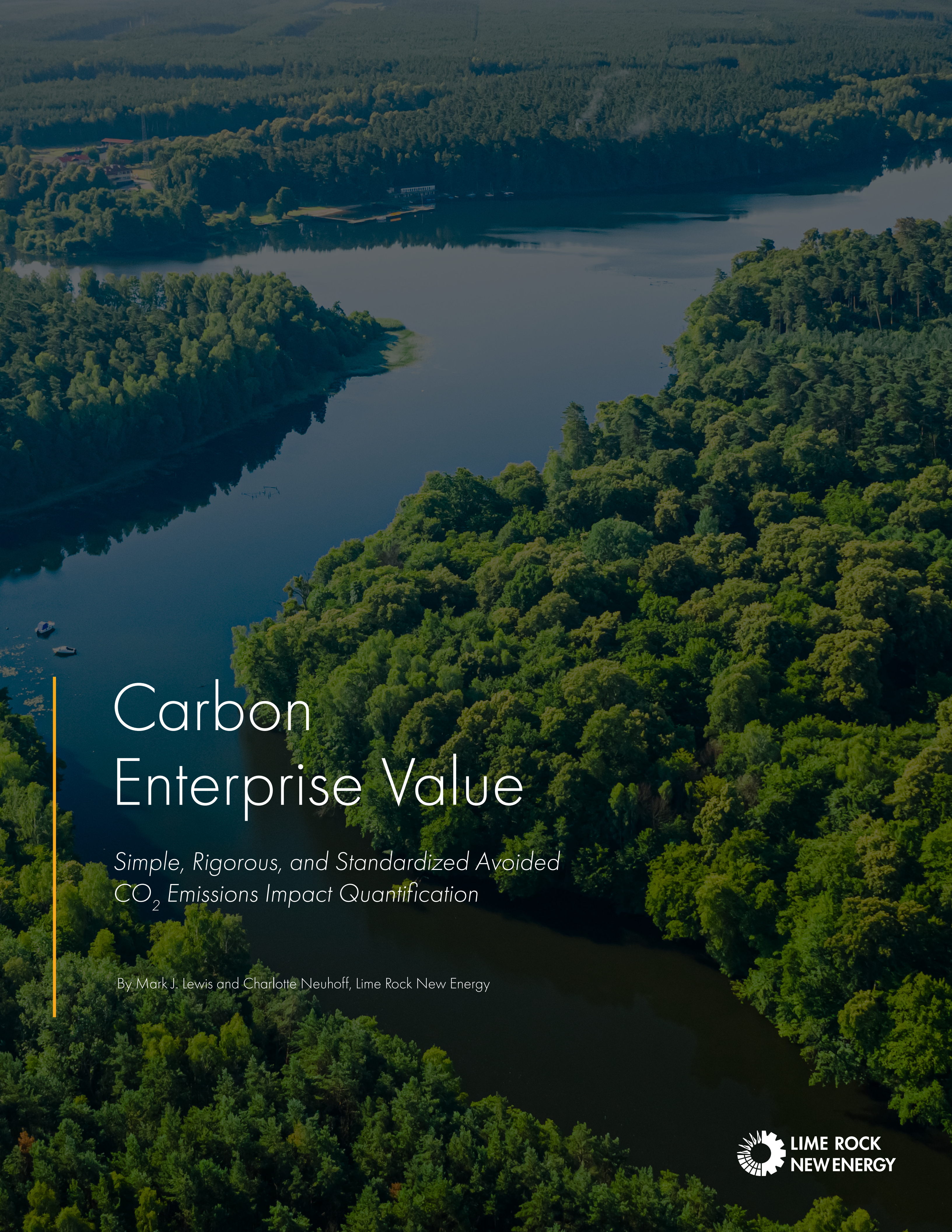


Carbon Enterprise Value

Simple, Rigorous, and Standardized Avoided CO_2 Emissions Impact Quantification

By Mark J. Lewis and Charlotte Neuhoff, Lime Rock New Energy

LIME ROCK NEW ENERGY

The Problem:

