

Duke Carbon Offsets Initiative:
Forestry Carbon Financial Risk Analysis

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ABSTRACT

In 2007, Duke University signed the American College & University Presidents' Climate Commitment, committing the University to develop an institutional plan to achieve carbon neutrality by 2024. Achieving this goal will require Duke University to offset approximately 183,000 tons of carbon dioxide equivalent (CO₂e) in 2024. To address this challenge, the University established the Duke Carbon Offsets Initiative in 2009 to procure carbon offsets that prioritize investment in local and regional carbon offset projects that yield significant environmental, social and economic benefits beyond greenhouse gas emission reductions. The Offsets Initiative is currently assessing the feasibility of purchasing or developing forestry-based carbon offset projects in North Carolina and the Southeast region.

From the perspective of Duke University, this report assesses the financial implications of forestry carbon offset procurement. Specifically, this report analyzes two potential investment opportunities: an existing afforestation project and a hypothetical avoided conversion project. Each project analysis begins with a project overview and identifies key players to understand incentive structures and assess qualitative project risks. Following this qualitative description, a quantitative analysis is performed to determine the levelized cost per offset (LCO) in present value terms to Duke University and to further assess additional risks and mitigation strategies. The analyses do not attempt to quantify intangible benefits such as educational, research, or ecosystem co-benefit values. Rather the financial analyses are intended to compliment the Offsets Initiative's larger feasibility study on forestry carbon offsets.

The analyses show both projects as potential candidates for long-term investments. The afforestation project has low project risk and provides sufficient offset supply to meet the University's need. Additionally, the LCO is low relative to substitute over-the-counter forestry offsets. However, the project requires high upfront investment and exposes Duke University to price risk. This risk may be mitigated through the purchase of a real option from the project developer. The avoided conversion project is found to require little upfront investment and may produce a large offset supply if scaled up. However, sensitivity analysis performed on key parameters derived from the tax equity project finance structure produces a wide range of possible LCOs. Duke University can better understand its LCO by first performing an assessment on the tax equity value to determine if the project is financially feasible.

TABLE OF CONTENTS

INTRODUCTION	3
ANALYSIS METHODOLOGY	3
GREENTREES, LLC INVESTMENT	4
KEY PLAYERS	5
ANALYSIS METHODOLOGY	9
LEVELIZED COST	10
PRICE FORECAST	11
MONTE CARLO MODEL	13
RECOMMENDATIONS	14
REAL OPTION PRICING	16
CONSERVATION EASEMENT FLIP INVESTMENT	17
KEY PLAYERS	18
ANALYSIS METHODOLOGY	21
FINANCING STRUCTURE	21
OPTIMIZATION MODEL	22
RECOMMENDATIONS	23
CONCLUDING THOUGHTS	23
APPENDICES	25
APPENDIX A	25
APPENDIX B-C	26
REFERENCES	27

INTRODUCTION

In 2007, Duke University signed the American College & University Presidents' Climate Commitment, committing the University to develop an institutional plan to achieve carbon neutrality^a by 2024. The University's Climate Action Plan¹ recommends transportation and energy greenhouse gas reduction measures that would reduce the campus carbon footprint to the lowest levels possible. However, achieving carbon neutrality would require offsetting the remaining emissions – approximately 183,000 tons of carbon dioxide equivalent (CO₂e) in 2024.

Understanding that the University could not reach net zero greenhouse gas emissions through reduced energy consumption and energy efficiency alone, the University commissioned the Nicholas Institute for Environmental Policy Solutions to undertake a comprehensive feasibility study in 2008 to explore how carbon offsets could be employed to reach that goal.² The study identified swine-based agricultural methane projects, forestry, and energy efficiency as the three most likely areas for local offset development by the University.

To pursue the procurement of carbon offsets, the University established the Duke Carbon Offsets Initiative in 2009 with the mission to encourage, facilitate, and catalyze local and regional carbon offset projects that yield significant environmental, social and economic benefits beyond greenhouse gas emission reductions. The Offsets Initiative is moving forward in developing an agricultural methane offset project from a North Carolina swine farm and is evaluating opportunities to implement energy efficiency and organic waste digestion and composting offsets projects.

Additionally, the Offsets Initiative is currently assessing the feasibility of purchasing and/or developing forestry-based carbon offset projects in North Carolina and the Southeast region. It is the goal of this report to analyze these potential forestry carbon investments and determine the cost to Duke University as well as identify key risks and to develop strategies to mitigate these risks. In doing so, this financial risk analysis will help inform Duke University administrators how best to allocate resources to procure carbon offsets for the University's carbon neutrality goal.

Analysis Methodology

This report assesses the financial implications from the perspective of Duke University for forestry carbon offset procurement. Specifically, this report analyzes two potential project scenarios in which Duke University, via the Offsets Initiative, has the opportunity to invest:

^a Duke University has committed to being a net zero carbon emitter by 2024. For more information, please see http://sustainability.duke.edu/climate_action/index.php.

- Afforestation project in which the Offsets Initiative may purchase offsets directly from the project developer
- Avoided conversion project that the Offsets Initiative may originate in conjunction with an investment partner to produce offsets

Each case study begins with an overview of the project and identifies key players in order to understand incentive structures and assess qualitative project risks. Following this qualitative description, a quantitative analysis is performed to determine the levelized cost per offset (LCO) to Duke University and further assesses additional risks and mitigation strategies. The analyses do not attempt to quantify intangible benefits such as educational, research, or ecosystem co-benefit values. Rather the financial analyses are intended to compliment the Offsets Initiative’s larger feasibility study on forestry carbon offsets.

GREENTREES, LLC INVESTMENT

PROJECT SPECIFICS INCLUDING ALL FINANCIALS ARE DISGUISED
AND/OR ARE OMITTED IN THE FOLLOWING ANALYSIS IN ORDER TO
PROTECT CONFIDENTIAL INFORMATION CURRENTLY IN
DISCUSSION BETWEEN DUKE UNIVERSITY AND GREENTREES, LLC.

GreenTrees[®], LLC (herein after referred to as GreenTrees) is an afforestation^b project managed by C₂I, LLC³. The project is based throughout the Lower Mississippi Alluvial Valley (MAV)^c, which is the United States’ largest watershed and provides critical habitat for migratory birds spanning 40% of North America’s waterfowl migratory route as well as 60% of all bird species migration⁴. The 22 million acre expanse of the MAV was largely forested pre-World War II but now currently holds only 4 million acres of natural forestland⁵. The goal of the GreenTrees project is to reestablish 30 million trees throughout 1 million acres of the MAV⁶. The project is anticipated to create value through generating carbon offsets, conservation recreation, timber, and biomass feedstock assets throughout the life of the project.

b Afforestation is defined as the process of reforesting land that was previously converted directly by human-induced actions and has not been forested for at least 50 years. A reforestation project, however, is defined as reforesting land that was converted within the past 50 years; GreenTrees MRV Protocol, 2010.

c The area of the Lower Mississippi Alluvial Valley includes portions of Louisiana, Mississippi, Arkansas, Kentucky, Tennessee, Missouri and Illinois. Approximately 2.7 million people reside in the area. Source: ACR, GreenTrees Forest Carbon Project, accessed Feb. 25, 2011 online: <http://www.americancarbonregistry.org/carbon-registry/projects/greentrees-forest-carbon-project>.

