Waste, not waste

The development of waste-to-energy Technology in Mumbai, India

Global Enterprise Experience, 2012

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Business Concept

The Concept - *"Alternative Energy Limited"* is a company focused on the provision of clean, alternative energy sources and waste management solutions for the crowded city of Mumbai, India. *"Alternative Energy Limited"* has a core goal of improving the lifestyle of people living in the slums of Mumbai. Our business concept involves taking developed waste-to-energy technology and developing a system in the slums of Mumbai. Providing a reliable and sustainable source of electricity, a solution for the cities dire waste management issues and promoting local employment.

Waste-to-energy technology - It is a little known fact that waste can be used as a source of useable electricity, this is known as waste-to-energy technology. Generally waste-to-energy technology involves the combustion of municipal solid waste (MSW) to directly produce electricity or in some cases produce a combustible fuel commodity such as methane or ethanol. This technology takes un-productive waste destined for a landfill and creates a marketable commodity (electricity) providing reliable power for communities as well as providing a practical waste management solution. For the purposes of this report we are going to focus on the waste-to-energy technology of D4 Energy Limited. D4 Energy provides a devolatization system which processes a carbon-based feedstock in a continuously closed-loop system. The system breaks down the feedstock (waste) to a molecular level, using high temperature incineration, creating a high quality Btu Gas. This gas is then used to power an electricity generator. The system works as follows. At first, the municipal solid waste (MSW) after being collected is delivered to the D4 energy system. The MSW is sorted with people removing the metal and the non-fuel producing material such as glass and ceramics. The MSW is then fed into a shredder with the newly ground material going into a hammer mill where they go through a compressed refuse derived fuel pelletization process, essentially creating compact pellets of MSW. These pellets travel through a compaction screw where the remaining air is squeezed out. The pellets are then fed into the devolatization process, a burner system that incinerates the pellets at extremely high temperatures. High quality 700-750 Btu Gas and activate carbon is produced. Finally the gas and activate carbon travel to the collection point. There is then an export gas stream to power an engine or turbine generator, which produces the electricity. The carbon can then be captured and used in other processes (D4 Energy Limited, 2012).

Business Model

Revenue Streams – This business concept presents three main sources of revenues.

- The first is the provision of electricity; India currently faces a shortage in electricity supply and the government will guarantee a minimum price per KWh for waste-to-energy sources so this revenue stream is all but guaranteed.
- The second is the collection of "tipping fees" a fee charged to local rubbish collectors (who are either employed or contracted by local government) to dump their waste. Mumbai in particular faces a serious waste management issue with fees at traditional landfills beginning to rise (Bhada, 2007). This ensures both the supply of waste for the D4 System and a certain price per ton of waste processed. This is a unique characteristic of waste-to-energy technology, the ability to charge, rather than pay, for raw materials.
- The third is the sale of recyclables; material such as glass, ceramics, metal and hard plastic, which as mentioned will be separated from the MSW then packaged and on sold to recycling plants.

Business Objectives – The objectives of *"Alternative Energy Limited"* can be broadly defined in four main points.

- Create a sustainable business providing a reliable source of electricity to the broader Mumbai population.
- Create a practical, long-term waste management solution for the slums of Mumbai.
- Promote the development of alternative energy sources not only in Mumbai but India and other developing countries.
- Wealth creation through the provision of productive electricity and employment.

Connecting economies

"Alternative Energy Limited" provides a link between developed economies in that it utilizes technology found in predominantly developed economies, this case in the United States, and applies it in a developing economy, here India. Waste-to-energy technology forms the link, connecting developing and developed economies in a mutually beneficial cycle. The developed economy has the benefit of the advancement and spread of their technology while the basic services provided by the system is of huge benefit to the developing economy.

Target Market Analysis

India – In recent years India has undergone a process of opening its economy to world trade, while India has high tariffs in comparison with other countries, and has many restrictions on investment (World Bank, 2012). Many of the quantitative restrictions on imports have been eliminated, and Foreign Direct Investment (FDI) is now active in many sectors (World Bank, 2012). India is now pursuing much more liberal trade around the world, mainly in services. India also has a role as a leader among developing nations in global trade negotiations (World Bank, 2012). India currently has preferential Trade Agreements with Afghanistan, Chile and Mercosur (World Bank, 2012) and is currently pursuing agreements with some East Asian Countries and the United States.