Current Methods for Reporting Carbon Emissions Avoidance (aka Scope 4 Emissions) are Confusing and Inconsistent

As a climate-focused investor, Lime Rock New Energy is dedicated to deploying growth equity capital in businesses delivering products or services that help reduce greenhouse gas emissions, particularly carbon dioxide (CO_2) emissions. But simply avoiding emissions is only part of the battle. Accurately quantifying the avoided carbon emissions resulting from the use of a product or service versus the traditional solution, or the counterfactual, is critical. We are strong believers in the adage that you cannot fix or improve what you don't measure. To properly understand and communicate the impact that the dollars we invest have on the climate, we believe that carbon emissions avoidance analysis should be based on real world data combined with objective, independent assumptions. Our challenge has been identifying and implementing a measurement and reporting approach that we felt was sufficiently rigorous and that wasn't reliant on "fat thumb" estimates and assumptions.

Many competing and often conflicting methodologies have been developed to quantify avoided carbon emissions (sometimes referred to as Scope 4 emissions). These methodologies use varying degrees of analytical rigor and verifiable assumptions, the results of which are generally not easily comparable. This makes it almost impossible to understand what different carbon emissions avoidance reporting numbers mean. We have heard this concern from our limited partners, other investment firms, corporates, and academics who also struggle with clearly measuring, managing and, critically, comparing the emissions impact that a business delivers. This has understandably led to confusion and skepticism about the accuracy and usefulness of emissions reductions calculations and reporting, providing fodder to climate and energy transition skeptics who would dismiss CO_2 emissions avoidance efforts as mere "greenwashing".

The Challenge

We sought to develop an approach to quantifying avoided CO_2 emissions that largely avoids the subjectivity found in other methodologies, can be easily adopted by impact practitioners, and can be understood by technical and non-technical audiences alike. Our key criteria included that the approach be:

- Simple and easily understood yet methodologically rigorous;
- Quantitatively focused with clear, independently developed, and objective assumptions;
- Consistent with the fact that carbon emissions avoided today have a greater impact (i.e., value) on the climate than carbon emissions avoided at some future date;
- Based on and measured against a counterfactual (the conventional alternative to the lower or no-carbon product or service offered), and;
- Comparable across companies.

Our Solution:

Carbon Enterprise Value

Faced with this challenge, we hit upon the idea that there is already a widely accepted model that incorporates the criteria we note above, albeit used for a different purpose. This model is the discounted cash flow model, or DCF. In corporate finance theory and practice, a DCF is used to value a business by calculating the sum of future cash flows discounted back to a present value. This present value of future cash flows is commonly termed the "enterprise value" of the business. The riskiness of a business' future cash flows, and hence the present value of the business, is determined in part by using two key assumptions: the discount rate (with a higher discount rate reflecting a higher degree of risk and uncertainty) and the assumed exit multiple or perpetuity growth rate, to capture the value of future cash flows beyond the forecast period (generally 5 or 10 years). It occurred to us that the same logic could be applied to future avoided carbon emissions "flows" resulting from the use of the company's products or services relative to the counterfactual. The insight of treating avoided carbon emissions in a manner similar to cash flows underlying the enterprise value of a business led us to develop the concept of Carbon Enterprise Value (CEV).

Analogous to a discounted cash flow model, we view the avoided annual "flows" of CO_2 emissions as another valuable asset generated by the climate-focused companies in which we invest. As with cash flows received today versus those received in 5 or 10 years, avoided carbon emissions achieved today are inherently more valuable than those achieved in the future due to the cumulative damage caused by CO_2 in the atmosphere. The simple idea behind CEV is to treat these future, uncertain avoided CO_2 emissions in the same way that future, uncertain cash flows are valued - a "discounted carbon flow" model. Given that the carbon emissions avoidance resulting from the use of a climate-related company's products or services is directly tied to the sales of those products or services, the inherent riskiness of future carbon savings should be strongly correlated to the riskiness of future sales and therefore cash flows. This implies that the discount rate (which is the primary tool used to incorporate the riskiness and uncertainty of future revenues and cash flows in the valuation of the company), and the terminal multiple or perpetuity growth rate for avoided carbon emissions should be the same as those used to discount cash flows for a particular business. Logically, we can use this concept to discount the expected future carbon emissions reductions from the use of the product or service sold by a company to determine the "carbon net present value" of carbon emissions avoided in metric tonnes of CO_2 emissions avoided both as a total carbon enterprise value as well as on an annual and cumulative basis. CEV also automatically incorporates the carbon emissions avoidance of a product or service based on its expected useful life, while reflecting the fact that the product or service may not reach its full expected useful life and therefore deliver lower carbon savings.