Key Players:

The GreenTrees project consists of four key players:

- Landowner
- Certifier
- Management
- Investor

Landowner:

Private landowners hold 98% of the MAV. However, current landowners typically do not live on their land, as it is often inherited ownership⁷. Most recently, the MAV was typically used for raising soybeans during the 1960s and 1970s as agricultural commodity prices surged⁸. However, as agricultural commodity prices fell and demographics shifted, farming has become a less feasible economic activity⁹. As a result, landowners have endorsed conservation as a new revenue stream through channels such as the federal Conservation Reserve Program (CRP)^d, which provides rental payments to landowners for the abandonment of agricultural production on marginal land. GreenTrees incentivizes landowners to participate in its afforestation project by providing revenue streams with carbon offsets being the primary and senior revenue stream. Additionally, GreenTrees has designed its project to be eligible for CRP payments. Table 1 provides a breakdown of the financial incentive for landowners to enroll in GreenTrees. Other potential long-term revenue streams include recreation (fishing and hunting), timber, and biomass feedstock.

To enroll in the GreenTrees program, landowners must agree contractually to dedicate their land for the purpose of carbon sequestration for a minimum period of 15 years¹⁰. Landowners are required to sign a Carbon and Sustainable Forestry Lease Agreement prior to participation in CRP¹¹. The lease agreement specifies what type of tree planting mix is to be planted (cottonwood/hardwood interplanting mix) and provides the minimum basal area^e that must be maintained in the case of harvesting. Resulting carbon stocks are converted to carbon offsets, marketed, and sold on behalf of landowners by GreenTrees management.

d The Conservation Reserve Program is a voluntary program that encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover. Farmers enrolled in the program receive annual rental payments and earn cost-sharing for the vegetative replanting of the land. Source: <http://www.nrcs.usda.gov/programs/crp>.

e The basal area is described as the cross sectional area of a planted hardwood tree measured at diameter breast height and calculated in square feet on a per acre basis. GreenTrees requires landowners maintain a minimum basal area of 75 square feet per acre. Source: GreenTrees MRV Protocol, 2010.

Features	CRP Only	GreenTrees and CRP
Landowner Contract Length	15 Years	15 years
Total Estimated Planting Costs	(\$200)	(\$425)
50% CRP Cost Share	\$100	\$213
40% CRP PIP	\$80	\$170
<i>Subtotal per Acre</i>	(\$20)	(\$42)
Signing Incentive Payment (SIP)	\$100	\$100
Extra Enrollement Payment	N/A	\$25
<i>Net Incentive Payment to Landowner in First Year</i>	\$80/Acre	\$83/Acre
Soil Rental Rate	120%	120%
Fast Growth Forest?	No	Yes
Additional Incomes		
Estimated Carbon Income at Current Market Value of \$6-\$9 per ton	\$120-\$180/Acre	\$450-\$675/Acre
Estimated Cottonwood Harvest Income	\$0/Acre	\$120-\$180/Acre

Table 1, CRP vs. GreenTrees+CRP revenue to landowners.
Adapted from GreenTrees website.^f

The Carbon and Sustainable Forestry Lease allows for lease payments to be made to the landowner based on generated carbon. However, an executed lease does not require a landowner to participate in the project if she chooses not to plant. To mitigate contractual risk with landowners, (i.e., ensuring a landowner does not default on the contract by intentionally or unintentionally destroying existing carbon stock by harvesting or by other means removes the planted trees), GreenTrees performs credit checks and title checks prior to entering into a lease and will enact lien subordination to recover costs in case of a violated lease¹². The lease will record a restrictive covenant with the title on the land that enforces the terms of the lease (i.e., restricts harvesting for 15 years after the project start date and stipulates a minimum basal area that must be maintained throughout the life of the lease)¹³.

^f Explanation of contract terms:

Practice Incentive Payment (PIP): equal to 40% of the eligible installation costs for eligible participants who enroll certain practices. The one-time PIP will be issued after the practice is installed, eligible costs are verified, and other payment eligibility criteria are met.

Signing Incentive Payment (SIP): An up front signing incentive payment (CRP-SIP) up to \$100 per acre for eligible participants who enroll certain practices. The one-time SIP will be made after the contract is approved and all payment eligibility criteria are met.

Soil Rental Rate: Rental rates are based on the relative productivity of the soils within each county and the average dryland cash rent or cash rent equivalent.

Source: USDA Farm Service Agency, Newsroom, Program Fact Sheets: "Conservation Reserve Program Continuous Sign-up", 2006.

Additionally, GreenTrees cites that the conversion from forest back to cropland is very unlikely due to high switching costs¹⁴ (an NRCS study concluded the conversion rate from forest to crop land in the US was 0.0388%¹⁵).

Certifier – American Carbon Registry:

GreenTrees chose the American Carbon Registry (ACR)^g as its certifier of verified emission reductions, i.e., carbon offsets. ACR supports US-based projects and publishes greenhouse gas accounting standards, methodologies, and protocols to ensure projects producing carbon offsets are real, additional, permanent, and verifiable. Projects that meet ACR's requirements are eligible for registration under ACR's electronic registry system. Under this system, each carbon offset is branded as an Emissions Reduction Ton (ERT) and represents one metric ton of carbon dioxide equivalent (CO₂e). Each ERT is provided a serial number for tracking purposes to ensure no double counting of ERTs occurs. Sales of ERTs do not occur on the registry itself; however, the transfer of the ERT between accounts is recorded on the registry¹⁶.

ACR was established in 1996 as the first greenhouse gas registry in the US. Its ERTs are eligible for trade on the voluntary carbon market and was the most heavily traded offset commodity on the voluntary market in 2008 (22% of total transactions); however, ERT trading shrank significantly in volume in 2009 (7% of total transactions) due to increased competition from other certifiers and registries¹⁷. Nonetheless, the Waxman-Markey bill alludes to the allowable conversion of ERTs to federally recognized carbon offsets eligible for use in the presence of national climate legislation¹⁸. Additionally, ACR has worked with several notable organizations including Nike, Duke Energy, and Environmental Defense Fund¹⁹.

ACR provides market credibility through certifying that a project's carbon offsets are real, additional, verifiable, and permanent. ACR accomplishes these tasks via multiple screening hurdles as well as consistent monitoring and verification procedures throughout the life of the project. The robustness of the ACR certification has direct implications on the market value of the resulting ERTs issued from the GreenTrees project. In regard to domestic offsets, the market typically rewards offsets certified by very stringent certifiers. Currently the price spread of domestic voluntary offsets (including retail/wholesale, OTC, and exchange) can range from \$0.05-\$35.00 per offset²⁰. ACR's ERTs trade within the 20th percentile of this range²¹.

g The American Carbon Registry is a non-profit subsidiary of Winrock International. It was founded in 1996 as a greenhouse gas registry and provides protocols for greenhouse gas project certification. Additional information available online: <http://www.americancarbonregistry.org>.

In regard to forestry, ACR plays a crucial role in risk mitigation for all parties that have interest in the GreenTrees project by serving as an insurance mechanism. Forestry carbon projects are especially susceptible to reversals, i.e., the loss of grown carbon stocks resulting in a reversal of sequestered carbon emissions. Reversal can occur in various manners including pre-mature harvesting, extreme storms (e.g., tornadoes), pest infestations, and fires. The loss of carbon in such an event would immediately default any outstanding and/or retired ERTs. To ensure liability of such a loss is not placed on the buyer and to ensure forestry ERTs do not trade at a significant risk-adjusted discount, ERT employs the use of a risk pooling buffer referred to as the ACR Buffer Registry. ACR requires developers of ACR certified projects to submit an allocation of ERTs into the Buffer Registry^h; the ERTs in the buffer can be drawn upon in case of a reversal for any ACR certified project²². The developer need not commit ERTs from her specific project to the Buffer Registry but can instead fulfill the allotment with ERTs from any ACR certified project. The allocation base of ERTs is derived from the risk profile of the project (see Appendix A for GreenTrees risk profile). ACR required GreenTrees provide a 16% allocation based on total ERTs generated to the Buffer Registry²³. ACR may reduce the allocation over time for demonstrated strong project performance.

