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Romania ESCo Development Task: Financial and Technical Analysis of Project 1

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EVALUATION OF ESCO ENERGY EFFICIENCY OPPORTUNITIES AT THE CIMUS CEMENT PLANT, ROMANIA

OVERVIEW

The CIMUS cement plant is located in Cîmpulung, Romania, about 200 kilometers north-northwest of Bucharest in the foothills of the Carpathian Mountains Limestone is quarried from a nearby mountain, crushed, and transported by a belt conveyor down to the factory Clay is excavated adjacent to the factory, crushed, and dried Pyrite constitutes the third raw material In this dry cement-making process, the proper proportions of the three raw materials are ground to a fine dust in large ball mills The ground mixture is partially calcined in suspension preheaters before being fed into rotary kilns for the remaining calcining and clinkering processes The kiln output, now called clinker, is mixed with additional limestone and/or slag and ground in ball mills to make the final cement powder product

The Electrotek Team conducted a preliminary energy audit at CIMUS over two days in September 1997 followed by four site visits by subcontractors and ESCo staff to take energy measurements and analyze the results Nine energy conservation opportunities were identified as potential ESCo projects (two co-generation opportunities and seven energy savings opportunities) which were analyzed for this stage of project development The preliminary analysis conducted by the Electrotek Team acts as a scoping study Adequate data was collected to obtain "budget" cost estimates from equipment vendors These were then compared to savings estimates in order to determine whether measures could be considered for more careful study and inclusion in the project It must be emphasized that a measure that is selected in this initial technical and financial analysis must be subjected to much more rigorous scrutiny during the preparation of the project business plan to be presented to financing organizations (the project business plan deliverable is due May 31, 1998)

In order for an ESCo to be successful, the project development team must be able to weed through potential projects quickly so that time and resources are devoted principally to energy efficiency measures which show the most promise of being financially viable The technical and financial analysis of Cimus followed this basic approach As a first step in the weeding process, some measures were dropped at the technical analysis stage (and are not included in this report) because it was clear they could not be integrated into the company's industrial process or did not have the necessary characteristics to be considered For example, several potential applications of variable speed drives were dropped early in the process when initial measurements demonstrated that the industrial process required a constant load

The second stage in the analysis required the calculation of modified paybacks based on initial cost and benefit estimates The return on investment required by an ESCo generally dictates that an energy-saving measure needs a simple payback period of less than five years to be economically viable Simple payback periods of three years or less are usually sought to give plenty of room to cover the costs associated with project development, which include marketing,

energy auditing, feasibility reports, and project management At this stage in the analysis, a five year payback period was used as a threshold, recognizing that paybacks in the 4-5 year range would probably need to be reduced during refinement of the analysis in order for those components to be included in the final project business plan

Finally, the potential efficiency measurements with a payback of less than five years were analyzed using incremental cash flow analysis to calculate the net present values and internal rates of return Simple paybacks can often distort the financial viability of a measure (e g , a three-year payback is not viable if the asset life is only two years) The rate of return analysis therefore gives an objective comparison of the selected measures while the net present value provides a financial measure of potential discounted benefit which can be compared against any expected costs of further measurement and refinement of the analysis

It should be noted that the co-generation units were subjected to significantly more scrutiny at this stage of the analysis Since the co-generation units are expected to be owned by the ESCo (Energy-Serv) and the asset lives are generally likely to be well in excess of the loan repayment schedule, significantly higher payback periods could be considered Cash flows were also prepared assuming a 30% equity ownership by Energy-Serv, forming the basis for the IRR calculations

To adequately evaluate the potential ESCo projects, measurements of the air temperature, volumetric flow rate, and static pressure were needed at several different points along the cement production line Measurements of the dust concentration and particle size distribution of these air streams were also required The input kW of various motors and other electrical equipment were needed Equipment monitoring and further inquiries of the technical staff at CIMUS were conducted from October through December 1997 to collect the necessary data

POTENTIAL ESCO PROJECTS

A summary of the budget cost estimates and energy savings calculations are presented in Table 1 Details of the budget costs and estimated pre- and post-project operating costs are included in Appendix A

Summary Costs and Paybacks for Cimus Efficiency Measures

Measures Considered	Cost w/ Contingencies (USD)	Operating Cost Savings	Payback
A Clinker Cooler Heat Recovery			
Scenario 2 Heat Recovery Only	$1,014,005	$147,750	6 9
B Preheater Heat Recovery/New Core Separator			
Scenario 1 New Core Separator	$1,561,545	$147,750	10 6
C Replace Compressor/Motor Sets	$124,024	$8,986	13 8
D New Dynamic Separator	$688,568	$56,390	12 2
E High-Efficiency Motors			
800-kW Motors (2 preheater induced draft fans)	$126,990	$50,518	2 5
400-kW Motors (2 electrostatic filter exh fans)	$91,210	$24,114	3 8
F Kiln Seals	$447,400	$156,865	2 9
G Kiln Burners	$58,925	$22,912	2 6
H Motor Generator Units (2 x 920 kW)	$1,479,870	$485,044	3 1
TOTAL (All but B)	$4,030,992	$952,579	4 2
TOTAL (E-H)	$2,204,395	$739,453	3 0

Clinker Cooler Heat Recovery

About half of the heat rejected from the hot clinker is currently recovered and used to preheat the kiln combustion air However, approximately 150,000 m^3/hour of air is exhausted from the clinker cooler at 270°C and fed to a multi-cyclone dust removal system before being exhausted up the stack at 170°C The heat contained in this relatively hot exhaust air could be used to preheat combustion air in the slag dryers

With the existing multi-cyclone dust removal system, the exhaust air still contains so much clinker dust that the exhaust fan blades continually erode, necessitating frequent repair The inlet

dampers of this exhaust fan are varied to maintain a certain negative pressure in the kiln combustion chamber needed to draw the proper amount of combustion air

A retrofit was originally proposed to install a new, more effective dust removal system, called a core separator, to reduce erosion of the fan blades and allow an adjustable-speed drive (ASD) to save fan motor energy However, upon further investigation, it appears that the inlet dampers of the clinker cooler exhaust fan are varied only slightly to maintain control parameters Therefore, ASDs are not deemed to be a cost-effective retrofit It will be more cost-effective to simply recover heat immediately after the existing multi-cyclone with a heat pipe heat exchanger, eliminating the cost of a core separator and ASD

Balancing the chemical equation for the combustion of natural gas indicates that every cubic meter (m^3) of natural gas consumed by the slag dryers requires a minimum of 9 52 m^3 of air for complete combustion However, combustion devices such as dryers and kilns use combustion air in excess of the minimum needed for complete combustion The staff at CIMUS says that the slag dryers use 5 77 times the minimum amount needed for complete combustion Thus, 46,700 Nm^3/hour of combustion air is required for the 850 Nm^3/hour of gas consumed in the slag dryers Nm^3/hour stands for normal m^3/hour, or m^3/hour at standard conditions (0°C=273K and 1 atmosphere) Assuming that heat recovered from the 270°C clinker cooler air can preheat the slag dryer combustion air to 240°C (513K) at roughly atmospheric pressure, the actual flow of preheated air at 240°C will be 87,755 m^3/hour

The heat needed to raise ambient air to 240°C is estimated to be 13 49 x 10^6 kJ/hour Since the slag dryers operate about 3000 hours per year, the annual amount of heat needed to preheat the combustion air is 4 05 x 10^{10} kJ/year The heat content of natural gas is estimated to be 37,263 kJ/m^3 and the efficiency of the slag dryers is assumed to be 90% Thus, the annual natural gas use that can be saved by preheating slag dryer combustion air with recovered heat is 1 09 x 10^6 m^3/year This equates to an estimated annual operating cost savings of $134,700 after accounting for the fan energy to transport recovered heat to the slag dryers