India, as a target market presents the possibility of retaining 100% ownership of a firm after FDI has occurred, something that is not an option in many developing economies. However in order for this to occur companies have to show how their project/venture is going to create economic value for India; we believe our venture satisfies this requirement not only contributing to economic growth and improving the life styles of Mumbai's slum population but having a positive environmental impact as well.

Mumbai – Mumbai is the capital of the Indian state of Maharashtra and is one of the most populous cities in India. Mumbai has a total metropolitan population of approximately 20.5 Million people. Located on the west coast of India by the Arabian Sea Mumbai is both the richest city in India but also all of South, West or Central Asia. Despite this Mumbai has a phenomenal slum population, it is estimated close to 50% of the population is living in slums or "informal" housing (World Bank, 2012). Unfortunately the slums suffer from many deficiencies in services such as erratic water and power supply and sub-par sewerage, sanitation measures as well as a deficient transportation systems (World Bank, 2012). In the slums environmental conditions are deteriorating on a daily basis affecting the health of the population and decreasing the productivity and quality of life of its habitants (World Bank, 2012). In Mumbai, around 30% of the slums are legalized, while 10% of the slum habitants are living illegally. While some slums are legalized this does not subtract from the fact that they require suitable infrastructure to facilitate development (USAID, 2012). Mumbai is an ideal place for our venture because an overwhelming majority of slum population lack electricity, a huge hindrance on development. Waste management is also a serious problem in Mumbai's slums. A solution to this would not only provide cleaner streets but would also help stop the spread of disease and illness.

This project will not only benefit Mumbai but it will also benefit D4 Energy through the expansion of its markets and wider distribution of its products.

Waste Management in Mumbai – The generation of waste per capita in Mumbai is around 630 gm. per person each day (MCGM, 2004), and the solid waste at the municipal level in Greater Mumbai is 7,800 MT per day (Manadevia, Minstry & Pharate, 2005). The Municipal Corporation of Greater Mumbai (MCGM) is responsible for MSW collection, transport and final disposal of waste; MCGM also performs services such as street sweeping and disposal of animal carcuses. Waste is collected either via door-to-door collection or from communal collection points and is then transported to either a transfer station or directly to a dumpsite. Mumbai currently has many potential dump sites however many of these are reaching their capacity or are beginning to encroach on residential areas. Proposed new dump sites are widely contested by the community. It is clear that waste management is an issue in Mumbai and for the purpose of a waste-to-energy system there is no shortage of waste to feed into the system (Bhada, 2007).

Electricity Production in Mumbai – Electricity demand far out strips electricity supply in Mumbai with electricity being a rare luxury for much of Mumbai's slum population. In late 2011 nearly 300 million Indians did not have access to electricity (World Bank, 2012). The problem, predominately, is the production capacity. India cannot keep up with the electricity demands of its population. This is a less than ideal situation and presents an opportunity for *"Alternative Energy Limited"* to provide electricity using waste-to-energy technology.

Recycling in Mumbai – Recycling in Mumbai is largely performed by the informal sector. Rag pickers are women who pick through dump sites to retrieve recyclables material which are then on sold to middle men or directly to recycling plants. The main issue then is education around on site separation of recyclable material and the establishment of infrastructure to deal effectively with recyclables directly from the household (Bhada, 2007).

Business Strategy

Strategic Partnerships

D4 Energy Limited - D4 Energy is based in Washington DC and is involved in the production and maintenance of small, portable waste-to-energy systems. We have elected to use D4 Energy's technology for this project. The development of the proposed waste-to-energy system obviously involves a significant capital outlay. We estimate the initial development cost to be $1.9 million NZD. This is far too much capital to be raised through debt financing and/or government grants. This is why we propose entering into a strategic partnership with D4 Energy. The advantage of waste-to-energy projects is their high returns on capital. We propose we leverage this return to fund the initial development of the project. The agreement will work as follows. The initial development costs will be split 85:15 between *"Alternative Energy Limited"* and D4 Energy limited. In addition in year 3, 6 and 9, D4 Energy will fund the expansion of the system by 1 node, doubling the production capacity. The end result will be a system with 4 nodes and a 5MW production capacity. We estimate each expansion will cost $400,000 NZD. In return for funding 85% of the initial development and three expansions D4 Energy will receive a payment of $285,000 NZD in year zero representing 15% of the production costs then starting from the end of year 1 they will receive $250,000 NZD a year. In Years 3, 6 and 9 when expansions take place this figure will increase by $62,500 NZD. The final figure paid to D4 Energy will grow at 3% per year. These cash flows appear below.