Breaking Down the CEV Concept into its Components

Using the methodology described above, we determined three separate yet interrelated impact metrics: Carbon Enterprise Value, Annual Carbon Emissions Avoidance, and Cumulative Carbon Emissions Avoidance. In this section we will explore the three key components of CEV and how they are used. We will then dive into an example of the actual calculation of these three components.

01 Carbon Enterprise Value (CEV)

CEV is determined using many of the same underlying assumptions as the calculation of a company's financial Enterprise Value. The expected units of products or services sold, the discount rate, and the terminal multiple or perpetuity growth rate are all the same estimates as those used in the company's financial model due to the correlation between carbon emissions avoidance and financial success for climate-related companies. Other key components of this calculation include the annual carbon emissions avoided per unit sold and the useful life of that unit.

LRNE calculates the CEV for a portfolio company at the time of the initial investment. Much like the valuation of a company, CEV is generally updated only if there are material changes in the future forecasts of the business (whether positive or negative). This generally one-time calculation also allows investors to understand the enterprise-level avoided CO_2 emissions impact potential of an investment standalone as well as compared to the rest of a portfolio of investments. Of course, investors looking for a more up-to-date estimate can update the CEV as often as they wish to reflect changes in the outlook for a business.

02 Annual Carbon Emissions Avoidance

The calculation of annual carbon emissions avoidance for units sold in a specific year uses the same logic as the overall CEV, except it only values the expected lifetime carbon emissions avoidance of the products or services sold in a single year. The expected impact of the products or services sold in that year is forecast over their useful life and then discounted back using the same discount rate as is used for the CEV. Because the avoided carbon flows are discounted over the entire useful life of the product or service, no terminal value is required for this calculation. For example, for a product with an expected 5-year useful life you would calculate the NPV of the carbon savings achieved over that 5-year period, with no terminal value. The same logic would apply to a longer useful life of 10 or 20 years, or even longer.

03 Cumulative Carbon Emissions Avoidance

The cumulative carbon emissions avoidance for units sold during LRNE's ownership period can be used to determine our fund's total impact from initial investment until exit. The cumulative carbon emissions avoidance is calculated each year using historical product or service volumes sold in addition to the current year's unit sales volumes. Because we know that the historical product volumes are "in the field" and delivering on carbon emissions avoidance, we can treat prior carbon emissions avoidance on a present value basis as well, essentially "undiscounting" those avoided carbon flows to account for the fact that the avoidance has in fact occurred. This results in a higher NPV of CO_2 emissions avoided for products and services sold in prior years due to the carbon emissions avoidance already achieved.

Going Deeper:

Carbon Enterprise Value in Practice

Below we walk through a step-by-step calculation of Carbon Enterprise Value using placeholder assumptions. You can follow along with the calculations through our CEV Calculator.

Step 1: Determine the Company's Impact Pathways

The foundation of CEV is the impact pathway(s) by which the company's products or services reduce CO_2 emissions relative to the counterfactual. An example of carbon emissions avoidance relative to a counterfactual would be the installation of a new 100 MW solar facility. The counterfactual would be meeting power demand via increased power generation using the existing generation mix in a particular country or state, rather than building this new solar project. The solar project would generate no carbon emissions when in operation (ignoring the embedded carbon from the manufacture of the panels, racking, etc. – purely generation source as compared to another generation source), whereas the existing generation mix may emit anywhere from <0.227 MT CO_2/MWh (in nuclear or hydroelectric-heavy regions) to as much as >0.907 MT CO_2/MWh (in coal-heavy regions). According to the EIA[1], in 2021, U.S. power generation averaged 0.388 MT CO_2/MWh[2]. Given this, we now know that if we were to use the average carbon intensity of the U.S. power generation mix, the new solar project will avoid 0.388 MT CO_2 for every megawatt-hour of power that it produces over its useful life, which is typically 20-25 years. If we were evaluating this hypothetical solar project as an investment, we would look for a counterfactual that is more relevant than a national carbon intensity figure, more likely at the state level at a minimum and ideally within the state or region where the project will be built.

