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LEAP: Land Endowment Action Plan for Sustainable Colby

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Cover Page Footnote

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1. Introduction

Colby College opened the doors to its biomass plant in 2012, declaring carbon neutrality shortly after in 2013 (Jacobs). This was not just a victory for the college's environmental efforts, but it was also the beginning of a new energy chapter. This project analyzes the chemical and economic feasibility of using land endowments to fuel the biomass operations. By inserting ourselves into the natural forest carbon cycle and following innovative forest management systems, Colby can assure its carbon neutrality while also benefiting financially and academically.

Currently, Colby contracts with Cousineau Forest Products for sustainably harvested chipped biomass from within a 50-mile radius of campus. In order to offset the carbon emissions from this and other campus activities, the college must purchase over 8,000 metric tons of carbon equivalents (MTCE) every year. These carbon credits run on average for $4.50 each, ringing up to an annual $45,000 (Bright). With the volatility in the fuel market and the opportunity for curricular, financial and environmental improvement, however, this paper analyzes an innovative investment and action plan for the purchase of land endowments as a fuel source for the biomass plant.

2. Methods

After analyzing the energy content and growth rates of Maine's forests coupled with campus energy demands, LEAP allotted a necessary 30,000 acres^2. Assuming only 70 percent of the purchased forest stands at full growth, the college would require 20,000 acres^2 of land to supply the 18,000 tons of biomass it consumes annually. LEAP, however, calls for sustainably run and improved forest management. Colby would thus need to purchase the additional 10,00 acres^2-totaling to 30,000 acres^2- to allow time and space for sufficient growth and re-growth. The acreage provides 1,050,000 tons of biomass in its beginning state, assuming 50 tons of biomass per acre (see figure 1 for assumptions). With these requirements, this paper creates a dynamic model to analyze the economic feasibility and outlook of the projected endeavor. We breakdown the total biomass into two categories- merchantable wood and slash (the tops and limbs)- in order to determine the available biomass stocks for fuel and log sale. After accounting for the 18,000 tons needed to meet the campus' energy demand, we calculate the excess growth and harvest from year to year. Given the available biomass, Colby practices selective cutting and must chip all

harvested wood and slash until year 36. This estimate may vary depending on the makeup of the purchased forest. In year 36, Colby will have improved the forest growth enough that it can use the treetops and limbs for the biomass plant and sell the merchantable wood on the market. Colby maintains sustainable forest management in its selective cutting and improved biomass growth.

Mapping out Colby's energy demands as well as the biomass content of the proposed purchased land, our model can construct the financial requirements, timeline, and profits. We expect to spend $22.5 million on the 30,000 acres[2] of land as well as $4 million on implementation costs mainly comprised of labor, capital, and transport. Although this project can be funded in a multitude of ways, LEAP proposes an upfront loan of $26.5 million at 5 percent interest with a 30-year payback. Colby spends the $22.5 million on the land and invests the remaining $4 million in the bank so as to collect risk-free interest of an assumed 1 percent. The $4 million is spread across 10 years, with $400,000 withdrawn each year in order to ease the initial implementation and delivery costs. In the long term, this investment brings in significant annual revenues, sustainably harvested biofuel, as well as other monetary and non-monetary benefits.

3. Results and Discussion

a. The Economic Outlook

With a 30-year payback plan, Colby must make annual payments of $1,723,863.03 to meet the loan requirements. The annual costs for the first 10 years include the loan payments and estimated biomass delivery costs minus the $400,000 borrowed for implementation. In the beginning of year 11, when the entirety of the loan has been spent, the college is left with $192,774.89 in collected interest that can be put toward easing the delivery costs. When the college can retire the loan in year 30, it begins to turn annual profits (figure 2). In year 36, the land will have grown enough that the merchantable wood can be sold. The significant income from these sales quickly drives down the deficit. The project itself has an expected payback period of 40 years, when the revenue from the merchantable wood exceeds the costs of the first 40 years. At this point, annual revenue amplifies. By year 50, the college's total revenue from LEAP adds to $46,101,884.24, an increase of $44,009,740.51 in 10 years. Profits rise over time as the growing forest allows increasingly more merchantable wood for sustainable harvest. In year 39, the forest reaches full growth and the

annual growth rate as well the annual revenue peaks and continues at a steady rate. The model covers 100 years of biomass and income projections (figure 3), coming to a final total of $264,746,144.14, over one third of the college's endowment as of 2012. As opposed to directing these costs and revenues toward an outside contractor, LEAP's in-house structure allows Colby to retain these economic benefits.