The installed cost of the heat pipe heat exchanger, ductwork, fan, and motor is estimated to be $1,014,005 excluding Romania's value-added tax (VAT) of 22% for imported equipment The simple payback period of 6 9 years exceeds the 5-year maximum required for an ESCo to cover the debt service

Replace Existing Electrostatic Filter and Precipitator with New Core Separator

Air with a significant concentration of dust is pulled from the preheater at 325°C and about 205,000 m^3/hour by a large induced-draft fan The air duct then splits into two branches One branch sends air and dust back to the raw mill and the other branch goes to a precipitator to cool the air/dust mixture with water mist to 150°C before entering the electrostatic filter (air above 200°C would damage the electrostatic filter) The electrostatic filter removes the dust from the air using electrically charged plates and discharges the clean air up an exhaust stack

It was originally hoped that a core separator, capable of handling air/dust mixtures above 200°C, could replace both the electrostatic filter and the precipitator, thereby eliminating their energy consumption A heat pipe heat exchanger (HPHE) could then recover heat from the relatively clean, hot air and be used to preheat slag dryer combustion air

While the core separator will discharge cleaner air than the existing electrostatic filter and precipitator, the additional recirculation fan required will increase energy consumption over that of the existing equipment Even accounting for the decrease in water consumption and the value of the additional raw meal recovered, the annual operating costs associated with the core separator portion of the measure increase by $101,700

Offsetting this increase is the reduction of natural gas use by the slag dryers and some maintenance savings Estimating the slag dryer gas savings follows the same methodology described under the clinker cooler heat recovery measure The net result is an annual reduction in operating costs of $61,900 The 10 6-year simple payback period shows that this measure is not cost-effective

Replace Air Compressors

The cement plant uses compressed air to pneumatically transport raw material and finished cement product, and to mix raw materials in the silos Most of the existing air compressors have been overhauled several times and the motors operate at only 60% of their rated load By replacing two existing air compressor/motor sets with one new efficient air compressor, it was hoped that cost-effective energy savings could be gained

The reduction in motor electricity use and compressor oil consumption are estimated to result in annual operating cost savings of $13,500 However, the installed cost estimate of $124,000 gives a simple payback period in excess of 10 years -- double that required for a measure to be cost effective

Replace Existing Raw Mill Static Separator with New Dynamic Separator/Classifier

Classifiers are installed in the raw material and finish grinding systems to separate the fine particles suitable for clinker production (raw material grinding) or production-quality cement (finish grinding) The conventional turbo (static) classifiers currently used at CIMUS in the raw material grinding system typically recycle as much as 60% of the clinker-production-quality fines back to the raw mill, resulting in overgrinding and increased energy use Replacing the existing raw material classifier at CIMUS with a new high-efficiency air classifier offers the potential to increase mill capacity by 15% to 50% and reduce the unit energy use for raw material grinding by 10% to 25%

Assuming an optimistic 50% increase in mill capacity, the annual cost to grind the raw materials needed to produce the current rate of 800 tons/day of clinker decreases by $80,500 However, these savings are offset by a $26,100/year increase in electricity to power the additional motor

required by the new dynamic separator The net reduction in annual operating cost is estimated to be $56,000 With an installed cost estimate of nearly $700,000, the simple payback period is about 12 years The capital cost of this measure is not justified by the net annual savings

High-Efficiency Motors

CIMUS uses motors ranging from 100 to 1,600 kW that operate 15 to 24 hours per day These motors are over 10 years old and many have been repeatedly overhauled to uncertain quality standards Replacing selected, large, high-use motors with new high-efficiency motors often result in relatively quick simple payback periods In particular, spot measurements of motor input kW indicate that at least two 1000-kW induced draft preheater fan motors and two 500-kW raw mill deduster exhaust fans are significantly oversized and may offer potential for replacement with new, high-efficiency motors

Being oversized, the existing motors operate at less than full-load performance The new motors will be rated at 800 kW and 400 kW to more closely match the actual load of 782 kW and 383 kW, respectively The new motors will have better full-load performance than the existing motors and will also avoid the existing part-load energy penalties

It is impossible to determine the actual efficiency of the existing motors without shutting down one of the cement plant production lines While motor input kW can be easily measured in the field, calculating efficiency requires knowing how much power is delivered by the output shaft and comparing it to the input power Determining shaft output requires removing the motors and testing them in a laboratory on a dynamometer -- facilities that are difficult to locate in Eastern Europe, even if the disruption to cement plant operations could be tolerated

As a result, energy savings from installing new motors must be estimated by assuming a percentage increase in efficiency A somewhat conservative 5% efficiency increase might normally be assumed However, several factors favor assuming a 10% efficiency increase as an upper bound These factors include the age, the low relative efficiency, and the part-load energy penalties of the existing, presumably Russian-built, motors The annual energy savings are estimated at $50,000 and $24,000 for the 800-kW and 400-kW motors respectively assuming a 10% increase in efficiency

The installed cost of replacing the two existing 1000-kW induced-draft preheater fan motors and two 500-kW raw mill deduster exhaust fans with new 6000-volt high-efficiency motors is approximately $127,000 and $91,000 respectively This results in a simple payback period of 2 5 years and 3 8 years Upon further financial analysis, the first two motors appear to be well viable as an ESCo project, but the 400-kW motors would need to be sourced at a lower cost or energy prices would have to come up for them to be viable after sensitivity scenarios are run Nonetheless, it is close enough to viable to be worth further study

To improve the attractiveness of this measure, the Electrotek Team is attempting reduce the costs of the 400-kW motors by locating vendors with 380-volt models in this size range This could conceivably reduce the installed cost of the measure by almost $40,000

While the payback periods for the selected motors is under the maximum threshold for paybacks to be considered in a more detailed analysis, an intermediary step is necessary to reduce the chance of spending too much money on analysis of a measure which has a significant probability of being marginal The Electrotek project team will next develop a plan for carrying out additional, more costly measurements at Cimus and solicit bids to estimate the cost of this work For instance, the output requirements of the preheater fan motors could be estimated by taking measurements of the air flow from the exhaust, but these measurements may cost so much that they would increase the total project costs beyond what can be recovered by any increased efficiency gains through more accurate sizing of motors Using probability techniques, the team can make this determination based on bids by specialist measurement firms compared to the probabilistically weighted risk mitigation which is gained through increased certainty

Kiln Seals

Infiltration through inadequate kiln seals allows preheated air from the clinker cooler, which is used as secondary combustion air, to be displaced by cold ambient air More fuel is then required to achieve the necessary kiln gas temperature The seal on the feed end of the kiln can present an even larger source of leakage due to its closer proximity to the suction side of the induced draft fan Because the equipment is rotating, the design and maintenance of seals are difficult technical problems However, advances in the past five to ten years may offer the potential to achieve and retain cost-effective fuel savings

The technical staff at CIMUS indicates that false air entering the kiln is 1 059 Nm^3 per kg of clinker produced (Nm^3 denotes air at the standard conditions of 0°C and 1 atmosphere) This false air enters primarily through the existing kiln seals and must be heated from ambient temperature to the kiln combustion temperature of about 1900°C It is difficult to estimate the fuel savings that might result from installing new kiln seals since the operation of every kiln is somewhat unique However, it appears conservative to assume that new seals could reduce infiltration of false air by at least 3%

By correcting the density of false air based on the average monthly ambient temperature and applying it to the 1 059 Nm^3/kg and the estimated monthly production of clinker, the mass flow rate of false air entering each kiln each month can be estimated The fuel required to heat this false air to the kiln temperature can be derived using the specific heat of air, temperature difference between the kiln combustion temperature and the ambient air, kiln combustion efficiency, and the heat content of the fuel (e g , natural gas or fuel oil) The annual savings in kiln fuel costs savings are estimated to be about $157,00

The cost of installing two new kiln seals on each of the four operating kilns is $447,400, which results in a payback period of just under 3 years