GreenTrees Management:

GreenTrees is managed by C₂I, LLC, based in Middleburg, Virginia and focuses on conservation investment programs that strives to create a “blended return” of sound economic return and strong environmental value²⁴. C₂I’s sole carbon offsets project is GreenTrees, and the company appears to have devoted the majority of its resources to the GreenTrees project. Such resources include the establishment of a tree nursery in the MAV to support the project’s development as well as the development of the Advanced Carbon Restored Ecosystem Protocol (which was approved by ACR) specific to the MAV region and designed to create premium carbon offsets that incorporate co-benefitsⁱ in addition to carbon sequestration.

The GreenTrees carbon model assumes an 80% initial survival rate of hardwoods, 65% initial survival rate of cottonwoods, 0.5% annual mortality, a 16% buffer with a 15% buffer recovery at each verification, and a thinning in year 10 of the project. Given these assumptions, GreenTrees purported carbon offset generation aligns with model estimates produced by Duke University using a custom spreadsheet offsets decision support tool²⁵.

^h Buffer is comprised of all US registered projects. ACR has issued over 30 million ERTs.

ⁱ Co-benefits are realized ecosystem services in addition to carbon sequestration such as water quality or biodiversity.

The GreenTrees project creates incentives for management's self-interest in multiple ways. First, investors are offered a payment schedule that provides for investment installments throughout the life of the contract. This structure provides that strong performance by management is required for the long-term²⁶. Second, management has developed an Investor Committee, which empowers investors to remove management if problems arise with the GreenTrees project²⁷. Third, management is incentivized to see the successful completion of the project in order to tap additional revenue streams in the form of timber and biomass feedstock.

Management currently has no other carbon offset project underway and therefore has no existing track record to benchmark historic performance. Moreover, the GreenTrees project was initiated in 2008 and only began registering ERTs in 2009²⁸. Hence, the project is very young and it is therefore difficult to assess the future success of the project. There have, however, been numerous statements of support for the project from communities including landowners, NGOs (Audubon Arkansas and National Wildlife Federation), and state government agencies (Arkansas Game and Fish Commission and Arkansas Forestry Commission)²⁹. It is unclear how many parties have invested with GreenTrees; however, GreenTrees largest and most high profile investor is Duke Energy, which in 2009 invested in the replanting of 1700 acres (over 1 million trees)³⁰. Duke Energy's rationale for the investment was primarily pre-compliance for potential impending federal climate legislation³¹.

Investor:

Due to the relatively high capital cost of afforestation projects, GreenTrees seeks investors that are capable of making long-term commitments of large cash calls to support continued tree planting for the life of the project. As described above, much of the project risk has been mitigated by and/or shifted to ACR and GreenTrees management. Investors are primarily exposed to price risk associated with demand for ACR-issued ERTs, which is more broadly characterized by the demand for carbon offsets in the US.

Analysis Methodology

For Duke University and the Offsets Initiative, the investment risk revolves around the uncertainty of price escalation or de-escalation in the voluntary carbon market and the decision for when to invest. More specifically, the Offsets Initiative must assess the financial risk of purchasing carbon offsets today given the uncertainty of what future prices will be. The Offsets Initiative can hedge against future price escalations by locking in a forward contract. Alternatively, the Offsets Initiative can speculate what market prices will be and invest at a later date.

GreenTrees has offered Duke University a fixed price per ERT (at time of signing) at a specified minimum investment level. GreenTrees requires investors to enter a long-term contract with an investment schedule beginning at contract signing (i.e., year 0). In exchange, ERTs will be distributed each year of the contract beginning in year 1. The volume of ERTs delivered each year is assumed to be approximately uniform throughout the duration of the contract^j. The total volume of offsets expected over the life of the project is sufficient to meet a portion of Duke University’s carbon neutrality target if an investment is made today.

To help guide this investment decision process, this study determines the levelized cost per offset to Duke University and simulates forecasted domestic offset prices to understand what price risk Duke University is exposed to. These steps are described below, followed by a recommendation that minimizes Duke University’s risk and optimizes its investment.

- Determine the levelized cost per offset (LCO) to Duke University
- Simulate forecasted domestic offset prices via Monte Carlo model
- Recommendation and analysis of real option

Levelized cost:

To determine Duke University’s levelized cost per offset (LCO), a discounted cash flow of expected expenditures is developed. The levelized cost per offset is determined through the following calculation:

$$LCO = \frac{\sum_{n=0}^N \left(\frac{Investment_n}{(1+r)^n} \right)}{\sum_{n=0}^N \left(\frac{Offsets Received_n}{(1+r)^n} \right)}$$

n = project year

r = discount rate

The LCO is therefore the present value of the total investment cost divided by the present value of expected offsets received throughout the life of the project. In this formula, *n* refers to the time period (in years) and *r* is the discount rate. The investment cash flow as well as the offsets flow are discounted at 5.5%, which reflects Duke University’s Endowment annual spending rate and serves as a proxy for the Endowment’s expected real rate of return (i.e., adjusted for inflation and net of fees)^{k32}. Based on the

^j Non-uniform distribution of offsets may decrease the levelized cost per offset.

^k The Duke Endowment spending rate is capped at 5.5% per annum relative to the Endowment. Therefore, 5.5% represents the opportunity cost for Duke University as a 5.5% return will net a net present value of \$0.00 to the Endowment. Additional information available online: <http://giving.duke.edu/endowment>.

offer terms provided by GreenTrees, the levelized cost to Duke University is approximately \$6.00 per offset. In other words, this is the break-even price if the Offsets Initiative were considering this project a financial investment with an expected real rate of return of 5.5%. The LCO calculated here assumes that the project will provide offsets at a uniform rate during the project's life (no offsets are expected in the initial investment year, i.e., year 0). Non-uniform distribution of offsets may reduce the stated LCO slightly (approximate reduction of 3%).

The LCO of \$6.00 can be benchmarked against forestry offsets market data. To maintain consistency, it is most appropriate to benchmark against forestry offsets trading on the US voluntary carbon market on which the GreenTrees offsets are eligible for trade. Looking to this market, forestry offsets available directly from project developers are priced at a weighted average of \$7.22 per offset while over-the-counter (OTC) forestry offsets currently trade upwards toward \$8.50 per offset¹³³. Therefore, the current price offered by GreenTrees is a good opportunity for the Offsets Initiative.

However, because this is not an OTC transaction, further analysis is required to understand how the investment structure required by GreenTrees may further increase the financial risk of the investment from Duke University's perspective. Specifically, due to the long-term investment requirements, Duke University is exposed to price risk in regard to the fluctuating prices for offsets on the voluntary market. There is potential for the value of the GreenTrees offsets to appreciate, depreciate, or remain relatively flat between today and 2024 when Duke University must become carbon neutral. Therefore, an analysis of this potential price change is necessary to build intuition for how the GreenTrees offsets will be valued in the future, and based on that intuition the Offsets Initiative can understand when an investment should be made to optimize the value of Duke University's investment.

Price Forecasting:

Understanding how domestic offset prices may behave will help guide the Offsets Initiative's decision regarding when an investment should be made. More specifically, the Offsets Initiative needs to understand how carbon markets will affect the pricing offered by GreenTrees. However, developing such a price forecast is complex and may be constructed in various manners. In this forecast analysis, components of US carbon allowance forecasts and US voluntary carbon markets are incorporated into a Monte Carlo simulation to help build intuition for how the price of GreenTrees offsets will change between 2012 and 2024 (the time at which Duke University is to be carbon neutral).