[1] https://www.eia.gov/tools/faqs/faq.php?id=74&t=11

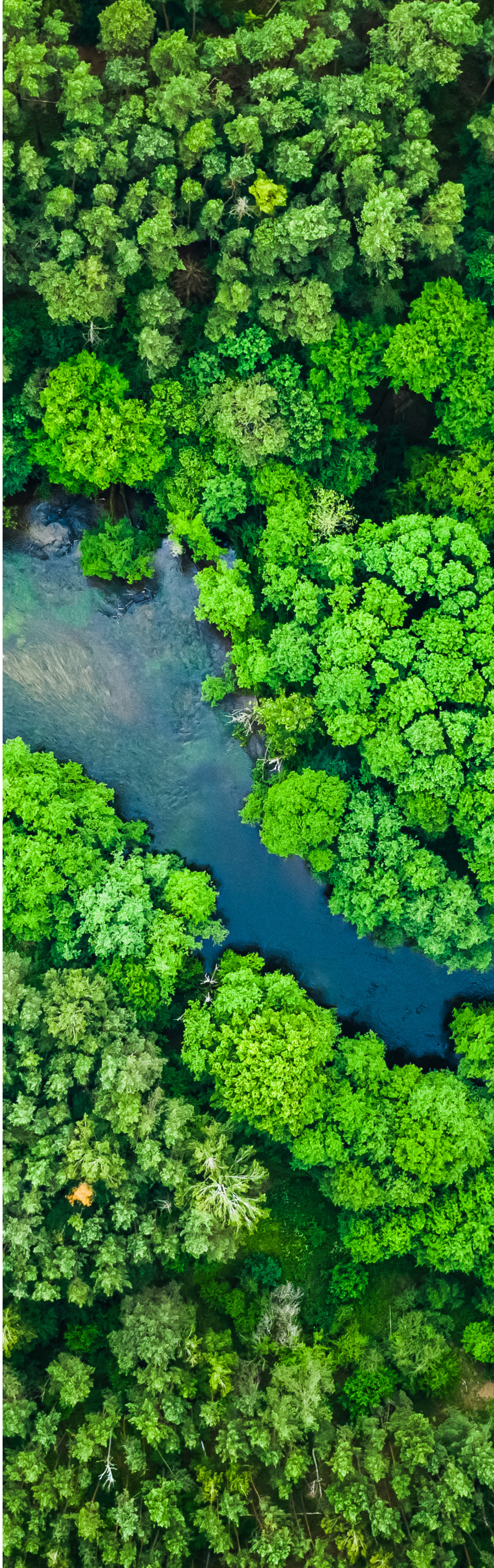
[2] 0.388 MT CO_2/MWh represents the 2021 power grid generation mix. In this example, as the generation mix in a particular geography can and does change over time, to yield results that most accurately reflect the then current generation mix CEV should be periodically recalculated to reflect the decarbonization of the grid over time.

Step 2: Assemble Inputs and Assumptions

Our conviction about CEV comes from the strong conceptual and actual connection between the assumptions driving the calculation of CEV and the financial model. Below, we have highlighted each assumption and source used in our CEV calculation.