New Kiln Burners

Based on discussions with the technical staff at CIMUS, it was originally thought that new burners in all four operating kilns could result in cost-effective energy savings After talking with several burner manufacturers, it appears the only real opportunity for energy savings by new burners is on kiln #5, which has a gas-only, single-nozzle burner built in 1972 A new burner can provide more stable and hotter flames, more complete combustion, and better flame-shaping control Again, the energy savings associated with these benefits are hard to quantify

The kiln combustion system consists of the burner, the primary air system, the fuel supply system, and the secondary air Because 75 to 90% of the combustion air is secondary air supplied directly from the clinker cooler, the kiln aerodynamics play a critical role in the fuel-to-air mixing and the overall performance of the burner By matching a new burner to the aerodynamics of the kiln/cooler system through precise regulation of the quantities and velocities of fuel and air, fuel savings of 2 to 10% can be achieved

However, most burners operate satisfactorily in most kilns without adjusting the aerodynamics Assuming fuel savings of 1% from the installation of a new burner alone appears reasonable A 1% reduction in the natural gas consumption of kiln #5 is estimated to save $23,000 annually The cost to replace the existing burner on kiln #5 is approximately $60,000 for a simple payback period of about 2 6 years

If necessary, kiln aerodynamics will be adjusted for optimal burner performance A detailed inspection of the kiln and clinker cooler are required to estimate the equipment and labor required to closely regulate fuel and air flows, but the increased savings should more than offset these additional costs, if needed

Motor Generator Units (2 x 920 kW)

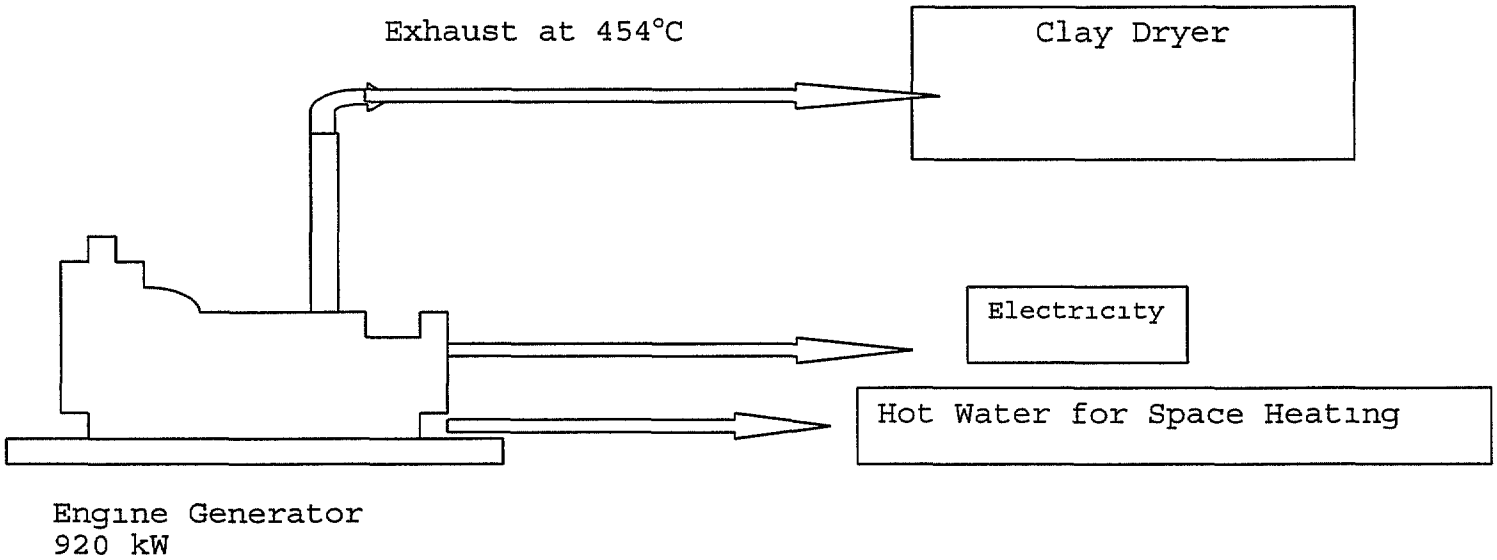
One of the primary raw materials in cement manufacturing is clay Cimus mines clay at a location about 100 meters from the plant, crushes it and then transports it by conveyors to the plant Before blending the clay with other raw materials and calcining the mixture in a rotary kiln, the clay must be crushed and dried Cimus uses the "dry process" of cement manufacturing, which basically means that all materials entering the rotary kiln have been pre-dried The dry-process is a more efficient cement manufacturing process then the "wet process" As the name implies, the wet process does not pre-dry materials before entering the kiln, and as a result, kiln energy consumption is significantly higher than in the dry process

Cimus uses two gas-fired dryers to dry the clay The temperature required for drying is about 200°C However, when natural gas is burned, it has a temperature in the range of 1000° C to 1500° C - much hotter than what is required for the clay drying operation To obtain the proper

drying temperature, Cimus mixes a lot of air in with the combustion gases to lower the temperature to the proper range, wasting energy in the process

Energy-Serv and the project team examined the feasibility of installing 2 x 920 kW natural gas fired reciprocating engine co-generation units The units, as shown in Figure 1, would burn natural gas to generate electricity, and use exhaust gases from the engine to dry the clay The exhaust gases are at a temperature of about 450°C, and can be exhausted directly into the dryer without any filtering/cleaning Additional energy will be recovered from the engine cooling water and used to heat buildings during the winter months

The primary benefit of the co-generation units is the electricity generation Electricity accounts for 87% of energy costs at Cimus The 2 generators will produce about 15,000 MWh per year, reducing power purchases from RENEL by 14%, or about $790,000/yr Natural gas consumption for the co-generation units will increase plant gas consumption by about 30%, or about $260,000/yr Therefore, the net savings from the installation of the two cogeneration units is about $485,000/yr At an investment cost estimated at $1 48 million, the project has a simple payback of about 3 years



CONCLUSIONS

Analysis of potential energy savings and development of budget cost estimates indicate that four of the eight measures have simple payback periods in excess of five years and, therefore, would not be economically viable as ESCo projects The four energy conservation measures that warrant further investigation are high-efficiency motors, kiln seals, a new kiln burner and the two co-generation units These latter components were subjected to more careful financial analysis using discounted cash flows to determine the ESCo's share in the project savings It should be borne in mind that a project can be viable as an energy efficiency savings measure for the company while not providing enough excess returns for the ESCo to realize sufficient benefits

The detailed financial analysis is contained in Appendix A together with the simple payback calculations and detailed cost tables The cash flow analysis determines first what the rate of return after taxes but before financing would be and secondly shows the allocation of these savings to both parties The cash flow analysis for the co-generation unit has been prepared somewhat differently since this component of the project is likely to be developed under a chauffage contract (in which Energy-Serv would own the actual units and provide power to the customer) A summary of the pre-financing internal rates of return (IRRs) are included below

Summary of IRRs for the Selected Cimus Measures

Measures to be Installed	Cost w/ Contingencies (USD)	IRRs
High-Efficiency Motors		
800-kW Motors (2 preheater induced draft fans)	$126,990	34%
400-kW Motors (2 electrostatic filter exh fans)	$91,210	20%
Kiln Seals	$447,400	29%
Kiln Burners	$58,925	33%
Motor Generator Units (2 x 920 kW)	$1,479,870	30%
Total	**$2,204,395**	**30%**

Based on the analysis in Appendix A, it is clear that all four components are likely to be attractive to the ESCo, although the 400-kW motors remain somewhat marginal All four measures merit further investigation to determine whether costs can be further reduced or savings increased The ESCo may also be able to supply electricity from the co-generation units to Cimus at a higher price than is currently being forecast while still providing the company with significant benefits Further measurements will also be important to determine whether the kiln seals and burners are likely to realize the projected savings The clinker cooler may also be re-examined if there is a significant change in energy prices or equipment and installation costs can be lowered The further analysis of these measures will be carried out over the next 30-60 days in preparing the project business plan Site visits by certain vendors may also be required to validate energy savings estimates

