

# A Historical Exit-Based Cash Flow Approach to Valuing pre-revenue Direct-Air-Capture (DAC) Start-Ups

**Arnab Sinha**

Novonanmek Material Sciences Private Limited

**Abstract:** *Valuing early-stage, pre-revenue companies, particularly those in the nascent field of Direct Air Capture (DAC), is a formidable challenge. These companies often find themselves in pre-pilot, pre-revenue stages, making traditional valuation methods less applicable. However, this paper presents a pioneering valuation methodology tailored to address this challenge. Drawing inspiration from the remarkable exit event of a 15-year-old startup in the same industry, we illuminate a path for valuing early-stage DAC companies. By leveraging this historical reference, we navigate the complexities of assessing potential value in a landscape dominated by pre-revenue startups, offering a vital tool for stakeholders, investors, and enthusiasts seeking to understand the promise of this emerging field. It is important to note that this analysis serves as a starting point for further valuation exploration, recognizing that the dynamic nature of startups may require ongoing assessments and adjustments.*

## 1. Introduction

Valuing early-stage, pre-revenue companies, particularly those operating in pioneering fields like Direct Air Capture (DAC), poses a formidable challenge. Novonanmek Material Sciences Private Limited, a dynamic 4-year-old startup, finds itself among these companies, striving to quantify its potential amidst a landscape characterized by pre-pilot, pre-revenue stages. In this context, the valuation problem is accentuated, demanding innovative approaches. The emergence of Carbon Engineering, a 15-year-old stalwart in the same industry, with its remarkable exit event, has illuminated a path for assessing the value of early-stage DAC companies. It is important to note that Novonanmek Material Sciences, like most DAC companies, is pre-revenue and in its early stages with limited revenue, making traditional valuation methods less suitable. This paper introduces a groundbreaking valuation methodology, inspired by Carbon Engineering's success, designed to navigate the intricacies of valuing companies like Novonanmek Material Sciences Private Limited, and in doing so, offers a valuable resource for stakeholders, investors, and enthusiasts seeking to unlock the potential of this burgeoning field.

## 2. Valuation Approach

The valuation approach in this paper is referred to as a "Market Comparable Valuation" or "Market Approach." In a Market Comparable Valuation, the value of the subject company (in this case Novonanmek) is estimated by comparing it to similar companies in the market that have been sold or publicly traded. This method assumes that the market price of similar companies reflects the fair value of the subject company.

The method described here for valuing Novonanmek Material Sciences Private Limited, a 4-year-old startup based on the exit valuation of Carbon Engineering, a 15-year-old similar startup is derived from fundamental principles of financial analysis and valuation. It combines elements of benchmarking, delta factor analysis, and discounted cash flow (DCF) techniques to estimate the value of the younger startup. Delta Factor is the factor determining the degree of difference between the benchmark company and the subject start-up.

Here's why this method has been developed and how it can be useful:

- **Lack of Direct Comparables:** In the world of startup valuation, finding direct comparable companies can be challenging, especially when dealing with early-stage startups. Often, there aren't many startups with identical characteristics and financials to use as benchmarks. This method provides a way to estimate the value of a startup by indirectly comparing it to a similar but older and more established company.
- **Accounting for Maturity:** Startups evolve over time, and their valuations change as they grow and mature. A 15-year-old startup would have a different risk profile and market position than a 4-year-old startup. By using the DCF method to estimate the value of the older startup when it was the same age as the younger one, you account for the natural growth and maturation process.
- **Incorporating Risk and Time Value of Money:** The discount rate is applied to reflect the risk associated with an investment (if made) and to account for the time value of money. Money received in the future is worth less than money received today, and the discount rate helps adjust for this. A higher discount rate indicates a higher perceived risk, which is why it's an important parameter in the calculation.
- **Delta Factor:** Delta Factor is the factor accounting for the degree of difference between the benchmark company and the subject start-up. Even if two startups operate in the same industry, they may have different technologies, market positions, growth prospects, and risks. The delta factor quantifies how closely the subject company deviates from the benchmark company, allowing for a more accurate estimation of value. Two perfectly same company have a delta factor of 1. If they are 40% different, there comes into the picture two delta factors, Delta (Lower),  $\Delta l = 1 - 0.4 = 0.6$  and Delta (Upper),  $\Delta u = 1 + 0.4 = 1.4$ . Both account for 40% deviation from the benchmark company.
- **Benchmarking for Validation:** The method uses a known valuation – the exit valuation of Carbon Engineering, a DAC company based in Squamish, BC, Canada (the benchmark value of \$1.1 billion) as a reference point. This provides a level of validation and confidence in the estimate. If the calculated value closely aligns with the benchmark, it suggests that the estimation method is reasonable.

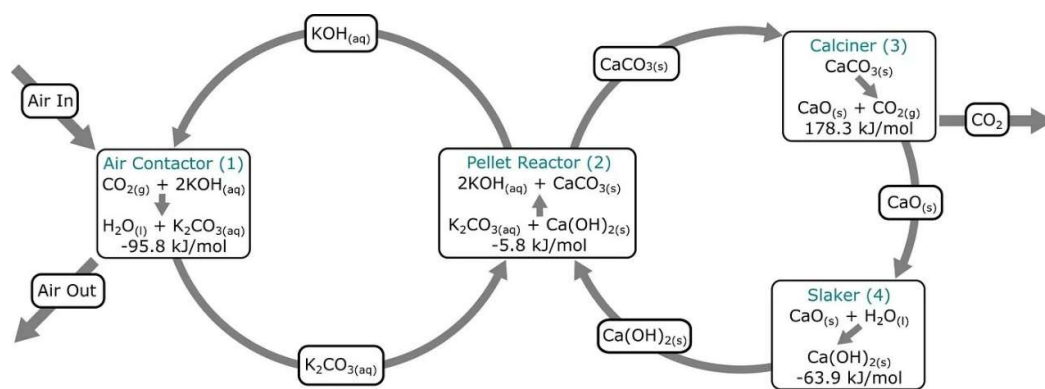
### 3. Benchmark Company & the Subject Start-Up

- **Carbon Engineering (Benchmark Company)** : Carbon Engineering is a Canadian-based company that specializes in the development of direct air capture (DAC) technology<sup>1</sup>. DAC is a process that captures carbon dioxide from the atmosphere and converts it into a purified form that can be stored or used to create synthetic fuels<sup>1</sup>. The company was founded in 2009 by David Keith, a professor of applied physics at Harvard University.