Assumption	Source
Annual and Forecast Units Sold	Company financial model[3]
Annual CO_2 Emissions Avoided / Unit of a Product or Service Sold	Ideally sourced from industry or academic research, government data, or other credible, independent third-party sources. In our example in Step 1 above, the 0.388 MT CO_2/MWh was sourced from the Energy Information Administration
Discount Rate	Company financial model
Useful Life of a Product or Service (Years/Unit)	Company financial model
Valuation Date	Date of Initial Investment (CEV) Year End (Annual & Cumulative Carbon Emissions Avoidance Calculations)
Perpetuity Growth Rate or Terminal Multiple	Company financial model

[3] This may be the company's financial model, or it may be an investor-generated model used for investment purposes. To ensure consistency, the CEV calculation should be based on the same model that the company or investor is using to forecast the financial results of the business.



Step 3: Calculate the Company's Carbon Enterprise Value

The calculation of CEV begins by determining the expected units sold on an annual basis throughout the expected investment holding period. This direct link between our CEV calculation and our financial model, through the forecast revenue and unit sales projections, illustrates the logical correlation between financial success and increased carbon emissions avoidance. An example of a 5-year forecast for units sold is highlighted below:

	2023	2024	2025	2026	2027
Units Sold	100	200	300	400	500

Next, we calculate the NPV of the carbon flows for each unit. The NPV calculation relies on a few key inputs: the expected CO_2 emissions avoided annually per unit, the discount rate used in our financial model, and the useful life of the unit. The NPV of Carbon Emissions Avoided / Unit is then calculated by simply adding up the PV of Annual Carbon Emissions Avoidance for the entire useful life of the product, in this case 5 years. As is the case with future cash flows for this hypothetical business, the NPV of future carbon flows declines in the outer years, given the higher uncertainty of these estimates.

Assumptions

20% Discount Rate	**100** Annual CO_2 Emmisions Avoided/Unit (MT)	**5** Useful Life of Unit (Years)
12.31.23 Valuation Date	**10%** Perpetuity Growth Rate	**10x** Terminal Multiple

For simplicity, we have not used a mid-year convention for our DCF analysis.

	2023	2024	2025	2026	2027
Units Sold	100	200	300	400	500
NPV of Cabon Emissions Avoided / Unit (MT)	359	299	249	208	173
NPV of Avoided Carbon Flows	**35,887**	**59,812**	**74,765**	**83,073**	**86,543**
Years Since Valuation Date	0	1	2	3	4
Discount Factor	1.00	0.83	0.69	0.58	0.48
PV of Annual Carbon Emissions Avoidance	100	83	69	58	48

Finally, we calculate the terminal value of our investment, using either the perpetuity growth rate or the terminal multiple method (depending on which assumptions were used in our financial model). The terminal value calculation employs the NPV of Carbon Emissions Avoidance Flows projected in the year before exit – the same logic used in a DCF model. Both terminal methodologies are highlighted below for reference.

Carbon Enterprise Value: Perpetuity Growth Rate

(CO_2 Emissions Avoided in MT)

	2023	2024	2025	2026	2027	Terminal Value @ 10% Perpetuity Growth Rate
Units Sold	100	200	300	400	500	5,500
NPV of Cabon Emissions Avoided / Unit (MT)	359	299	249	208	173	173
NPV of Avoided Carbon Flows	**35,887**	**59,812**	**74,765**	**83,073**	**86,534**	**951,873**

Carbon Enterprise Value	**1,291,944**

Carbon Enterprise Value: Terminal Multiple Method

(CO_2 Emissions Avoided in MT)

	2023	2024	2025	2026	2027	Terminal Value @ 10.0x Terminal Multiple
Units Sold	100	200	300	400	500	5,000
NPV of Cabon Emissions Avoided / Unit (MT)	359	299	249	208	173	173
NPV of Avoided Carbon Flows	**35,887**	**59,812**	**74,765**	**83,073**	**86,534**	**865,339**

Carbon Enterprise Value	**1,205,411**

This completes the one-time calculation of our portfolio company's CEV. By using the same methodology across portfolio companies, we can develop a consistent, easily comparable "common size" approach to carbon emissions avoidance across our entire portfolio.