APPENDIX A

BUDGET COST DETAILS AND PRE- AND POST-PROJECT OPERATING COSTS

PROJECT CASH FLOW ANALYSIS

Equipment and Installation Costs

	Base Estimate (USD)	Percent Physical Conting	Est w/ Physical Conting
A Clinker Cooler Heat Recovery			
Scenario 1 New dust removal system and heat recovery			
Core Separator	$180,000	20%	$216,000
Shipping	$15,000	20%	$18,000
Installation	$90,000	20%	$108,000
Heat Pipe Heat Exchanger	$750,000	20%	$900,000
Shipping	$18,000	20%	$21,600
Ductwork	$20 203	20%	$24,244
Installation	$40,161	20%	$48,193
Fan & Motor	$15,600	20%	$18,720
Installation	$1,040	20%	$1,248
Adjustable-speed Motor Drives	N/A		N/A
Value-Added Tax (Note VAT became reimbursable, Jan 98)			
SUBTOTAL INVESTMENT COSTS	$1,130,004		$1,356,005
Scenario 2 Heat Recovery Only			
Heat Pipe Heat Exchanger	$420,000	20%	$504,000
Shipping	$40,000	20%	$48,000
Ductwork	$20 203	20%	$24,244
Installation	$250,161	20%	$300,193
Fan & Motor	$15,600	20%	$18,720
Installation	$1,040	20%	$1,248
Value-Added Tax (on equipment only)			
SUBTOTAL INVESTMENT COSTS	$747,004		$896,405
B Preheater Heat Recovery/New Core Separator			
Scenario 1 New dust removal system and heat recovery			
Core Separator	$248,400	20%	$298,080
Shipping	$15,000	20%	$18,000
Installation	$124,200	20%	$149,040
Heat Pipe Heat Exchanger	$750,000	20%	$900,000
Shipping	$18,000	20%	$21,600
Ductwork	$40,406	20%	$48,488
Installation	$80,321	20%	$96,386
Fan & Motor	$23,400	20%	$28,080
Installation	$1 560	20%	$1 872
Adjustable-speed Motor Drives	N/A		N/A
Value-Added Tax (on equipment only)			
SUBTOTAL INVESTMENT COSTS	$1 301,288		$1 561 545
Scenario 2 Heat Recovery Only			
Heat Pipe Heat Exchanger	$750,000	20%	$900,000
Shipping	$18,000	20%	$21,600
Ductwork	$40,406	20%	$48,488
Installation	$80 321	20%	$96,386
Fan & Motor	$23,400	20%	$28,080
Installation	$1,560	20%	$1,872
Value-Added Tax (on equipment only)			
SUBTOTAL INVESTMENT COSTS	$913,688		$1,096,425

C Replace Compressor/Motor Sets			
Centrifugal compressor/motor set (380-volt)	$83,800	2%	$85,476
Shipping (from Vignate-Milan, Italy)	$8,380	15%	$9,637
Installation	$25,140	15%	$28,911
Value-Added Tax (on equipment only)			
SUBTOTAL INVESTMENT COSTS	$117,320		$124,024
D New Dynamic Separator			
New Dynamic Separator	$273,500	20%	$328,200
Shipping (from Concordia, Kansas, USA)	$22,000	20%	$26,400
Installation	$273,500	20%	$328,200
Motor	$4,370	20%	$5,244
Installation	$437	20%	$524
Value-Added Tax (on equipment only)			
SUBTOTAL INVESTMENT COSTS	$573,807		$688 568
E High-Efficiency Motors			
800-kW Motors (2 preheater induced draft fans)	$106,000	8%	$114,480
Shipping (Helsinki, Finland)	$1,200	15%	$1,380
Installation	$10,600	5%	$11,130
400-kW Motors (2 electrostatic filter exh fans)	$76,000	8%	$82,080
Shipping (Helsinki, Finland)	$1,000	15%	$1,150
Installation	$7,600	5%	$7,980
Value-Added Tax (on equipment only)			
SUBTOTAL INVESTMENT COSTS	$202,400		$218,200
F Kiln Seals			
New Kiln Seals (8)	$160,000	5%	$168,000
Shipping	$12,000	20%	$14,400
Installation	$212,000	25%	$265,000
Value-Added Tax (on equipment only)			
SUBTOTAL INVESTMENT COSTS	$384,000		$447,400
G Kiln Burners			
New Dual-Fuel Kiln Burner (for existing gas-only kiln)	$40,000	20%	$48,000
Shipping	$2,500	20%	$3,000
Installation	$6,340	25%	$7,925
Value-Added Tax (on equipment only)			
SUBTOTAL INVESTMENT COSTS	$48,840		$58,925
H Co-Generation Units			
Catepillar Engine Generators (2 x 920 kW)	$1 101 000	17%	$1,288,170
Water Softener	$12 000	10%	$13 200
Shipping	$11 000	5%	$11 550
Engineering & Environmental Study	$55 650		$55 650
Installation	$111,300		$111 300
Value-Added Tax (on equipment only)			
SUBTOTAL INVESTMENT COSTS	$1 290 950		$1 479 870
TOTAL (A2 and C - H)	$3,364,321		$3,913,392
TOTAL (of likely viable components E-H)	$1,926,190		$2,204,395

CIMUS CEMENT PLANT
Cash Flow

Assumptions	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Electricity Tariffs (US$/kWh)	0 051	0 051	0 051	0 051	0 051	0 051	0 051	0 051	0 051	0 051
Gas Tariffs (US$/'000 cubic meters)	99	99	99	99	99	99	99	99	99	99
Heavy Fuel Oil Spot Price (US$/liter)	0 105	0 105	0 105	0 105	0 105	0 105	0 105	0 105	0 105	0 105

Cash Flows	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
E 1 High Efficiency Motors for 2 Preheater ID Fans		1	2	3	4	5	6	7	8	9	10
Pre project Cash Flow											
Power Requirement for Load (KW)		1564	1564	1564	1564	1564	1564	1564	1564	1564	1564
Annual Operating Hours		6785	6785	6785	6785	6785	6785	6785	6785	6785	6785
Total Electricity Consumed (kWh)		10 611 740	10 611 740	10 611 740	10 611 740	10 611 740	10 611 740	10 611 740	10 611 740	10 611 740	10 611 740
Total Cost of Electricity (US$)		$541 199	$541 199	$541 199	$541 199	$541 199	$541 199	$541 199	$541 199	$541 199	$541 199
Maintenance & Monitoring Costs (US$)		$300	$309	$318	$328	$338	$348	$358	$369	$380	$391
Total Cost of Operating Existing Motors		$541 499	$541 508	$541 517	$541 527	$541 536	$541 547	$541 557	$541 568	$541 579	$541 590
Post project Cash Flow											
Capital Cost	$126 990										
Power Requirement with New Motors (KW)		1408	1408	1408	1408	1408	1408	1408	1408	1408	1408
Annual Operating Hours		6785	6785	6785	6785	6785	6785	6785	6785	6785	6785
Total Electricity Consumed (kWh)		9 550 566	9 550 566	9 550 566	9 550 566	9 550 566	9 550 566	9 550 566	9 550 566	9 550 566	9 550 566
Total Cost of Electricity (US$)		$487 079	$487 079	$487 079	$487 079	$487 079	$487 079	$487 079	$487 079	$487 079	$487 079
Maintenance & Monitoring Costs (US$)		$2 000	$2 060	$2 122	$2 185	$2 251	$2 319	$2 388	$2 460	$2 534	$2 610
Total Cost of Operating with New Motors		$489 079	$489 139	$489 201	$489 264	$489 330	$489 397	$489 467	$489 539	$489 612	$489 688
Incremental Cash Flow											
Capital Cost	($126 990)										
Energy Savings (kWh)		1 061 174	1 061 174	1 061 174	1 061 174	1 061 174	1 061 174	1 061 174	1 061 174	1 061 174	1 061 174
Value of Energy Savings (US$)		$54 120	$54 120	$54 120	$54 120	$54 120	$54 120	$54 120	$54 120	$54 120	$54 120
Incremental Maintenance Cost (US$)		($1 700)	($1 751)	($1 804)	($1 858)	($1 913)	($1 971)	($2 030)	($2 091)	($2 154)	($2 218)
Gross Incremental Profit/(Cost) (US$)	($126 990)	$52 420	$52 369	$52 316	$52 262	$52 207	$52 149	$52 090	$52 029	$51 966	$51 902
Depreciation Expense (for tax calculations SYD)		($31 748)	($27 212)	($22 677)	($18 141)	($13 606)	($9 071)	($4 535)	$0	$0	$0
Interest Expense		($15 239)	($13 728)	($12 037)	($10 142)	($8 020)	($5 643)	($2 981)	$0	$0	$0
Income Before Tax		$5 434	$11 428	$17 603	$23 979	$30 581	$37 435	$44 573	$52 029	$51 966	$51 902
Income Tax Expense		($1 902)	($4 000)	($6 161)	($8 393)	($10 703)	($13 102)	($15 601)	($18 210)	($18 188)	($18 166)
Add Back Depreciation and Interest		$46 986	$40 941	$34 713	$28 283	$21 626	$14 714	$7 517	$0	$0	$0
Net Incremental Cash Flow Before Financing	($126 990)	$50 518	$48 369	$46 155	$43 870	$41 503	$39 047	$36 489	$33 819	$33 778	$33 736
IRR Before Financing	34%										