Not only does the land endowment provide biomass for Colby's fuel needs, but it also grants the college independence from the volatile fuel market. Over the last year, Maine, the most petroleum-dependent state in America for home heating, has seen a 23 percent increase in propane prices, 4 percent increase in heating oil prices, and a 3 percent increase in that of kerosene. Natural gas, a rapidly expanding fuel source across the country, also shows unpredictable pricing trends and forecasts (figure 4). The energy market faces an uncertain future as the increased movement toward cleaner or renewable fuels suggests both a lack of stability as well as a likely overall fuel price increase. Through LEAP, Colby's biomass does not depend on contractors or markets. While the college will continue to use #2 oil in order to meet peak needs, a significant portion of its energy bill will stem from the reliable, predictable, and controllable land endowment.

The opportunities LEAP presents draw indirect economic benefits, as well. Increased media attention will increase Colby's reputation and competitive standing, likely drawing the attention of potential students, faculty, and donors. Alumni and outside donors may increase their involvement with the college both in financial and non-financial terms. LEAP opens the door to economic activity that could significantly impact or even redefine Colby's financial structure.

b. Environmental Benefits

LEAP creates multiple avenues for environmental progress, most notably through improved forest management, assured sustainable and local harvest, and land conservation. Upon purchasing the land endowment, Colby will remove dead trees, limbs, leaves, and other scrap from the forest floor for use in the biomass plant. This leaves space for more, new plant material to grow. Colby will continue to selectively cut so as to ensure sustainable and efficient harvesting. While natural forests have growth rates of about 1 percent per year, the improved management aims for a rate of 1.25 or even 2 percent. The sustainable harvesting not only benefits the health of the forest, but it also provides Colby with a solidified guarantee. The contract with Cousineau Forest Products also guarantees sustainably harvested biomass from within a 50-mile radius, but Colby does not investigate the degree to which this promise is

upheld. The college relies on this promise in claiming the school's carbon neutrality status. Carbon neutrality, which is calculated in-house, assumes that Cousineau Forest Products fulfills the contract. LEAP, however, ensures that the biomass comes sustainably harvested, thus providing a grounded foundation for neutrality claims. Colby could even take this argument a step further if the purchased land sits closer than 50 miles.

In owning 30,000 acres[2], Colby protects a valuable piece of Maine forest. While there may not be a current threat, land conversion and degradation are certainly possible. About 96 percent of Maine forests are privately owned and already in use, leaving only 4 percent for the remaining competition. Land conservation in Maine is especially important given the high value of its forests. Ecosystems services within Maine range from $500 to $2,501 per acre per year (figure 4). The value in forest and ecosystem protection in Maine only adds to the environmental benefits of LEAP.

c. Academic Benefits

The college has expanded its interests in environmental affairs most noticeably over the last five years. Through the construction of the biomass plant, interdisciplinary hiring of environmentally focused professors, and the creation of the sustainability coordinator position as well as the projects implemented in his time, Colby administration has reflected the similar environmental passion that runs through its students. LEAP presents major curricular opportunities that would set Colby apart from competing institutions. Integrating the forest and sustainable forest management into the curriculum would give students a unique, first-hand experience so vast that the monetary value may even be difficult to narrow down. Comparing LEAP to other academic projects on campus, however, allows for some understanding of its academic value.

In the last five years, Colby has also expanded its academic construction. The library storage facility cost $3.6 million in construction and the art museum was a $15 million renovation eased by a $5 million Harold Alfond Fund donation. On top of this, the museum received a $100 million art donation from the Lunder Family (Colby). The biomass plant's total cost rang in at $11.25 million including a $750,000 Efficiency Maine grant (Jacobs). Most notably, the Davis Building cost $18.6 million in construction- partially funded by a $10 million Davis Family gift- and unreported future costs of annual upkeep and maintenance (Calder). The Davis Building will house three departments: Computer Science, Mathematics and Statistic, and Psychology. Comparing this to the land endowment, LEAP requires a $26.5 million loan to implement and serves an almost unlimited

number of departments, especially Economics, Environmental Studies, and Chemistry. Placing a value on education has its challenges, but the curricular additions of LEAP provide significant benefits outside of the financial total.

4. Conclusion

LEAP presents a diverse array of economic, environmental, and academic opportunities. Through improved forest management, Colby can source enough biomass from 30,000 acres[2] to sustainably meet the needs of the biomass plant while also turning a significant profit. Selective cutting and amplified forest growth allow the college to chip trees and limbs for fuel while also selling merchantable wood on the market. With a 40-year payback period, Colby can bring in and retain revenues totaling to nearly $265 million in 100 years, over one third of the 2012 endowment. Increased media attention may draw alumni and donor gifts as well as give Colby an edge on competing institutions. At the same time, the land endowment provides green energy and independence from an unstable fuel market. LEAP improves forest health, assures sustainable and local harvesting, and conserves valuable ecosystems. Students and faculty can explore these benefits and others as the project creates invaluable curricular opportunities. Several departments could integrate the forest and management practices into the curriculum, giving Colby students a rare, first-hand academic experience in the field. A long-term investment, indeed, LEAP provides a significant value even on top of energy purposes.

