    - 30% of a €100 million bio-refinery in Quebec Canada. 80% of product to Europe
    - 51% toward a Moringa plantation in Zambia
    - 51% of a Moringa pellet or BioOil plant in Zambia, 70% for export
    - 30% of ground supply chain and port enhancement for Zambian exports

7.5. Example Project Path

It is recognized that some projects described in section 7 may already be underway by the time the Bio-trade Fund is ready to invest. It is also expected that many more lucrative investment opportunities will be uncovered. Table 7.2 reflects the value of the fund over time if it started today and these (or similar) projects were available. By year 4 the Fund could have acquired capital of €121 million, but the fund would be worth €152 million based on the NPV of project cash flow.

Table 7.2 Example Project investment Requirements

Fund Capitalization (€000)								
		Year	1	2	3	4	5	6
Invested Capital			1,800	24,093	39,561	119,441		
NPV						148,290	174,982	178,481
Equity Inj			1,800	22,293	15,468	79,880		
Op. Expenses			-1,800	-1,836	-1,873	-1,910	-1,948	-1,987
3 existing projects								
Safe location	150,000 t pellet plant	51%		-5,712	1,787	1,823	1,859	1,896
Canada	150,000 t BC pellet plant	30%		-3,360	1,051	1,072	1,094	1,116
Safe Location	80,000 t pellet plant	45%		-4,185	1,309	1,335	1,362	1,389
Low Risk:								
Canada	Canada- Prince Rupert Port loading	49%		-1,500	427	436	444	453
	Canada- Prince Rupert Port Silos	49%		-5,700	1,642	1,675	1,708	1,743
	Canada- Prince Rupert Rail/Dumper	49%			-5,700	1,642	1,675	1,708
	Vancouver- Kinder Morgan FlexLoader	49%				-1,715	409	417
	Squamish Port	49%						
Australia	2nd Gen Ethanol Plant	49%				-18,293	5,723	5,838
	20,000 ha plantation	49%						
	150,000 tonne pellet plant	49%			-5,488	1,717	1,751	1,786
Medium Risk:								
Finland	Ultralight Freshwater Vessel	49%			-8,624	1,699	1,699	1,733
Argentina	BioOil Plant	49%				-11,760	3,085	3,146
Argentina	BioOil barges	100%				-4,267	470	480
Brazil	2nd Gen Ethanol Plant	49%						
Brazil	Santos Ethanol Terminal	30%						
Brazil	Ethanol Pipeline	10%				-53,333	12,850	13,107
Canada	Biorefinery	0%						
World	Chemical Panamax upgrade	0%						
High Risk:								
Zambia	2nd Gen Ethanol Plant							
	Supply chain project							
Russia	Karelian Supply chain							
			0	0	0	0	32,182	32,825

Appendix 1- Principles of Investment

How do debt and equity differ. Companies are generally owned by shareholders, and companies exist to provide a fair return to shareholders by way of dividends, share appreciation, or both. Investors buy a company's shares on the expectation that share prices will rise in value. For share value to appreciate, companies must either invest in projects that will result in cash flows that provide a reasonable rate of return on investment, or they must have a technology or other opportunity that are anticipated to result in future cash flows and investors are willing to gamble that this will happen. There are exceptions, such as environmental investment that may not generate a return, but these are required for continuing in business. Shareholder's investment in a business is called **equity**.

Companies often borrow money so that projects are funded both by the company's equity and **debt**. Debt lenders and equity investors have a very different risk tolerance, and accordingly receive different returns. Debt holders are much more risk averse than equity holders and usually fashion loan packages that provide assurance that the loan will be paid back on a timely basis, and interest will be paid. The assurance is often provided by the company putting up collateral, such as an asset of value that can be sold, in the event the company cannot make principle or interest payments. Only after debt holders have received contracted payments do shareholders have a claim on remaining profits. Because debt holder has reduced the risk of lending money, it is willing to accept a low rate of return. Because the shareholder is second in line to get returns from profits, his risk is much higher. The shareholder, or equity holder, demands higher return.

The Table below illustrates this mechanism. A company undertakes three projects- 1,2,3. Each requires investment in working capital (inventory, working cash, etc) and fixed assets (machinery, equipment, land, etc). In this example the investment in the three projects is $34, $45 and $11 for a total of $90. The company chooses to pay for this investment using $50 of its own equity, and borrows $40 in debt. The cost of debt is 8% in this example, but because interest payments are tax deductable the actual cost to the company is only 4.8%. It is essentially cheap money. In this example, because of the riskiness of its projects, the equity holder demands a 25% rate of return. The combined cost of capital is 16%. The company would thus invest in projects that were projected to provide a return of at least 16%. In this way both the debt and equity holders get their required rate of return.

Table- Company Balance Sheet

	Projects			
	1	2	3	Total
Investments:				
Working Capital	4	5	1	10
Fixed Assets	30	40	10	80
Investment	34	45	11	90

	Financing		
	Amount	Cost bt	Cost at
Debt	40	8.0%	4.8%
Equity	50	25.0%	25.0%
Capital	90		16.0%