Cash Flows	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Motors Shared Savings Cash Flow After Financing											
Gross Incremental Savings (US$)		$52 420	$52 369	$52 316	$52 262	$52 207	$52 149	$52 090	$52 029	$51 966	$51 902
Interest Expense		($15 239)	($13 728)	($12 037)	($10 142)	($8 020)	($5 643)	($2 981)	$0	$0	$0
Principal Payments		($12 587)	($14 097)	($15 789)	($17 684)	($19 806)	($22 183)	($24 844)	$0	$0	$0
Tax Effect		($1 902)	($4 000)	($6 161)	($8 393)	($10 703)	($13 102)	($15 601)	($18 210)	($18 188)	($18 166)
Total Cash Flow Net of Financing		$22 692	$20 543	$18 330	$16 044	$13 678	$11 221	$8 664	$33 819	$33 778	$33 736
of which Customer s Share		$11 346	$10 272	$9 165	$8 022	$6 839	$5,611	$4 332	$33 819	$33 778	$33,736
ESCo s Share		$11 346	$10 272	$9 165	$8 022	$6 839	$5 611	$4 332	$0	$0	$0
NPV of ESCo s Share of Savings @35% discount	**$23,163**										

Cash Flows	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
E 2 High Efficiency Motors for 2 Electrostatic Filter Fans		1	2	3	4	5	6	7	8	9	10
Pre project Cash Flow											
Power Requirement for Load (KW)		746	746	746	746	746	746	746	746	746	746
Annual Operating Hours		6785	6785	6785	6785	6785	6785	6785	6785	6785	6785
Total Electricity Consumed (kWh)		5 061 610	5 061 610	5 061 610	5 061 610	5 061 610	5 061 610	5 061 610	5 061 610	5 061 610	5 061 610
Total Cost of Electricity (US$)		$258 142	$258 142	$258 142	$258 142	$258 142	$258 142	$258 142	$258 142	$258 142	$258 142
Maintenance & Monitoring Costs (US$)		$300	$309	$318	$328	$338	$348	$358	$369	$380	$391
Total Cost of Operating Existing Motors		$258 442	$258 451	$258 460	$258 470	$258 480	$258 490	$258 500	$258 511	$258 522	$258 534
Post project Cash Flow											
Capital Cost	$91 210										
Power Requirement with New Motors (KW)		671	671	671	671	671	671	671	671	671	671
Annual Operating Hours		6785	6785	6785	6785	6785	6785	6785	6785	6785	6785
Total Electricity Consumed (kWh)		4 555 449	4 555 449	4 555 449	4 555 449	4 555 449	4 555 449	4 555 449	4 555 449	4 555 449	4 555 449
Total Cost of Electricity (US$)		$232 328	$232 328	$232 328	$232 328	$232 328	$232 328	$232 328	$232 328	$232 328	$232 328
Maintenance & Monitoring Costs (US$)		$2 000	$2 060	$2 122	$2 185	$2 251	$2 319	$2 388	$2 460	$2 534	$2 610
Total Cost of Operating with New Motors		$234 328	$234 388	$234 450	$234 513	$234 579	$234 646	$234 716	$234 788	$234 861	$234 937
Incremental Cash Flow											
Capital Cost	($91 210)										
Energy Savings (kWh)		506 161	506 161	506 161	506 161	506 161	506 161	506 161	506 161	506 161	506 161
Value of Energy Savings (US$)		$25 814	$25 814	$25 814	$25 814	$25 814	$25 814	$25 814	$25 814	$25 814	$25 814
Incremental Maintenance Cost (US$)		($1 700)	($1 751)	($1 804)	($1 858)	($1 913)	($1 971)	($2 030)	($2 091)	($2 154)	($2 218)
Gross Incremental Profit/(Cost) (US$)	($91 210)	$24 114	$24 063	$24 011	$23 957	$23 901	$23 843	$23 784	$23 723	$23 661	$23 596
Depreciation Expense (for tax calculations SYD)		($22 803)	($19 545)	($16 288)	($13 030)	($9 773)	($6 515)	($3 258)	$0	$0	$0
Interest Expense		($10 945)	($9 860)	($8 645)	($7 284)	($5 760)	($4 053)	($2 141)	$0	$0	$0
Income Before Tax		($9 633)	($5 342)	($922)	$3 642	$8 368	$13 275	$18 385	$23 723	$23 661	$23 596
Income Tax Expense		$0	$0	$0	($1 275)	($2 929)	($4 646)	($6 435)	($8 303)	($8 281)	($8 259)
Add Back Depreciation and Interest		$33 748	$29 405	$24 933	$20 314	$15 533	$10 568	$5 399	$0	$0	$0
Net Incremental Cash Flow Before Financing	($91 210)	$24 114	$24 063	$24 011	$22 682	$20 972	$19 197	$17 349	$15 420	$15 379	$15 337
IRR Before Financing	**20%**										
Shared Savings Cash Flow After Financing											
Gross Incremental Savings (US$)		$ 24 114	$ 24 063	$ 24 011	$ 23 957	$ 23 901	$ 23 843	$ 23 784	$ 23 723	$ 23 661	$ 23 596
Interest Expense		$ (10 945)	$ (9 860)	$ (8 645)	$ (7 284)	$ (5 760)	$ (4 053)	$ (2 141)	$	$	
Principal Payments		$ (9 041)	$ (10 125)	$ (11 340)	$ (12 701)	$ (14 225)	$ (15 933)	$ (17 844)	$	$	
Tax Effect		$	$	$	$ (1 275)	$ (2 929)	$ (4 646)	$ (6 435)	$ (8 303)	$ (8 281)	$ (8 259)
Total Cash Flow Net of Financing		$ 4 128	$ 4 077	$ 4 025	$ 2 696	$ 986	$ (789)	$ (2 636)	$ 15 420	$ 15 379	$ 15 337
of which Customer's Share		$ 2 064	$ 2 039	$ 2 012	$ 1 348	$ 493	$	$ -	$ 15 420	$ 15 379	$ 15 337
ESCo s Share		$ 2 064	$ 2 039	$ 2 012	$ 1 348	$ 493	$ (789)	$ (2 636)	$ -	$	$ -
NPV of ESCo s Share of Savings @35% discount	**$3,529**										