D4 Energy NPV Analysis

	Outflow	Inflow	Discounted Outflow	Discounted Inflow
Year 0	$1,900,000.00	$285,000.00	$1,900,000.00	$285,000.00
Year 1	$0.00	$250,000.00	$0.00	$227,272.73
Year 2	$0.00	$257,500.00	$0.00	$212,809.92
Year 3	$400,000.00	$331,531.25	$300,525.92	$249,084.34
Year 4	$0.00	$341,477.19	$0.00	$233,233.51
Year 5	$0.00	$351,721.50	$0.00	$218,391.38
Year 6	$400,000.00	$434,727.78	$225,789.57	$245,392.50
Year 7	$0.00	$447,769.61	$0.00	$229,776.61
Year 8	$0.00	$461,202.70	$0.00	$215,154.46
Year 9	$400,000.00	$554,211.91	$169,639.05	$235,039.95
Year 10	$0.00	$942,698.63	$0.00	$363,451.13
	$3,100,000	**$4,657,840.57**	**$2,595,955**	**$2,714,606.53**

This agreement provides D4 Energy with a positive net present value (NPV) of **$118,651.99 NZD** making this strategic partnership a very worthwhile venture for them. They will also get the benefit of the expansion of their technology into India and *"Alternative Energy Limited"* will continue to contract out to them for system maintenance totaling $50,000 NZD per year and education and training a total figure of $35,000 NZD paid across year 1 and 2 (full financial details appear in the finance section). We will assume that these positive factors are enough to convince D4 Energy to enter into a strategic partnership.

Mumbai Energy Alliance - "Mumbai Energy Alliance (MEA) is a novel partnership intended to scale up implementation of energy efficiency programs in the Greater Mumbai region. The vision of MEA is to mobilize a collaborative effort to deliver large-scale, measurable energy efficiency improvements in Mumbai targeted at reducing the city's long-term energy costs and carbon footprint. The MEA plans to implement citywide energy efficiency programs using innovative service delivery mechanisms combining technological, economic, social and financial mechanisms" (Alliance, 2009). The Mumbai Energy Alliance has funds in place aimed at providing money for the development of infrastructure around alternate energy. The kind of waste-to-energy technology that *"Alternative Energy Limited"* wants to develop fits this mould very well so there is a lot of scope for our venture to work with the Mumbai Energy alliance here.

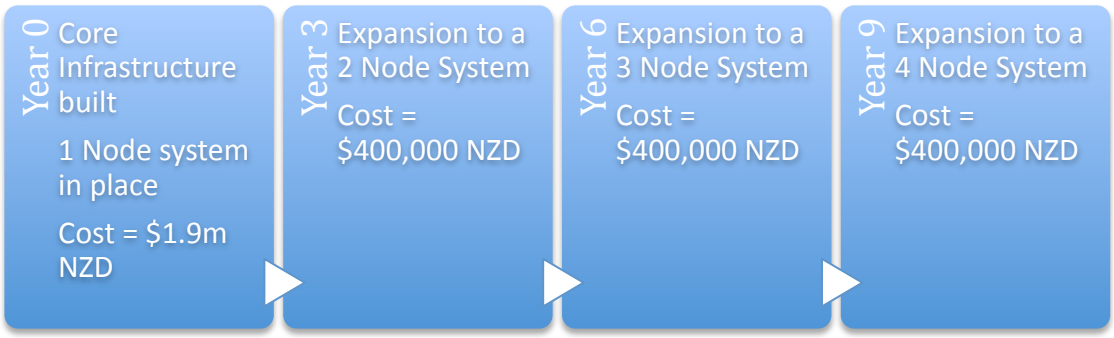
Logistics

System establishment and location – The D4 energy waste-to-energy system is very small using only 12,000 sq feet for a standard one-node system. All that is required onsite is a concrete slab for the system to be erected on. The MCGM has advised that land would be provided virtually free of cost to a waste-to-energy operator. Taking this guidance into account we have assumed 1 hectare of land can be leased at $1189.71 NZD in year one increasing at 10% a year. For simplicity we will assume this site already has a concrete slab in place. We have decided to locate the plant in central Mumbai near Mahim Bay and the Dharavi slums one of the largest slum settlements in the world. This area already has a number of industrial developments and provides easy access for trucks to deliver waste.

Connecting to the grid – Connecting to the electricity grid in India is a relatively easy process; we do not envision any substantial costs involved in this. A contract would have to be signed between *"Alternative Energy Limited"* and the Power Grid Corporation of India. India has relatively liberal electricity markets so there are little to no barriers for small and independent electricity producers.