Step 4: Calculate the Company's Annual Carbon Emissions Avoidance

A company's annual carbon emissions avoidance from units sold follows a similar calculation to the CEV, but only for the useful life of products or services sold in that year alone. Using the NPV of Carbon Emissions Avoided / Unit as calculated in Step 3, we can then multiply it by the units sold in that year to determine the total carbon emissions avoided throughout the useful life of the company's units sold in that year. For example, if a company sold 100 units in Year 1, the company's lifetime carbon emissions avoidance of units sold in Year 1 would be equal to calculation outlined to the right.

Annual Carbon Emissions Avoidance

(CO_2 Emissions Avoided in MT)

	2023
Units Sold	100
NPV of Cabon Emissions Avoided / Unit (MT)	359
NPV of Avoided Carbon Flows	**35,887**
Annual Carbon Emissions Avoidance	**35,887**

Step 5: Calculate the Company's Cumulative Carbon Emissions Avoidance

The cumulative carbon emissions avoidance value for units sold (typically during the course of LRNE's investment holding period) is calculated in a similar fashion to the annual carbon emissions avoidance value. As outlined above, the cumulative carbon emissions avoidance calculation "undiscounts" carbon emissions avoidance that has already occurred in the past since these avoided carbon flows have already happened. To illustrate what this looks like in practice, the calculation to the right highlights what the carbon emissions avoidance calculation looks like for a company that has had units in the field from 2021-2023.

Cumulative Carbon Emissions Avoidance: 2021-2023

(CO_2 Emissions Avoided in MT)

	2021	2022	2023
Units Sold	25	50	100
NPV of Cabon Emissions Avoided / Unit (MT)	453	411	359
NPV of Avoided Carbon Flows	**11,319**	**20,532**	**35,887**

Cumulative Carbon Emissions Avoidance	**67,739**
Annual Carbon Emissions Avoidance	**35,887**

A key part of this calculation is intended to properly account for carbon emissions that have definitively already been avoided by the product, again relative to the counterfactual. In the example above, we assume that each year a unit avoids 100 MT of CO_2. If a unit is in year 3 of emissions avoidance by 2023, it therefore has already avoided 200 MT of CO_2 for its first 2 years in deployment. This explains the higher NPV of 411 MT of CO_2 for the unit that has already been in the field for 2 years, compared to units sold in the current year which have yet to avoid carbon emissions. The example shown below breaks down the NPV of Carbon Emissions Avoided/Unit calculation in 2023 for a unit sold in 2022, which has been accredited for two years' worth of carbon emissions avoidance to date.

	2022	2023	2024	2025	2026
Units Sold	50				
NPV of Cabon Emissions Avoided / Unit (MT)	**411**				
NPV of Avoided Carbon Flows	**20,532**				
Years Since Valuation Date	(1)	0	1	2	3
Discount Factor	1.00	1.00	0.83	0.69	0.58
PV of Annual Carbon Emissions Avoidance	**100**	**100**	**83**	**69**	**58**

Step 6: LRNE Attribution to Carbon Enterprise Value

Within each of these three components of CEV process, LRNE determines our fund's attributable carbon impact via our ownership percentage in each portfolio company. For example, assuming our ownership percentage in a company was 40%, we would therefore attribute 40% of the carbon emissions avoided to LRNE's carbon impact for that year. This logic applies for CEV, Annual Carbon Emissions Avoidance, and Cumulative Carbon Emissions Avoidance alike. We do not, however, assume credit for any emissions reductions from the company prior to our ownership.

The Logic Behind the CEV Discount Rate

From our experience, the discount rate has been the main source of questions about the CEV approach to quantifying carbon emissions avoidance. It is an understandably fraught topic as many practitioners view high discount rates as an obstacle to their ability to demonstrate large carbon emissions reductions. Our philosophy, however, is that we are not solving for a (large) number or target, but rather for expected CO_2 emissions reductions numbers that are realistic and reflective of the true risk-adjusted impact that the business has on the environment as best we can estimate it.

LRNE's approach is to use the same discount rate (and exit multiple or perpetuity growth rate) in our CEV model as the discount rate used in our financial model for a particular business. In the example shown above, we have used a 20% discount rate given it is reflective of typical private equity target returns, equating to roughly a 2.5x ROI over a 5-year investment horizon.