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Cash Flows	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
F Kiln Seals		1	2	3	4	5	6	7	8	9	10
Pre project Cash Flow											
Natural Gas Requirement for kilns 1&5(000 m^3/hr)		7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0
Annual Operating Hours		6785	6785	6785	6785	6785	6785	6785	6785	6785	6785
Total Natural Gas Consumed (000 m^3/yr)		47 495	47 495	47 495	47 495	47 495	47 495	47 495	47 495	47 495	47 495
Total Cost of Natural Gas (US$)		$4 702 005	$4 702 005	$4 702 005	$4 702 005	$4 702 005	$4 702 005	$4 702 005	$4 702 005	$4 702 005	$4 702 005
Oil Requirement for kilns 2&3 (liters/hr)		7 200	7 200	7 200	7 200	7 200	7 200	7 200	7 200	7 200	7 200
Annual Operating Hours		6 785	6 785	6 785	6 785	6 785	6 785	6 785	6 785	6 785	6 785
Total Oil Consumed (liters/year)		48 852 000	48 852 000	48 852 000	48 852 000	48 852 000	48 852 000	48 852 000	48 852 000	48 852 000	48 852 000
Total Cost of Oil (US$)		$5 111 873	$5 111 873	$5 111 873	$5 111 873	$5 111 873	$5 111 873	$5 111 873	$5 111 873	$5 111 873	$5 111 873
Maintenance & Monitoring Costs (US$)		$40 692	$41 913	$43 170	$44 465	$45 799	$47 173	$48 588	$50 046	$51 547	$53 094
Total Cost of Operating Existing Kilns		$9 854 570	$9 855 791	$9 857 048	$9 858 344	$9 859 677	$9 861 051	$9 862 467	$9 863 924	$9 865 426	$9 866 972
Post project Cash Flow											
Capital Cost	$447 400 00										
Natural Gas Requirement kilns 1&5 (000 m^3/hr)		6 9	6 9	6 9	6 9	6 9	6 9	6 9	6 9	6 9	6 9
Annual Operating Hours		6785	6785	6785	6785	6785	6785	6785	6785	6785	6785
Total Natural Gas Consumed (000 m^3/yr)		46 830	46 830	46 830	46 830	46 830	46 830	46 830	46 830	46 830	46 830
Total Cost of Natural Gas (US$)		$4 636 177	$4 636 177	$4 636 177	$4 636 177	$4 636 177	$4 636 177	$4 636 177	$4 636 177	$4 636 177	$4 636 177
Oil Requirement for kilns 2&3 (liters/hr)		7 072	7 072	7 072	7 072	7 072	7 072	7 072	7 072	7 072	7 072
Annual Operating Hours		6 785	6 785	6 785	6 785	6 785	6 785	6 785	6 785	6 785	6 785
Total Oil Consumed (liters/year)		47 982 000	47 982 000	47 982 000	47 982 000	47 982 000	47 982 000	47 982 000	47 982 000	47 982 000	47 982 000
Total Cost of Oil (US$)		$5 020 836	$5 020 836	$5 020 836	$5 020 836	$5 020 836	$5 020 836	$5 020 836	$5 020 836	$5 020 836	$5 020 836
Maintenance & Monitoring Costs (US$)		$40 692	$41 913	$43 170	$44 465	$45 799	$47 173	$48 588	$50 046	$51 547	$53 094
Total Cost of Operating with New Seals		$9 697 705	$9 698 926	$9 700 184	$9 701 479	$9 702 813	$9 704 187	$9 705 602	$9 707 059	$9 708 561	$9 710 107
Incremental Cash Flow											
Capital Cost	($447 400)										
Natural Gas Savings (000 m^3/yr)		665	665	665	665	665	665	665	665	665	665
Value of Natural Gas Savings (US$)		$65 828	$65 828	$65 828	$65 828	$65 828	$65 828	$65 828	$65 828	$65 828	$65 828
Oil Savings (liters/yr)		870 000	870 000	870 000	870 000	870 000	870 000	870 000	870 000	870 000	870 000
Value of Oil Savings (US$)		$91 037	$91 037	$91 037	$91 037	$91 037	$91 037	$91 037	$91 037	$91 037	$91 037
Incremental Maintenance Savings (US$)		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Gross Incremental Profit/(Cost) (US$)	$ (447 400)	$156 865	$156 865	$156 865	$156 865	$156 865	$156 865	$156 865	$156 865	$156 865	$156 865
Depreciation Expense (for tax calculations SYD)		($111 850)	($95 871)	($79 893)	($63 914)	($47 936)	($31 957)	($15 979)	$0	$0	$0
Interest Expense		($53 688)	($48 367)	($42 407)	($35 731)	($28 255)	($19 882)	($10 504)	$0	$0	$0
Income Before Tax		($8 673)	$12 627	$34 565	$57 219	$80 674	$105 026	$130 383	$156 865	$156 865	$156 865
Income Tax Expense		$0	($4 419)	($12 098)	($20 027)	($28 236)	($36 759)	($45 634)	($54 903)	($54 903)	($54 903)
Add Back Depreciation and Interest		$165 538	$144 238	$122 299	$99 646	$76 191	$51 839	$26 482	$0	$0	$0
Net Incremental Cash Flow Before Financing	$ (447 400)	$156 865	$152 445	$144 767	$136 838	$128 629	$120 106	$111 231	$101 962	$101 962	$101 962
IRR Before Financing	29%										

Cash Flows	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Kiln Seals Shared Savings Cash Flow After Financing											
Gross Incremental Savings (US$)		$156 865	$156 865	$156 865	$156 865	$156 865	$156 865	$156 865	$156 865	$156 865	$156 865
Interest Expense		($53 688)	($48 367)	($42 407)	($35 731)	($28 255)	($19 882)	($10 504)	$0	$0	$0
Principal Payments		($44 345)	($49 667)	($55 627)	($62 302)	($69 778)	($78 152)	($87 530)	$0	$0	$0
Tax Effect		$0	($4 419)	($12 098)	($20 027)	($28 236)	($36 759)	($45 634)	($54 903)	($54 903)	($54 903)
Total Cash Flow Net of Financing		$58 832	$54 412	$46 734	$38 805	$30 596	$22 073	$13 198	$101 962	$101 962	$101 962
of which Customer's Share		$29 416	$27 206	$23 367	$19 402	$15 298	$11 036	$6 599	$101 962	$101 962	$101 962
ESCo s Share		$29 416	$27 206	$23 367	$19 402	$15 298	$11 036	$6 599	$0	$0	$0
NPV of ESCo s Share of Savings @35% discount	**$58,098**										