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6. *Appendix*

Figure 1. Measurement Assumptions

Measurement	Amount	Units
Tops and limbs	25%	percent
Growth rate	1.25	tons/acre/year
Growth rate of merchantable wood	1	ton/acre/year
Annual Colby demand	18,000	tons/year
Initial land purchase	30,000	acres
Max above ground live tree biomass	50	tons/acre
Years to maturity	40	years
% growth merchantable wood	2%	merch/total biomass
% growth tops and limbs	0.5%	tops/total biomass
Mass/cord	2.00	tons/cord
Growth profile	70%	fraction of land at full growth
Value of saw logs	200.00	$/ton
Price per acre	750.00	$/acre
Cost of money	5%	percent/year
Biomass delivery	20	$/ton
Price of biomass	50.00	$/ton
Implementation costs	4.00E+06	$ over 10 years
Inflation rate	2%	percent

Figure 2. Milestone Projections

Year	Status	Total $
0	Loan	-775,469.98
30	Loan paid off	-19,168,022.80
31	+ income	-18,651,052.10
36	Sell logs	-15,454,018.70
39	Full growth	-2,313,999.36
40	Profit	2,092,143.73
100	Century	264,746,144.14

Figure 3. LEAP Total Revenue in 2013 dollars

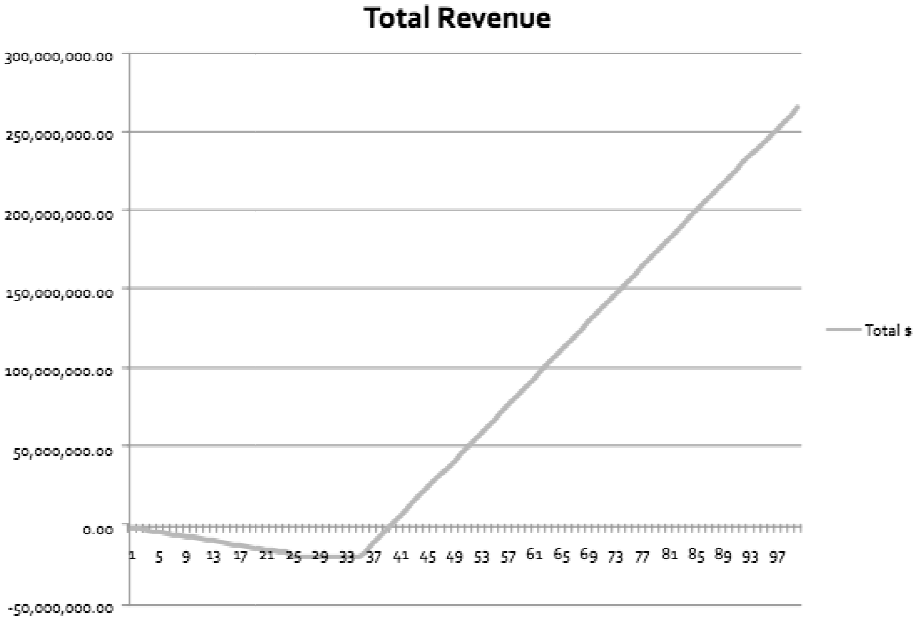

Figure 4. Natural Gas Spot Prices Y

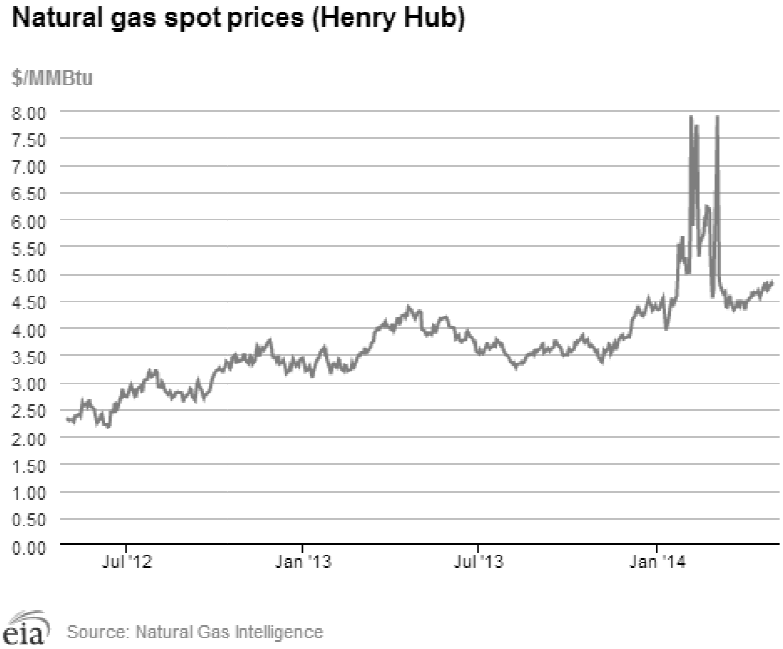

Figure 5. Average Ecosystem Value Per Acre Per Year Per County