Growth

The initial growth strategy is outlined above, expanding from a one-node system to a four-node system over the period of 10 years. However there is significant room for expansion post this period. The following financial strategy outlines strong forecasted revenue growth supplying sufficient capital for the development of at least two more system in the medium term. A portion of profit will also be set aside for community development projects.



Finance

Electricity Sales - The Maharashtra Electricity Regulatory Commission (MERC), the local government body responsible for setting tariffs relating to electricity purchases, transmission and distribution advised in 2004 that the tariff for MSW-based plants would be set at 3.5 Indian Rupees per KWh ($0.085 NZD) and that this tariff would gradually increase to 5 Rupees per KWh by 2015 ($0.115 NZD). For prudency reasons we have assumed a flat rate of $0.085 NZD per KWh with no increases for at least the first 10 years of operation. This advice was offered in response to a proposal by a company to set up a large-scale MSW-based plant in 2004. If needed there is also the option to hedge electricity prices. Electricity futures contracts are provided by the Multi Commodity Exchange the predominant commodity exchange in India. A high level of certainty in the expected electricity revenues is essential because this will be used as the basis for applying for an ANZ business loan to fund the required 15% development costs and to provide a cash cushion for the first year of operation.

Tipping fees – Based on average tipping fees charged to dump waste at land fills it is assumed the MCGM would pay 225 Rupees a Ton ($5.5 NZD) to unload waste at our waste-to-energy facility (Bhada, 2007).

Recyclable sales - Estimated to be $50 NZD per 24-hour period (Bhada, 2007). This is based on sales directly to a recycling plant rather than via a middle man.

Debt Financing – We plan to apply for a 10-year business loan of $300,000 NZD from ANZ India. As mentioned we have a high degree of certainty in revenues from electricity sales and plan to apply for the loan on this basis. There is also the option to hedge out the price up to 5 years in the future using electricity futures contracts provided by Multi Commodity Exchange Limited. Despite this there is still a significant risk factor for ANZ India. We propose to mitigate this risk with a 12% interest rate. Details of the loan are outlined below:

Debt Financing – Business Loan, ANZ India	
Principle	$300,000.00 NZD
Interest	12% pa
Term	10 Years
Annual repayment (Principle +Interest)	$51,649.56 NZD

Operating costs – Operating costs are estimated but fundamentally based on research done by Bhada in 2007. We have assumed an inflation rate of 3% pa and have increased expected costs in line with this figure. We have also assumed 15% system down time and adjusted revenues in line with this figure. For prudency reasons we have not adjusted costs for this down time. Applicable costs have been scaled up proportionately to account for the expansion of the plant.

Employment – To start with we plan to have a total of 19 employees, 1 Manager, 2 Supervisors and 17 Workers. After the first expansion of the system we plan to employee 60% more staff after the second expansion 40% and 20% more after the third expansion. The D4 Energy system is highly customizable. We have chosen the most labour intensive system so we can provide more jobs for the local slum population.