Cash Flows	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
G New Kiln Burner on Kiln 5 Replace Gas Burner		1	2	3	4	5	6	7	8	9	10
Pre project Cash Flow											
Fuel Requirement for Kiln 5 (000 m^3/hr)		3 5	3 5	3 5	3 5	3 5	3 5	3 5	3 5	3 5	3 5
Annual Operating Hours		6785	6785	6785	6785	6785	6785	6785	6785	6785	6785
Total Fuel Consumed (000 m^3/yr)		23 748	23 748	23 748	23 748	23 748	23 748	23 748	23 748	23 748	23 748
Total Cost of Gas (US$)		$2 351 003	$2 351 003	$2 351 003	$2 351 003	$2 351 003	$2 351 003	$2 351 003	$2 351 003	$2 351 003	$2 351 003
Maintenance & Monitoring Costs (US$)		$10 173	$10 478	$10 793	$11 116	$11 450	$11 793	$12 147	$12 512	$12 887	$13,273
Total Cost of Operating with Existing Burner		$2 361 176	$2 361 481	$2 361 795	$2,362,119	$2 362 452	$2 362 796	$2 363 150	$2 363,514	$2,363 889	$2 364,276
Post project Cash Flow											
Capital Cost	$58 925										
Gas Requirement with New Burner		3	3	3	3	3	3	3	3	3	3
Annual Operating Hours		6785	6785	6785	6785	6785	6785	6785	6785	6785	6785
Total Gas Consumed (000 m^3/yr)		23 510	23 510	23 510	23 510	23 510	23 510	23 510	23 510	23 510	23 510
Total Cost of Gas (US$)		$2 327 492	$2 327 492	$2 327 492	$2 327 492	$2 327 492	$2 327 492	$2 327 492	$2 327 492	$2 327 492	$2 327 492
Maintenance & Monitoring Costs (US$)		$10 173	$10 478	$10 793	$11 116	$11 450	$11 793	$12 147	$12 512	$12 887	$13 273
Total Cost of Operating with New Burner		$2 337 665	$2 337 971	$2 338 285	$2 338 609	$2 338 942	$2 339 286	$2 339 640	$2 340 004	$2 340 379	$2 340 766
Incremental Cash Flow											
Capital Cost	($58 925)										
Fuel Savings (000 m^3/yr)		237	237	237	237	237	237	237	237	237	237
Value of Fuel Savings (US$)		$23 510	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510
Incremental Maintenance Cost (US$)		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Gross Incremental Profit/(Cost) (US$)	($58 925)	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510
Depreciation Expense (for tax calculations SYD)		($14 731)	($12 627)	($10 522)	($8 418)	($6 313)	($4 209)	($2 104)	$0	$0	$0
Interest Expense		($7 071)	($6 370)	($5 585)	($4 706)	($3 721)	($2 619)	($1 383)	$0	$0	$0
Income Before Tax		$1 708	$4 513	$7 403	$10 386	$13 475	$16 683	$20 022	$23 510	$23 510	$23 510
Income Tax Expense		($598)	($1 580)	($2 591)	($3 635)	($4 716)	($5 839)	($7 008)	($8 229)	($8 229)	($8 229)
Add Back Depreciation and Interest		$21 802	$18 997	$16 107	$13 124	$10 035	$6 827	$3 488	$0	$0	$0
Net Incremental Cash Flow Before Financing	($58 925)	$22 912	$21 930	$20 919	$19 875	$18 794	$17 671	$16 502	$15 282	$15 282	$15 282
IRR Before Financing	**33%**										
Shared Savings Cash Flow After Financing											
Gross Incremental Savings (US$)		$23 510	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510	$23 510
Interest Expense		($7 071)	($6 370)	($5 585)	($4 706)	($3 721)	($2 619)	($1 383)	$0	$0	$0
Principal Payments		($5 841)	($6 541)	($7 326)	($8 205)	($9 190)	($10 293)	($11 528)	$0	$0	$0
Tax Effect		($598)	($1 580)	($2 591)	($3 635)	($4 716)	($5 839)	($7 008)	($8 229)	($8 229)	($8 229)
Total Cash Flow Net of Financing		$10 001	$9 019	$8 008	$6 963	$5 882	$4 760	$3 591	$15 282	$15 282	$15 282
of which Customer s Share		$5 000	$4 509	$4 004	$3 482	$2 941	$2 380	$1 795	$15 282	$15 282	$15 282
ESCo s Share		$5 000	$4 509	$4 004	$3 482	$2 941	$2 380	$1 795	$0	$0	$0
NPV of ESCo s Share of Savings @35% discount	**$10,123**										

Cash Flows	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
H Engine Generator Sets (2 x 920 kW)		1	2	3	4	5	6	7	8	9	10
Pre project Cash Flow											
Total Electricity Consumption (MWh) RENEL		109 431	109 431	109 431	109 431	109 431	109 431	109 431	109 431	109 431	109 431
Drying Gas (Nm3 000)		2 383	2 383	2 383	2 383	2 383	2 383	2 383	2 383	2 383	2 383
Cost of Electricity		$5 580 981	$5 580 981	$5 580 981	$5 580 981	$5 580 981	$5 580 981	$5 580 981	$5 580 981	$5 580 981	$5 580 981
Cost of Drying Gas		$235 917	$235 917	$235 917	$235 917	$235 917	$235 917	$235 917	$235 917	$235 917	$235 917
Total Cost without Co Gen Units		$5 816 898	$5 816 898	$5 816 898	$5 816 898	$5 816 898	$5 816 898	$5 816 898	$5 816 898	$5 816 898	$5 816 898
Post project Cash Flow											
Capital Cost	$1 479 870										
Electricity Consumption (MWh) RENEL		93 895	93 895	93 895	93 895	93 895	93 895	93 895	93 895	93 895	93 895
Electricity Supplied by Energy Serv		15 536	15 536	15 536	15 536	15 536	15 536	15 536	15 536	15 536	15 536
Gas Consumption for Dryer		1 044	1 044	1 044	1 044	1 044	1 044	1 044	1 044	1 044	1,044
Gas Consumption for Co Gen Units		4 144	4 144	4 144	4 144	4 144	4 144	4 144	4 144	4 144	4 144
Cost of Electricity from RENEL (US$)		$4 788 645	$4 788 645	$4 788 645	$4 788 645	$4 788 645	$4 788 645	$4 788 645	$4 788 645	$4 788 645	$4 788 645
Cost of Gas for Dryer (US$)		$103 356	$103 356	$103 356	$103 356	$103 356	$103 356	$103 356	$103 356	$103 356	$103 356
Cost of Gas for Co Gen Units (US$)		$410 256	$410 256	$410 256	$410 256	$410 256	$410 256	$410 256	$410 256	$410 256	$410 256
Operations and Maintenance Cost (US$)		$29 597	$29 597	$29 597	$29 597	$29 597	$29 597	$29 597	$29 597	$29 597	$29 597
Total Cost of Operating w/ Co Gen Units (US$)		$5 331 854	$5 331 854	$5 331 854	$5 331 854	$5 331 854	$5 331 854	$5 331 854	$5 331 854	$5 331 854	$5 331 854
Gross Incremental Cash Flow	($1 479 870)	$485 044	$485 044	$485 044	$485 044	$485 044	$485 044	$485 044	$485 044	$485 044	$485 044
Pre Financing IRR	**30%**										
Chauffage ESCo Cash Flow											
Equity Financing	($443 961)										
Debt Financing	($1 035 909)										
Sale of Electricity from Co Gen Units (MWh)		15 536	15 536	15 536	15 536	15 536	15 536	15 536	15 536	15 536	15 536
Selling Price to Cimus (US$/kWh 15% below retail)		0 043	0 043	0 043	0 043	0 043	0 043	0 043	0 043	0 043	0 043
Avoided Gas for Dryers (netted off Co Gen)		1 339	1 339	1 339	1 339	1 339	1 339	1 339	1 339	1 339	1 339
Gas required to run Co Gen Units		4 144	4 144	4 144	4 144	4 144	4 144	4 144	4 144	4 144	4 144
Net Gas Attributed to Co Gen Units		2 805	2 805	2 805	2 805	2 805	2 805	2 805	2 805	2 805	2 805
Value of Electricity Sales from Co Gen (US$)		$673 486	$673 486	$673 486	$673 486	$673 486	$673 486	$673 486	$673 486	$673 486	$673 486
Cost of Net Gas Consumption by Co Gen (US$)		($277 695)	($277 695)	($277 695)	($277 695)	($277 695)	($277 695)	($277 695)	($277 695)	($277 695)	($277 695)
Operations & Maintenance Cost (US$)		($29 597)	($29 597)	($29 597)	($29 597)	($29 597)	($29 597)	($29 597)	($29 597)	($29 597)	($29 597)
Opearting Profit (US$)		$366 193	$366 193	$366 193	$366 193	$366 193	$366 193	$366 193	$366 193	$366 193	$366 193
Depreciation Expense (for taxes SL)		($211 410)	($211 410)	($211 410)	($211 410)	($211 410)	($211 410)	($211 410)	$0	$0	$0
Interest Expense		($124 309)	($111 988)	($98 188)	($82 732)	($65 422)	($46 034)	($24 320)	$0	$0	$0
Income Before Tax		$30 474	$42 795	$56 595	$72 051	$89 361	$108 749	$130 463	$366 193	$366 193	$366 193
Income Tax Expense		($10 666)	($14 978)	($19 808)	($25 218)	($31 276)	($38 062)	($45 662)	($128 168)	($128 168)	($128 168)
Add Back Depreciation		$211 410	$211 410	$211 410	$211 410	$211 410	$211 410	$211 410	$0	$0	$0
Principal Payments		($102 677)	($114 998)	($128 798)	($144 254)	($161 564)	($180 952)	($202 666)	$0	$0	$0
Net Cash Flow Attributed to Equity	($443 961)	$128 541	$124 229	$119 399	$113 989	$107 931	$101 145	$93 545	$238 026	$238 026	$238 026
IRR on Equity	**27%**										