¹³³ All prices reported in 2011 dollars.

While there are few price forecast analyses for domestic carbon offsets, several analyses have been conducted on the potential pricing of carbon allowances^m in the presence of federal climate legislation. These forecasts vary significantly due to different policy assumptions. One such assumption is based on the volume of offsets that will be permitted for use in a cap and trade climate program. Therefore, there is high correlation between the price of allowances and the price of offsets. This is seen

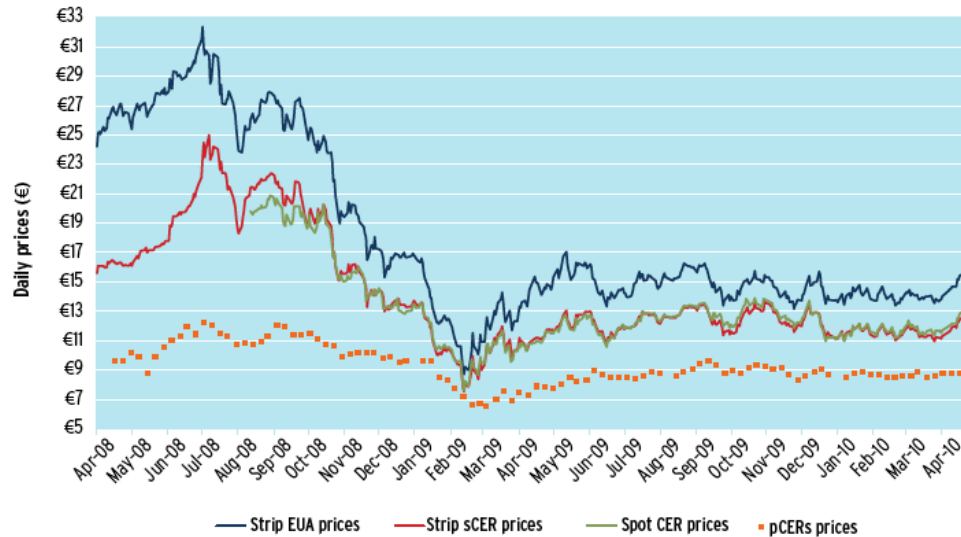


Figure 1: Price spread between EUAs and CERs. Source: World Bank, State of the Carbon Markets: 2010

in the European Emissions Trading Scheme (EU ETS) in which the price of offsets closely follows the price of allowances (referred to as CERs and EUAs in the EU ETS, respectively) (see Figure 1). The average spread between CERs and EUAs based on spot and 2012 futures prices is approximately 35%³⁴. Similar behavior has also been observed in the impending California cap and trade market in which eligible carbon offsets are trading at a discount to California Carbon Allowances (CCAs). The average spread observed in this market is approximately 24%³⁵. Due to these observations, the GreenTrees price forecast developed in this analysis assumes the price of GreenTrees offsets is pegged at a risk-adjusted rate to the potential federal carbon allowance price.

However, given that there is no present legislation, a second assumption incorporated into the price forecast is the presence of a voluntary market price. In 2012, the voluntary price of GreenTrees

^m Note that allowances refer to government-issued permits allowing the discharge of quantified emissions. Offsets may serve the same purpose but are in most cases issued by private companies and therefore do not carry guaranteed eligibility.

offsets is assumed to remain at the current offer price; however, this price is assumed to grow at a real rate of 5% per annum. Hence, this voluntary market price serves as a price floor for GreenTrees offsets.

Monte Carlo Model:

The Monte Carlo simulation is intended to simulate multiple scenarios based on variation within key parameters. The model makes the assumption that the GreenTrees offsets will not be eligible for a federal cap and trade program. However, as discussed above, the price of the GreenTrees offsets will inevitably be affected by the introduction of climate legislation. The model includes the following parameters:

- Federal carbon allowance price forecastsⁿ
- Probability of federal climate legislation^o
- Risk discount factor for compliance offsets^p
- Risk discount factor for voluntary offsets^q
- Voluntary carbon price forecast^r

Figure 2 below depicts the steps the model takes to simulate the prices. Each parameter is assigned distributions to provide variation in the model. The model calculates the price for each year between 2012 and 2024 based on whether or not the simulation has assumed federal climate legislation is present.

The model predicts a significant price escalation in GreenTrees offsets to occur around 2015-2017 as the probability of legislation being passed increases (see Figure 3 and Figure 4 below). The plateaus along the curves in Figure 3 and Figure 4 reflect the bimodal construction of the model. The LCO is predicated by two potential forecasts; the plateau in the curve reveals that these forecasts do not converge. Instead, this plateau region represents a LCO range that has very low probability of being realized. Thus, the intuition of the model is that the risk of price escalation of the GreenTrees offsets is highly dependent on the probability of legislation being enacted. The simulation predicts only a 35% probability that the LCO from Duke University's perspective will be less than \$6.00 in 2015 (see Figure 4).

n Forecast is average of following forecast analyses: Point Carbon, "US Carbon Price Forecast Update", Carbon Market Research North America, December 17, 2009; Synapse Energy Economics, Inc., "2011 Carbon Dioxide Forecast", Lucy Johnston, Ezra Hausman, Bruce Biewald, Rachel Wilson, David White, February 11, 2011.

o Probability of legislation was provided via expert testimony by Tim Profeta, Director of the Nicholas Institute, Duke University, on February 21, 2011. It is assumed for this model that any climate legislation passed will include some form of a carbon market. The size of the market will depend on the nature of the legislation (i.e., cap and trade vs. carbon tax). This potential size differential was not taken into consideration in the model.

p Discount factor is based on spreads observed in the EU ETS and in the California carbon market.

q Discount factor is based on spreads observed between the US voluntary market and the California carbon market.

r Base price reflects offer price from GreenTrees. Growth rate is assumed at 5% per annum.

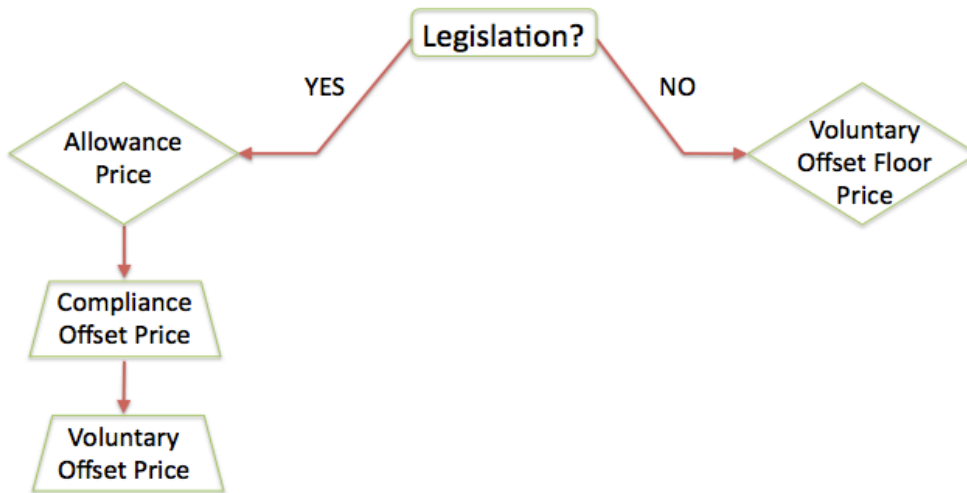


Figure 2: Monte Carlo simulation model framework

The mean and median predicted LCOs in 2015 are \$10.29 and \$7.43, respectively (see Appendix B for expected LCO mean, median, and coefficient of variation for full model time frame).