Forecast Earnings

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenue										
Electricity Production	$672,466.88	$672,466.88	$1,344,933.75	$1,344,933.75	$1,344,933.75	$2,017,400.63	$2,017,400.63	$2,017,400.63	$2,689,867.50	$2,689,867.50
Tipping Fees	$51,191.25	$51,191.25	$102,382.50	$102,382.50	$102,382.50	$153,573.75	$153,573.75	$153,573.75	$204,765.00	$204,765.00
Recyclable Sales	$15,512.50	$15,512.50	$31,025.00	$31,025.00	$31,025.00	$62,050.00	$62,050.00	$62,050.00	$124,100.00	$124,100.00
Total Revenue	**$739,170.63**	**$739,170.63**	**$1,478,341.25**	**$1,478,341.25**	**$1,478,341.25**	**$2,233,024.38**	**$2,233,024.38**	**$2,233,024.38**	**$3,018,732.50**	**$3,018,732.50**
Expenses										
D4 Energy Payment	$250,000.00	$257,500.00	$331,531.25	$341,477.19	$351,721.50	$434,727.78	$447,769.61	$461,202.70	$554,211.91	$942,698.63
Land Lease	$1,189.71	$1,308.68	$1,439.55	$1,583.50	$1,741.85	$1,916.04	$2,107.64	$2,318.41	$2,550.25	$2,805.27
Education and Training	$25,000.00	$10,000	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Plant Maintenance	$50,000.00	$51,500.00	$66,306.25	$68,295.44	$70,344.30	$90,568.29	$93,285.34	$96,083.90	$123,708.02	$127,419.26
Wages	$93,540.00	$96,346.20	$158,778.54	$163,541.89	$168,448.15	$242,902.23	$250,189.30	$257,694.98	$318,510.99	$328,066.32
Debt repayments	$51,649.56	$51,649.56	$51,649.56	$51,649.56	$51,649.56	$51,649.56	$51,649.56	$51,649.56	$51,649.56	$51,649.56
Admin/ Legal expenses	$15,000.00	$15,450.00	$15,913.50	$16,390.91	$16,882.63	$17,389.11	$17,910.78	$18,448.11	$19,001.55	$19,571.60
Depreciation Expense	$190,000.00	$171,000.00	$153,900.00	$138,510.00	$124,659.00	$112,193.10	$100,973.74	$90,876.41	$81,788.77	$73,609.89
Total Expenses	**$676,379.27**	**$654,754.44**	**$779,518.65**	**$781,448.49**	**$785,447.00**	**$951,346.11**	**$963,885.98**	**$978,274.06**	**$1,151,421.05**	**$1,545,820.53**
Gross Profit	**$62,791.36**	**$84,416.18**	**$698,822.60**	**$696,892.76**	**$692,894.25**	**$1,281,678.27**	**$1,269,138.40**	**$1,254,750.31**	**$1,867,311.45**	**$1,472,911.97**
Profit	**$43,953.95**	**$59,091.33**	**$489,175.82**	**$487,824.93**	**$485,025.97**	**$897,174.79**	**$888,396.88**	**$878,325.22**	**$1,307,118.01**	**$1,031,038.38**

The forecasted earnings show strong increases in revenues in the first 10 years. Developments of the plant also contribute significantly to revenues. As mentioned a portion of revenues will be allocated for community development and education initiatives.

Forecast Balance Sheet

	Year 0	Year 1	Year 2
Current Assets			
Cash	$35,000.00	$44,453.95	$29,091.33
Non Current Assets			
Property, Plant and Equipment	$1,900,000.00	$1,710,000.00	$1,539,000.00
Total Assets	**$1,935,000.00**	**$1,754,453.95**	**$1,568,091.33**
Non Current Liabilities			
Loan - ANZ	$300,000.00	$280,000.00	$260,000.00
Total Liabilities	**$300,000.00**	**$280,000.00**	**$260,000.00**
Net Assets	**$1,635,000.00**	**$1,474,453.95**	**$1,308,091.33**
Equity			
Contributed Equity		$1,430,500.00	$1,337,182.66
+ Retained Earnings	0	$43,953.95	59,091.33
- Dividends	0	0	-30,000.00
Total Equity	**$1,635,000.00**	**$1,474,453.95**	**$1,308,091.33**

Community Development

We plan to set aside approximately 30% of revenues on a yearly basis to fund community development programs. These programs will be focused on educating Mumbai's slum community on good waste management practices such as separation of recyclables onsite. We also hope to help fund the development of a community centre in the Dharavi area near the location of our system. This community development is a key part of the business strategy because it contributes to the core goal of *"Alternative Energy Limited"* which is to improve the lifestyles of Mumbai's slum population, these community development initiatives allow us to extend this goal outside of our normal business operations. At the end of the day this project is not about profit it is about developing communities.

Conclusions

Alternative Energy Limited represents a dynamic business concept; we have aimed to create a profitable venture that connects developed and developing economies for mutual benefit. When approaching this project we looked to identify some substantial issues faced by developing economies and tried to find ways we could employ technology found in developed economies to remedy these issues. Using the technology as the link. We found that many densely populated developing cities face serious waste management problems, these cities lack sufficient infrastructure to deal with the amount of waste being created which has lead not only to dirty streets but also to the spread of illness and disease. We also found that where this waste is being dealt with it is ending up in unproductive and over used landfills. Our thoughts at this stage were there must be a better way; it was then that we discovered waste-to-energy technology and how we could use municipal solid waste (MSW) to create productive electricity. Waste-to-energy technology kills two birds with one stone in a city like Mumbai (which we focused on) because not only does it have a serious waste management issue but also faces serious shortages in electricity. The decision then was logical we need to look at the development of waste-to-energy technology in Mumbai. However we wanted to have a wider focus for this business venture one arm was obviously the commercial element but we wanted a second arm focused on community development. This broad focus led us to the over arching goal of improving the lifestyles of people living in the slums of Mumbai.

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