Pre Project Operating Costs

	Electricity		Natural Gas		Fuel Oil		Total
	(kWh/yr)	($/year)	(km^3/yr)	($/year)	(kliters/yr)	($/year)	($/year)
A Clinker Cooler Heat Recovery							
Energy required for fan motors	857,084						
Cost of running fan motors		$31 511					$31,511
Maintenance & repair of fan blades							$3,136
Energy required for slag dryers			2 550				
Cost of running slag dryers				$346 800			$346 800
Value of recovered clinker dust							$54
PREPROJECT COST SUBTOTAL							$381 501
B Preheater Heat Recovery/New Core Separator							
Energy required for precipitator pump	439 425						
Water required for precipitator pump			60	<--Water			
Cost of running precipitator pump		$16 155		$1,197	<--Water		$17 353
Energy required for electrostatic filter	2 176 720						
Cost of running electrostatic filter		$80,027					$80 027
Energy required for fans	7 856 599						
Cost of running fans		$288 848					$288,848
Maintenance costs of pump, filter, fans							$4,368
Energy required for slag dryerr			2 550				
Cost of running slag dryers				$346 800			$346 800
Value of recovered raw meal							$155,231
PREPROJECT COST SUBTOTAL							$892 627
C Replace Compressor/Motor Sets							
Energy required for existing compressors (2)	1,632,540						
Cost of running compressor		$60 020					$60 020
Maintenance of compressors/motors							$2,184
Cost of oil consumed							$31
PREPROJECT COST SUBTOTAL							$62 236
D New Dynamic Separator							
Energy required for static separator fans	1,242,150						
Cost of running static separator fans		$45,668					$45,668
Maintenance of classifier							$2,464
Energy required for mill motors/ton clinker	27 7						
Cost of running mill motors/ton clinker		$1 02					$241,613
PREPROJECT COST SUBTOTAL							$289 745
E High-Efficiency Motors							
Energy required for preheater ID fans	10,638,719						
Cost of running preheater ID fans		$391,133					$391 133
Maintenance							$301

Energy required for electrostatic filter exh fans	5 074 479						
Cost of running electrostatic filter exh fans		$186 563					$186 563
Maintenance							$301
PREPROJECT COST SUBTOTAL							$578,298
F Kiln Seals							
Fuel required to run kiln 1			23,808				
Cost to run kiln 1				$3,237,871			$3,237,871
Maintenance costs for kiln 1							$10,173
Fuel required to run kiln 2					24 488		
Cost to run kiln 2						$2,669 203	$2 669,203
Maintenance costs for kiln 2							$10,173
Fuel required to run kiln 3					24 488		
Cost to run kiln 3						$2 669 203	$2 669 203
Maintenance costs for kiln 3							$10,173
Fuel required to run kiln 5			23 594				
Cost to run kiln 5				$3,208 813			$3 208 813
Maintenance costs for kiln 5							$10,173
PREPROJECT COST SUBTOTAL							$11,825,783
F Kiln Burners							
Fuel required to run kiln 1			28 569				
Cost to run kiln 1				$3,885,445			$3 885,445
Maintenance costs for kiln 1							$10,173
Fuel required to run kiln 2					24,488		
Cost to run kiln 2						$2 669 203	$2 669 203
Maintenance costs for kiln 2							$10 173
Fuel required to run kiln 3					24,488		
Cost to run kiln 3						$2 669 203	$2 669 203
Maintenance costs for kiln 3							$10,173
Fuel required to run kiln 5			23 808				
Cost to run kiln 5				$3 237 871			$3 237 871
Maintenance costs for kiln 5							$10 173
PREPROJECT COST SUBTOTAL							$12,502,415

Post Project Operating Costs

	Electricity		Natural Gas		Fuel Oil		Total
	(kWh/yr)	($/year)	(km^3/yr)	($/year)	(kliters/yr)	($/year)	($/year)
A Clinker Cooler Heat Recovery							
Energy required for fan motors	1,658,661						
Cost of running fan motors		$60,981					$60,981
Maintenance & repair of fan blades							$3,136
Energy required for slag dryers			1,343				
Cost of running slag dryers				$182,684			$182,684
Value of recovered clinker dust							$54
POST PROJECT COST SUBTOTAL							$246 855
B Preheater Heat Recovery/New Core Separator							
Energy required for precipitator pump	0						
Water required for precipitator pump			0	<--Water			
Cost of running precipitator pump		$0		$0	<--Water		$0
Energy required for electrostatic filter	0						
Cost of running electrostatic filter		$0					$0
Energy required for fans	13 298 399						
Cost of running fans		$488,916					$488 916
Maintenance costs of pump filter fans							$2,856
Energy required for slag dryerr			1 343				
Cost of running slag dryers				$182 684			$182,684
Value of recovered raw meal							$156,284
POST PROJECT COST SUBTOTAL							$830 739
C Replace Compressor/Motor Sets							
Energy required for existing compressors (2)	1,306,032						
Cost of running compressor		$48 016					$48 016
Maintenance of compressors/motors							$756
Cost of oil consumed							$12
POST PROJECT COST SUBTOTAL							$48,784
D New Dynamic Separator							
Energy required for static separator fans	1,951,950						
Cost of running static separator fans		$71,763					$71,763
Maintenance of classifier							$2 464
Energy required for mill motors/ton clinker	18 47						
Cost of running mill motors/ton clinker		$0 68					$161,075
POST PROJECT COST SUBTOTAL							$235 303
E High-Efficiency Motors							
Energy required for preheater ID fans	9 574,847						
Cost of running preheater ID fans		$352 019					$352 019
Maintenance							$301

Energy required for electrostatic filter exh fans	4 567 031						
Cost of running electrostatic filter exh fans		$167 907					$167 907
Maintenance							$301
POST PROJECT COST SUBTOTAL							$520 528
F Kiln Seals							
Fuel required to run kiln 1			23,464				
Cost to run kiln 1				$3,191,160			$3 191,160
Maintenance costs for kiln 1							$10 173
Fuel required to run kiln 2					23,991		
Cost to run kiln 2						$2,615,072	$2,615,072
Maintenance costs for kiln 2							$10,173
Fuel required to run kiln 3					23,991		
Cost to run kiln 3						$2 615 072	$2,615,072
Maintenance costs for kiln 3							$10 173
Fuel required to run kiln 5			23,251				
Cost to run kiln 5				$3,162,102			$3,162,102
Maintenance costs for kiln 5							$10,173
POST PROJECT COST SUBTOTAL							$11,624,099
F Kiln Burners							
Fuel required to run kiln 1			28,569				
Cost to run kiln 1				$3,885,445			$3,885,445
Maintenance costs for kiln 1							$10,173
Fuel required to run kiln 2					24,488		
Cost to run kiln 2						$2 669 203	$2 669 203
Maintenance costs for kiln 2							$10 173
Fuel required to run kiln 3					24,488		
Cost to run kiln 3						$2 669 203	$2 669 203
Maintenance costs for kiln 3							$10 173
Fuel required to run kiln 5			23,570				
Cost to run kiln 5				$3 205 492			$3,205 492
Maintenance costs for kiln 5							$10 173
POST PROJECT COST SUBTOTAL							$12,470,037