Recommendation to Duke University:

From a financial perspective, the GreenTrees project will best serve Duke University as a long-term investment strategy. The project offers a large volume of forestry offsets in annual intervals at a levelized cost of \$6.00 per offset, which is competitive with over-the-counter (OTC) prices for alternative forestry carbon projects (~\$8.50 per offset)³⁶. GreenTrees has also garnered support and investment from Duke Energy thereby bolstering the credibility of the project. The hurdle to investment for the Offsets Initiative is the high upfront investment required by GreenTrees. While the risk associated with the project has largely been mitigated, Duke University is still exposed to price fluctuations on the carbon market. The general intuition from the Monte Carlo model shows that the price of the GreenTrees offsets is expected to increase. This may indicate that GreenTrees will increase its investment offer terms if the Offsets Initiative decides to delay the investment thereby increasing Duke University's costs.

To mitigate this price risk, it is recommended the Offsets Initiative seek a real option from GreenTrees in order to lock in the current offer price while delaying Duke University's investment to a predetermined period in the future. Doing so will allow the Offsets Initiative to gain more certainty in

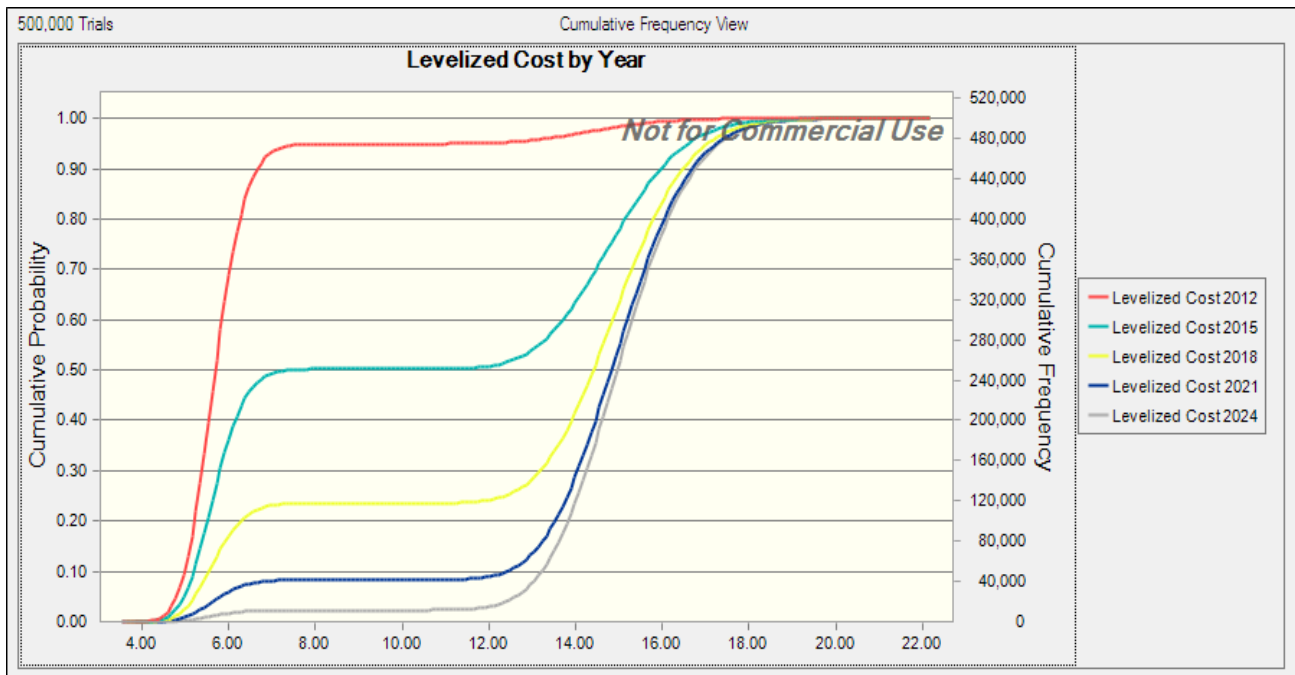


Figure 3: Monte Carlo overlay chart of various annual levelized cost probabilities

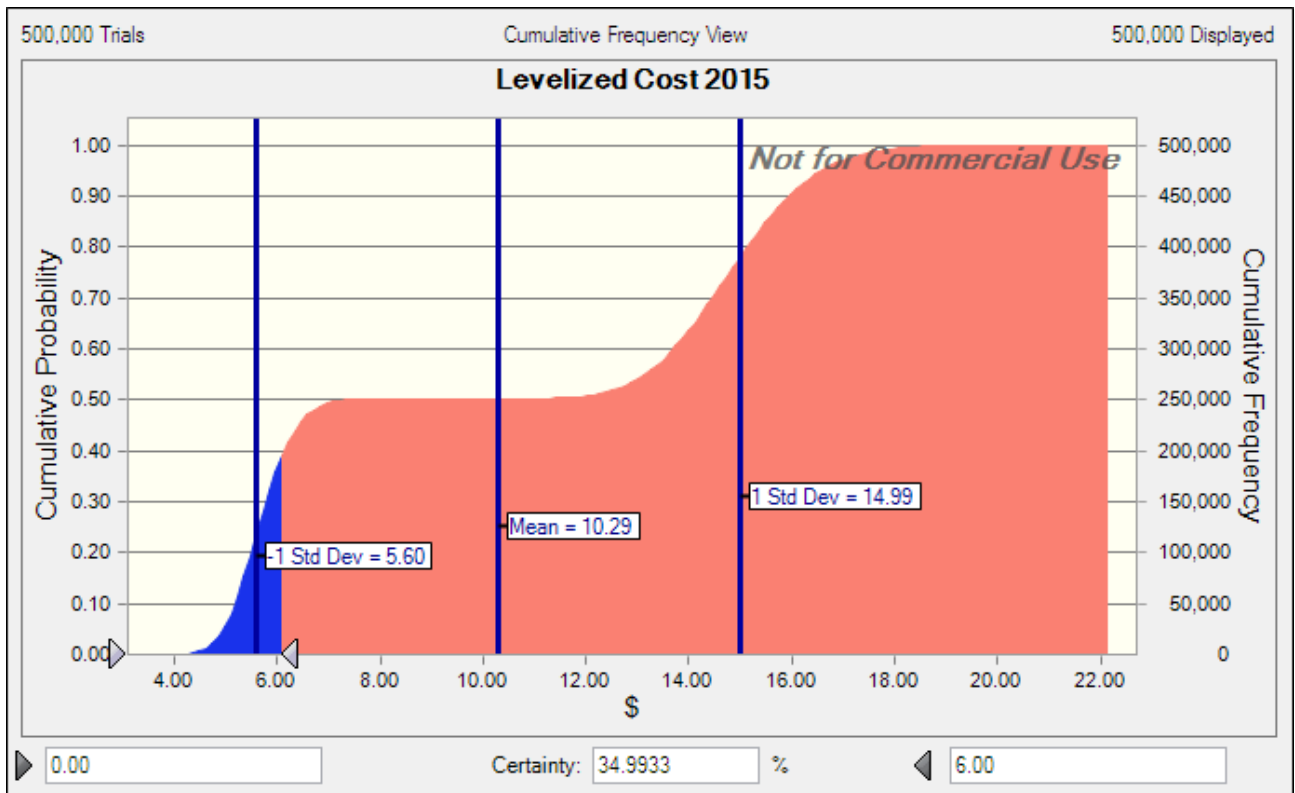


Figure 4: Price probability of levelized cost in 2015. Note that there is little increased cumulative probability for an LCO in the range of \$8.00-12.00.

regard to pricing for voluntary offsets, specifically GreenTrees offsets, and will have the option to purchase the offsets at today's offer price. Choosing the duration of this option will largely depend on how such an option is valued.