While a 20% discount rate may seem overly punitive compared to the 3%-7% applied to other carbon metrics like the Social Cost of Carbon, we view this discount rate as logical, consistent, and most importantly, reflective of the risk of future emissions reductions achieved through the use of the company's products or services for the following reasons:

01

The expected riskiness of a company's financial forecast and its unit sales forecast, and thus the riskiness of achieving the forecast unit sales of products or services, is generally highly correlated. By logical extension, the discount rate by which you are "judging" the riskiness of future cash flows should also reflect the riskiness of future unit sales. As a company matures the discount rate used to value the business generally decreases due to its lower overall risk profile, thus reflecting increased confidence in the company's ability to achieve both its financial and carbon emissions avoidance goals.

02

The expected useful life of a product or service is not necessarily a given. While a product may technically be able to function for its entire useful life, it may malfunction or be replaced by an improved technology before it reaches the end of its expected life. A good example of this is first-generation smart meters, many of which are being replaced well before their expected 20-year useful life due to technology advancements. The use of a higher discount rate reduces the "value" of emissions avoidance 10 or 15 years in the future, thereby accounting for the riskiness that a particular technology may not reach its full intended service lifespan.

03

Related to the point above, carbon not emitted today is inherently more valuable than emissions avoided 5 or 10 years from now. Carbon emitted today is far more impactful to the climate than carbon emitted one or two decades from now due to the cumulative impact of the heat-trapping properties of CO_2 in our atmosphere. Once in the atmosphere, CO_2 emitted today will continue to trap heat for a century or longer. Near-term action to reduce CO_2 emissions is critical if we are to reach the targeted Paris Climate Agreement goals of limiting global warming to 1.5 degrees Celsius.

Using CEV to Quantify Investment Life Cycle Impact

As growth equity investors, we measure financial success through the multiple of our invested capital, or MOIC. The same logic can also be applied to CEV to contextualize the return on our impact through the investments we make. By comparing the CEV at the entry and exit points of an investment, investors can quantify the increase in the CEV, and therefore impact, created during the hold period for a particular investment – a Multiple of CEV.