Real Option Pricing:

It is unclear how GreenTrees would set terms for an option; however, C₂I, Inc. has indicated a willingness to sell an option³⁷. Yet, before deriving a fair price for an option, the Offsets Initiative needs to decide what year the option should mature. Given that the Monte Carlo model predicts the price of the GreenTrees offsets will likely exceed the current levelized offset cost by 2015 (i.e., the LCO at today's offer terms, see Figure 3), it is recommended that the Offsets Initiative propose an option that matures no earlier than that year. Ideally, the option would mature in 2024; however, pricing such an option may be cost prohibitive⁵, or such an offer will likely be unacceptable to C₂I, Inc. Therefore, a maturity date of 2015 is used for this analysis.

A common valuation tool used to value options is the Black-Scholes model. This model is particularly adherent to financial options, which typically reflect liquid assets such as securities, and may be exercised only at the expiration date (i.e., European option). In contrast, a real option reflects an asset that may not be tradable or is not liquid and it may be exercised at any time before its expiration. Despite these discrepancies, Black Scholes or slight variations on the model have often been used to value real options. In this analysis, the standard Black Scholes model is employed; however, an annualized dividend yield (i.e., the flow of offsets) is factored into the model^t.

Assuming the Offsets Initiative and C₂I, Inc. agree to a 2015 option, the option may be priced by making assumptions for the following parameters:

- *Present value of underlying GreenTrees asset* (i.e., the value of the stock)
- *Initial investment cost to secure the asset* (i.e., the strike price)
- *Expiration date*
- *Market volatility* (i.e., GreenTrees offsets value fluctuation between today and the expiration date)
- *Risk-free rate*

For this valuation, the present value of the asset is the present value total investment cost discounted at 5.5% and represents the current stock value that Duke University would purchase through its

^s An option with a maturity of 12 years is valued at approximately 23% of the total present value investment cost, resulting in a LCO of approximately \$7.30. This additional cost may be permissible to Duke University; however, it is likely to be less probable for such an option to be offered by C₂I, Inc.

^t This variation of the Black Scholes model was developed by Professor Aswath Damodaran of the Stern School of Business at New York University. Available online:

http://pages.stern.nyu.edu/~adamodar/New_Home_Page/spreadsh.htm.

investment in the project. The initial investment to secure the asset is Duke University's first upfront payment. The time to the University's decision to invest or not is 4 years. Determining the actual volatility of the voluntary carbon market is very difficult due to numerous uncertainties. Similarly, it is difficult to assess what is a representative value for the risk-free rate given the current economic state that has biased the risk-free rate downwards. Estimating market volatility of 30% and a risk-free rate of 5%, the value of the option is approximately 12% of the total present value investment cost (sensitivity analysis for the option pricing was performed but has been omitted from this public version of the report). The purchase of the option would increase the approximate LCO to \$6.70. Despite the cost increase, the addition of the option does not make the GreenTrees investment uncompetitive when benchmarked against other OTC forestry offsets that trade near or above \$8.50. It should also be noted that modeling the value of the option can only provide an estimate of the option value; the actual price paid for the option will need to be negotiated between both parties.

CONSERVATION EASEMENT FLIP INVESTMENT

The Offsets Initiative has indicated a preference for catalyzing high quality carbon offset projects within the local vicinity. In terms of forestry projects, avoided conversion projects in the state of North Carolina potentially provide such an opportunity to meet the Offsets Initiative's project goals. Avoided conversion projects can have positive implications for not only carbon sequestration but also other ecological co-benefits. Additionally avoided conversion projects may be particularly attractive from a financial perspective. Due to state incentives for land conservation and the federal tax deductible charitable donation (described below), the Offsets Initiative may be able to catalyze its own carbon offset project at low investment costs. It should be noted that a single project may yield only a small volume of offsets throughout the life of the project. However, this supply may be scaled up to high yields by developing multiple projects throughout the state.

North Carolina Conservation Tax Credit and Federal Donation Tax Deduction:

The state of North Carolina implemented the first land conservation tax incentive mechanism in the US in 1983³⁸ through legislation that provides tax credits for entities that deed conservation easements on land. The North Carolina Conservation Tax Credit (CTC) program has been tremendously successful over its history and currently achieves approximately 85 easement donations each year at an average 11,500 acres per donation³⁹. Much of this success is attributed to the increase in tax credit value, which initially established at \$5,000 for both individuals and corporations has now risen to \$250,000 per individual and \$500,000 for corporations⁴⁰. Credits may be carried forward for five years but are not transferable⁴¹.

The tax credit value is derived from the value of the conservation easement. Easement values are determined by the difference between a pre-easement appraised value of the land and a post-easement appraised value of the land. The pre-easement appraisal is based on the highest and best use of the land, i.e., not appraised on the current use of the land but on what the maximum economic value of the land could obtain⁴². It is possible for the pre-easement appraisal value to be reduced as much as 90%⁴³ after imposing the conservation easement, as the easement must be issued in perpetuity to be eligible for tax shields⁴⁴. Therefore the easement may retain significant value. In North Carolina, the tax credit is valued at 25% the value of the conservation easement⁴⁵. Easement titles must be donated to qualified land trusts or proper state or local agencies. There are various methods to determine the eligibility of a conservation easement; however, it is common for the landowner to retain ownership of her land and continue or establish activities on the land deemed allowable by the easement⁴⁶.

In addition to the CTC, landowners wishing to pursue a conservation easement are also eligible for a federal tax deduction. Under the rules of the CTC mentioned above, the conservation easement must be donated and is therefore considered a charitable gift. The donated value of the conservation easement is eligible for a maximum 30% tax liability deduction from an individual's adjusted gross income; corporations may deduct 10%. Deductions may be carried forward for five years⁴⁷.

Key Players:

The conservation easement approach to forestry offsets involves six key players:

- Developer
- Tax Equity Investor
- Appraiser
- Regulator
- Qualified Recipient
- Certifier

Developer:

The project developer serves as management and is responsible for establishing and coordinating all aspects of the land purchase, appraisal process, easement establishment, relations with land trust, etc. The project developer also ensures the generation of carbon offsets and manages all resulting revenue streams. The incentive for the developer is ultimately the stream of carbon offsets for the life of the project. Therefore the developer is incentivized to see the project through to completion and understands it is responsible for managing all relationships with partners for the duration of the project.

In this scenario, the Offsets Initiative will serve as the developer. In addition to earning carbon offsets for the University's carbon neutrality goal, the Offsets Initiative may also derive additional, non-financial benefits from this project. First, the project may serve additional ecosystem services including water quality and habitat that will bolster biodiversity efforts. Additionally, developing its own project allows the Offsets Initiative to realize additional climate action goals of education and research. Therefore, the Offsets Initiative has multiple long-term incentives to ensure project success.

Tax Equity Investor:

The role of the tax equity investor is foremost to absorb eligible tax benefits. Due to Duke University's 501.c3 tax status, it is unable to utilize the tax credits and deduction earned through the donation of the land conservation easement. In order to receive the tax benefits, the tax equity investor must initially invest a majority equity stake in the project. The incentive for the tax equity investor is the return derived from the tax equity as well as a carried interest in the form of any other potential revenue streams earned from the project. The combination of the tax benefits and additional revenue streams will allow the tax equity investor to realize its required internal rate of return from the project.

Appraiser:

The land appraiser plays a small but crucial role in the project. The appraiser's pre-easement and post-easement appraisal values of the land ultimately establish the value of the tax equity. Therefore the appraiser will indirectly dictate the terms of the project financing and whether the project is financially feasible from the perspective of the Offsets Initiative and the tax equity investor.

Regulator:

Regulators will verify the validity of the transaction between the donation and tax credits/deduction. Hence, the regulators will examine that the easement meet required criteria. At the federal level, one of the following conditions must be met by the easement in order for the charitable deduction to be valid⁴⁸:

- Preservation of land areas for outdoor recreation or education for the benefit of the general public.
- Protection of a relatively natural habitat of fish, wildlife, plants or similar ecosystem.
- Preservation of open space, including farm and forest land, where such preservation will yield a significant public benefit either for 1) the scenic enjoyment of the general public; or 2) pursuant to a clearly delineated federal, state, or local governmental conservation policy.
- Preservation of a historically important land area, or certified historic structure.

Additionally, the easement must be given with “donative intent” in which there is no expectation for economic benefits resulting from the donation⁴⁹.

At the state level, the easement donation is subject to a certification review by the North Carolina Department of Justice and Department of Environment and Natural Resources. The certification review primarily focuses on the following questions⁵⁰:

Does the donation provide one or more of the following public benefits?

- Public beach access or use
- Public access to public waters or trails
- Fish and wildlife conservation
- Forestland or farmland conservation
- Watershed protection
- Conservation of natural areas as that term is defined in G.S. 113A-164.3(3)
- Conservation of natural or scenic river areas as those terms are used in G.S. 113A-34
- Conservation of predominantly natural parkland
- Historic landscape conservation

Does the instrument of transfer adequately protect/conserve public benefit(s)?

In 2010, 4 out of 103 CTC applications were rejected by the North Carolina Department of Environment and Natural Resources citing failure for the easement to provide public benefit as a result of inadequate protection and/or the site itself did not meet the program requirements⁵¹.

Qualified Recipient:

The CTC requires the easement be donated to a qualified recipient that can protect the conservation values of the easement and enforce restrictions on the property. Qualified recipients include state or local government agencies or qualified non-governmental organizations that can manage land for conservation purposes in perpetuity and are able to receive charitable contributions under G.S. 105-130.9⁵² (i.e., land trusts).

A qualified recipient may negotiate financing terms with the project developer to support required monitoring and management costs to ensure the property’s conservation value is maintained. These values can vary tremendously depending on the size and characteristics of the property (estimated costs range from \$10,000-\$100,000⁵³). In this scenario, it is expected that the Offsets Initiative will provide any financial support that is required to carry out these duties.

Certifier:

Upon established of the conservation easement, carbon generation will begin. The flow of carbon offsets, however, will vary based on what certifier is selected for the project. Buffer allocations may vary

among certifiers, which will affect the overall flow of offsets and final LCO. Moreover, avoided conversion projects often have a low carbon yield as the forest is typically mature. This causes certifiers to set very conservative baselines which also reduce the total flow of carbon and increase costs.

Analysis Methodology

To further analyze the costs and risks this hypothetical project poses to the Offsets Initiative, the following sections describe a potential financing structure based on tax equity derived from the conservation tax shields. This financing structure is modeled to determine the LCO and to identify any key risks. Finally, a recommendation is developed based on the findings of the model.

- Design project finance structure between Offsets Initiative and tax equity investor
- Simulate finance structure in an optimization model and determine minimum LCO via Solver
- Identify key risks and provide recommendation to mitigate risks

Financing Structure:

Both the North Carolina Conservation Tax Credit (CTC) and federal tax deduction can be used as tax equity financing mechanisms to develop an avoided conversion forestry project. Several variations of tax equity investments can be conceived; however, given Duke University's 501c3 status, the Offsets Initiative cannot utilize the tax equity. Therefore, the Offsets Initiative must identify a tax equity investor as a partner to finance the land acquisition. Below is a suggested financing framework that the Offsets Initiative could adopt (see Figure 5). The framework is adapted from renewable energy project finance structures that also leverage tax equity partners and have been highly successful for the past decade.

The creation of the project would begin with the formation of a subsidiary LLC^u established by the Offsets Initiative and the tax equity investor. The project finance structure around an LLC will allow for non-recourse action if the project fails. Both parties will contribute capital to purchase property, which will be held by the LLC. The vast majority of the upfront capital (up to 95%), however, will be provided by the tax equity investor. This unbalanced contribution allows for the tax equity to flow back to the investor after the easement is in place. It is assumed the investor will take all eligible tax equity in a single year. The Offsets Initiative will pay for all transaction costs associated with the easement appraisal process and donation to land trust as well as establishing the avoided conversion project (including all negotiated land trust fees, property taxes, and carbon offset certification fees).

^u An LLC is formed in order to establish a subsidiary that has no recourse to Duke University or to the investment partner. Structuring the subsidiary as an LLC simplifies the process for allocating the flows of tax equity and carbon offsets to each party. An LLC also allows for the creation of an internal partnership that will allow for carried interest payments (if required) as well as for exit terms and ownership flip.

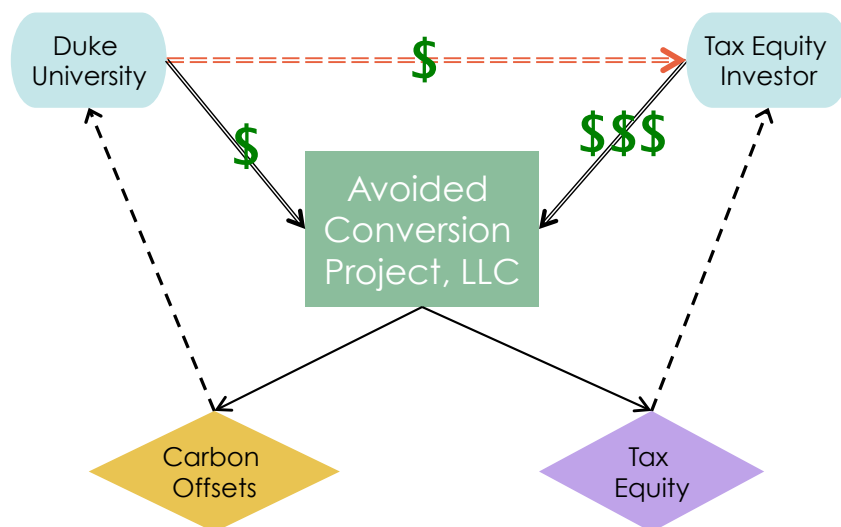


Figure 5: Tax Equity Project Finance Structure

Additionally, the Offsets Initiative may be required to make a carried interest payment (i.e., make payments for receiving offsets generated by the project) for a pre-determined amount of time at pre-determined price. This carried interest may be necessary for the tax equity investor to realize its desired rate of return. However, when the investor has realized its return, it will exit the partnership and flip all or the vast majority of its ownership in the LLC to the Offsets Initiative. The Offsets Initiative will terminate payment for offsets to the investor after the flip and retains full (or near full) ownership of land to continue sourcing offsets as well as any other services.

Optimization Model:

A model was developed to generate the LCO based on this financing structure. Key assumptions in the model are explained in Appendix C. Due to the numerous input parameters, the model was set up as an optimization and Solver was used to determine Duke University’s minimal LCO. In determining a solution to the model, it was noticed that a highly sensitive variable was the pre-easement appraisal value. In the model the pre-easement appraisal value is derived as a multiple of the input purchase price of the land (i.e., “Appraisal Factor” listed in Table 2 below). Therefore it is difficult to determine with certainty what the actual LCO will be from this project. Table 2 illustrates this sensitivity.