Applications Beyond Climate-Focused Growth Equity

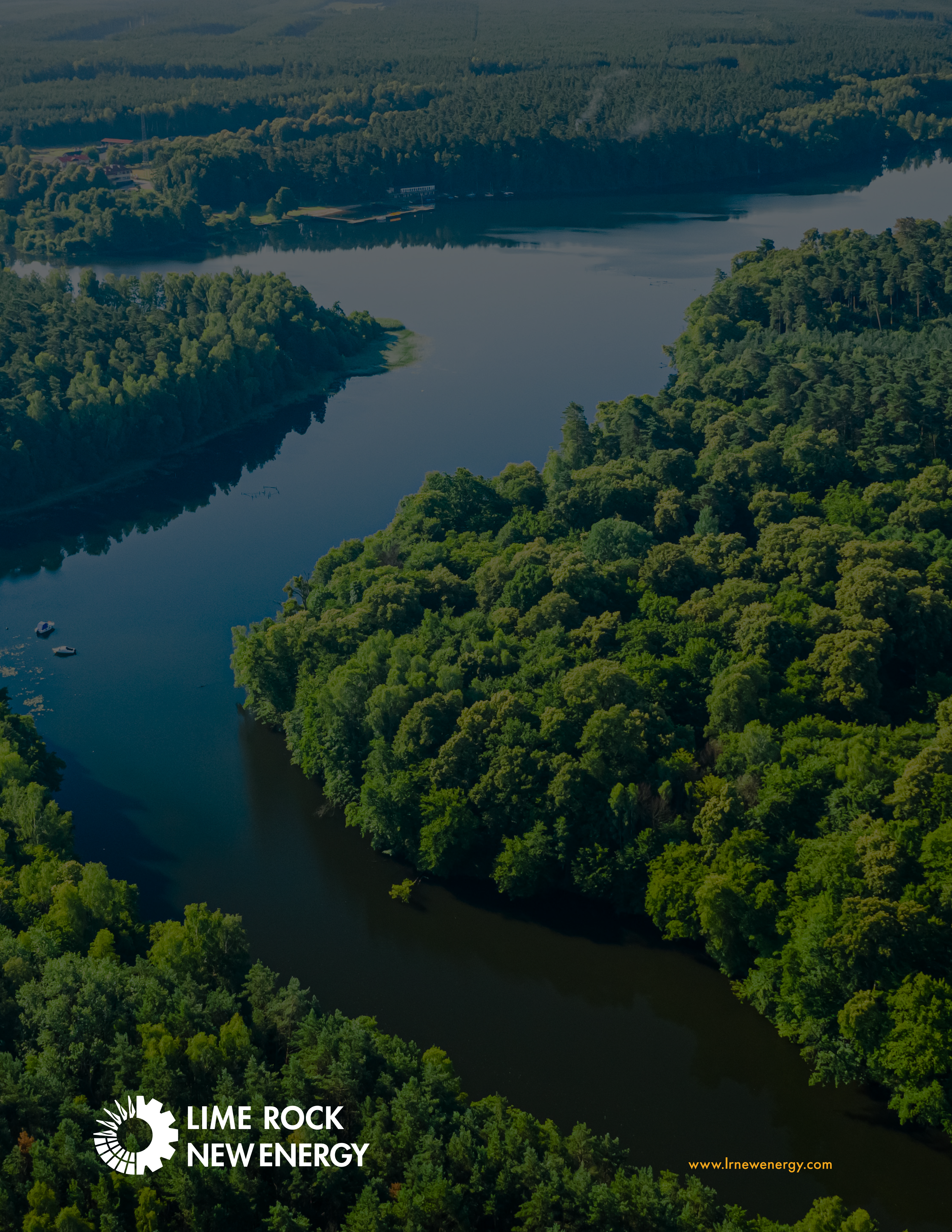
While this white paper has highlighted how LRNE uses Carbon Enterprise Value in our investments, we recognize that there are a variety of opportunities to utilize the concept beyond climate-focused growth equity. Theoretically, the CEV concept can be used by investors investing at earlier or later stages than LRNE, or any company whose products or services have a direct impact on carbon emissions relative to the counterfactual. Examples may include traditional infrastructure investors, venture capital investors, discrete projects such as reforestation or carbon capture projects, or large corporations with product lines delivering carbon emissions avoidance. It is worth noting that for investors or project developers/owners who have different investment and risk profiles than LRNE key inputs such as the discount rate must be adjusted according to the nature of the product or project. For example, a 20% discount rate is unlikely to be appropriate for a utility-scale solar project with a 20-year power purchase agreement with an AA-rated offtaker. In this case, a single digit discount rate will be more appropriate, reflecting the maturity of solar power technology today, as well as the relatively high degree of certainty that the project will continue to deliver power for the full 20 years given the offtake agreement.

Conclusion

Lime Rock New Energy is excited to share our approach towards measuring carbon emissions avoidance and to introduce the Carbon Enterprise Value concept. We believe using the same scrutiny, thoughtfulness, and quantitative mindset for both financial analysis and carbon emissions avoidance calculations yields a more rigorous, defensible, and useful measurement of carbon emissions avoidance. We also want to be sure to highlight what CEV is not, which is infallible. Like any forecasting model, CEV is only as good as the inputs that go into the model. If forecast sales growth and unit sales fall far short of expectations, the CEV of the business is going to come up short as well.

We have benefitted from the input, thoughts, and challenges to our own thinking on this topic from many practitioners and users of impact data in the development of the CEV concept and we are grateful for this collaboration. While there are too many individuals who have encouraged, challenged, and supported us in the development of the CEV concept to list here, we would like to acknowledge the invaluable contributions of Remy Garderet of UpMetrics and Stephanie Kater of Bridgespan Social Impact.

If you have any comments or questions, please contact Mark Lewis at ml@lrnewenergy.com or Charlotte Neuhoff at cneuhoff@lrnewenergy.com. We look forward to continuing the discussion and working to solve the climate crisis.



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