<i>Appraisal Factor</i>	2.5	2	1.5
<i>Duke Upfront Investment</i>	5%	5%	30%
<i>Land Price</i>	\$1,930,502	\$1,152,074	\$1,531,372
<i>Price per Offset to Investor</i>	\$0.00	\$0.00	\$0.74
Levelized Cost per Offset	\$4.75	\$6.33	\$16.73

Table 2: Varying LCO by appraisal factors. LCOs are averaged between high and low cost scenarios.

Recommendation:

The key risk identified in this model is the appraisal values, specifically the pre-easement level appraisal. Duke University's LCO could be as high as \$39.00 if the pre-easement level appraisal is not favorable and does not increase above the purchase price, *ceteris paribus*. A simple method to mitigate this key risk is to have the Offsets Initiative request a pre-appraisal performed before making any investment in property. The cost of having an appraisal performed is a low-cost option to obtain further certainty as to the value and feasibility of the project. Specifically, the Offsets Initiative will know upfront what the value the easement holds in terms of viable tax equity. This will allow for an immediate decision as to whether or not the project is financially feasible. Additionally, if a favorable appraisal is returned, the Offsets Initiative will be able to attract an investor more easily.

Further risks that could jeopardize the project implementation reflect the tax equity investor's appetite for risk. In order to mollify a risk adverse investor, the Offsets Initiative may offer to prolong its carried interest payment schedule and/or provide a guaranteed price floor for offset payments that will help ensure the investor realizes its required rate of return within a specified time frame.

CONCLUDING THOUGHTS

Both the GreenTrees afforestation investment and the avoided conversion project are potential long-term investment options to help fulfill Duke University's need for carbon offsets. However, as discussed below, both projects have significant differences in regard to Duke University's engagement and fulfilling the complimentary goals of the Offsets Initiative.

GreenTrees provides access to an established project that has a high credibility profile due to its investment incentive structure and due to the presence of its lead investor, Duke Energy. Moreover, the estimated LCO to Duke University is fair relative to substitute over-the-counter forestry offsets. And if Duke University allows for its climate policy to permit unconstrained banking of offsets, investment in GreenTrees can provide sufficient supply to meet the 2024 carbon neutrality target. However, GreenTrees requires a large upfront investment. Such a fee may be unacceptable to Duke University at this time due to financial constraints or uncertainty in carbon offset investments as was discussed above regarding price risk exposure. This high upfront investment and price risk may be mitigated through the purchase of a real option.

Additionally, the transaction is fairly simple and should require only a small amount of the Offsets Initiative's resources to initiate and maintain the contract terms. However, this also reduces

opportunities for the Offsets Initiative and Duke University to achieve non-financial goals such as research and education.

In contrast to GreenTrees, the avoided conversion project should not require a large upfront investment at the project level, as the tax equity investor will primarily finance the project. Duke University's overall investment could escalate if it decides to establish additional projects in order to increase the yield of offsets; however, the LCO will remain the same. The investment may be low-risk if a fairly accurate portrayal of the tax equity value can be established before the subsidiary LLC is formed. This will allow the Offsets Initiative to understand if the project is financially feasible, and if so, what the LCO will be. This in turn will facilitate identifying and recruiting a partnering investor.

A project of this nature, however, would place the majority of management responsibilities with the Offsets Initiative. These additional management costs are not reflected in the reported LCOs in Table 2. Nonetheless, accepting such management duties may allow the Offsets Initiative to achieve its non-financial goals such as local project catalyzation as well as achieving ecosystem co-benefits and the opportunity for research and education.

These projects must be balanced with other potential forestry investments and ultimately with the carbon offsets portfolio as a whole. Moreover, the Offsets Initiative must determine how the financial findings concluded in this report weigh against other non-financial and intangible factors considered in the forestry offsets feasibility study. However, based on the findings from the financial analyses in this report, procurement of forestry carbon offsets is feasible and may provide a reliable supply of offsets while also allowing Duke University to take an innovative leadership role in charting a path toward carbon neutrality that peer universities and colleges may emulate.

APPENDIX A: Risk categories for GreenTrees development

Risk Area	Type	Approach and Remedy
Project		
	Unclear Land Tenure	GreenTrees performs credit checks, title checks and does lien subordination (if necessary) on each landowner and land. In some cases, Green-Trees has turned away lands.
	Financial Failure	Land Contracts are between the landowners and the Series LLC. The investor in this Series is a long-established regulated U.S. utility company with a current Standard and Poors corporate credit rating of A-.
	Management Failure	Managers report to the Investor Committee and if there were to arise a problem, the investor committee would replace the manager.
Economic		
	Rising Land Opportunity Costs	Since GreenTrees records a deed restriction that runs with the title of the land, once the landowner is enrolled, the issue of rising land opportunity cost is not applicable to enrolled lands.
Regulatory and Social		
	Political Instability	Since the project is located in the United States and no civil wars have taken place in over 150 years, we deem this to be not relevant.
	Social Instability	The area has not seen riots or insurrection that we are aware of for at least 100 years.
Natural Disturbance		
	Devastating Fire	Due to the 60-90 inches of rain per year, the Mississippi Alluvial Valley has not seen a devastating fire. Given our lands are dispersed throughout the region, GreenTrees is well diversified.
	Pest or Disease	Stands are geographically dispersed and effectively independent of each other. In the region forestry is widely practiced and trees routinely grow to maturity. GreenTrees also has conservatively modeled in a .5% annual mortality rate to its carbon projections. GreenTrees sells offsets based on only a modest fraction of the potential sequestration and vigorous growth is maintained. If unprecedented high mortality did occur on one site, growth on other sites could replace the loss.
	Extreme Weather	Our particular silviculture withstands both floods and drought very well. In addition, since the lands are scattered throughout the Mississippi Alluvial Valley, the possibility is very remote that an extreme event would impact the whole pool of acres. Again, the diversity of the location of acres coupled with a projected annual mortality rate of .5% factored into GreenTrees underlying assumptions mitigate risks.
	Geological	The area is flat and not prone to landslides. It does flood and we are planting species that are adapted to this flooding and have already survived weeks of submersion in a test flooding.

Table adapted from GreenTrees MRV Protocol, 2010.

Appendix B: Monte Carlo LCO projections

<i>Year</i>	<i>2012</i>	<i>2013</i>	<i>2014</i>	<i>2015</i>	<i>2016</i>	<i>2017</i>	<i>2018</i>	<i>2019</i>	<i>2020</i>	<i>2021</i>	<i>2022</i>	<i>2023</i>	<i>2024</i>
<i>Mean</i>	\$6.17	\$8.15	\$9.30	\$10.29	\$10.97	\$12.14	\$12.83	\$13.48	\$13.95	\$14.29	\$14.55	\$14.73	\$14.87
<i>Median</i>	\$5.73	\$5.98	\$6.25	\$7.43	\$13.41	\$14.17	\$14.45	\$14.65	\$14.78	\$14.87	\$14.93	\$14.97	\$15.00
<i>Coefficient of Variation</i>	0.33	0.50	0.49	0.46	0.43	0.36	0.32	0.27	0.23	0.20	0.17	0.15	0.13

Appendix C: Tax equity project finance model assumptions:

- Price per acre is \$3,500 based on advertised market values in primarily rural western North Carolina
- Carbon offsets received per acre is equal to 5
- Project life is 100 years
- Buffer allocation is 15% that is reduced to 10% starting in year 16
- Costs to establish and maintain easement as well as to certify the avoided conversion project are analyzed at a high and low range
- Duke University discount rate is 5.5%
- Investor discount rate is the market return, i.e., 7.0%
- Investor required internal rate of return is 12%
- Project tax equity is available in year 2
- All tax equity is taken in a single year
- Carbon offsets begin generating in year 3
- Carried interest (if required) for offsets occur for 10 years
- Federal corporate tax rate is 35%

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