Carbon Engineering's DAC technology is based on a closed-loop system that uses a chemical process to remove carbon dioxide from the air. The captured carbon dioxide is then purified and compressed into a liquid form for storage or use<sup>1</sup>. The company has been working on scaling up its DAC technology to make it more cost-effective and efficient. In 2018, Carbon Engineering opened its first commercial-scale DAC plant in Squamish, British Columbia, which can capture up to one tonne of carbon dioxide per day<sup>1</sup>.

Carbon Engineering's process comprises two connected chemical loops with four reactors:

- Air Contractor (1)
- Pellet Reactor (2)
- Calciner (3)
- Slaker (4)



- The Process: The Air Contractor captures Carbon Dioxide (CO<sub>2</sub>) from the ambient air using an aqueous solution of Potassium Hydroxide (KOH). This solution binds with the CO<sub>2</sub> to form liquid Potassium Carbonate (K<sub>2</sub>CO<sub>3</sub>) and water (H<sub>2</sub>O).
- The Pellet Reactor combines the two loops. In the Pellet Reactor, the Potassium Carbonate (K<sub>2</sub>CO<sub>3</sub>) reacts with Calcium Hydroxide (Ca(OH)<sub>2</sub>) to form Calcium Carbonate (CaCO<sub>3</sub>).
- In the Calciner, the Calcium Carbonate (CaCO<sub>3</sub>) is heated at high temperatures in absence of air or oxygen to release pure CO<sub>2</sub>.
- In the Slaker, the remaining Calcium Oxide (CaO) is hydrated with water to create Calcium Hydroxide for the pellet reactor.

This circular process allows for continuous operation of the plant. To learn more about the process, you can read Carbon Engineering's article "A Process for Capturing CO<sub>2</sub> from the Atmosphere" that they published in 2018<sup>3</sup>.

In August 2023, Occidental Petroleum announced that it had entered into an agreement to acquire Carbon Engineering for approximately \$1.1 billion<sup>1</sup>. The acquisition is expected to close before the end of 2023 and will make Carbon Engineering a wholly owned subsidiary of Oxy Low Carbon Ventures<sup>1</sup>. The acquisition aligns with Occidental's integrated net-zero strategy and provides the company with an opportunity to rapidly advance DAC technology breakthroughs and accelerate deployment of DAC as a large-scale, cost-effective, global carbon removal solution<sup>1</sup>.

- **Novonanmek Material Sciences Private Limited (Subject Start-up):** is a 4-year-old Direct-Air-Capture (DAC) startup based in Delhi, India. Novonanmek has developed a “A Closed-Loop Hybrid-Sorbent Carbon Capture and Mineralization Process” for Direct-Air-Capture (DAC).

Novonanmek’s method is a hybrid sorbent method where both Solid and Liquid sorbents are used. In the process, the pelletized solid sorbent (CaO) itself acts as the contactor, doing away the need to have a separate air contactor. The process is a highly innovative Closed-Loop, Hybrid Sorbent, Twin Cycle contactor-less design. The process of Novonanmek is quite similar to that of Carbon Engineering, similar chemicals and reactions are deployed, bringing the two processes quite closer.

#### 4. Assumptions for Valuation:

1. Our valuation approach is been intentionally conservative to guard against overly optimistic expectations. We have utilized conservative assumptions to maintain a realistic and grounded valuation.
2. The cornerstone of our valuation approach is the historical success of Carbon Engineering, a 15-year-old startup operating in the same industry in Canada. This startup achieved a highly successful exit event, which serves as a reference point for assessing potential value within our market. This historical precedent provides valuable insights into the industry’s capacity for delivering substantial returns. The exit of Carbon Engineering underscores the validation of market demand and the feasibility of successful exits within our industry. This validation reinforces the soundness of our valuation approach, as it aligns with real-world market dynamics.
3. Benchmark Valuation: The benchmark valuation is taken as \$1.1 billion USD. This is the known valuation of the 15-year-old startup. The assumption here is that this valuation is a reasonable reference point for estimating the value of your 4-year-old startup.
4. Our valuation methodology relies on the assumption that Novonanmek will follow a trajectory akin to that of Carbon Engineering, albeit with age-related adjustments. This assumption is central to our analysis, allowing us to extrapolate from the recent success story of Carbon Engineering while accounting for the unique characteristics of Novonanmek.
5. The DCF method, even with one data point, has been considered because it provides a structured approach to estimate the present value of a significant future cash flow event, such as an exit. By applying a discount rate that accounts for risk and the time value of money, DCF quantifies the current worth of that event in today’s terms. This approach is akin to a rational investor’s perspective, valuing the anticipated windfall of a successful exit based on its potential to generate returns in the present, making it a practical and relevant method for assessing the startup’s value. We have used "delta Factor," scenario analysis, conservatism, transparency, and sensitivity analysis to collectively strengthen the reliability of our DCF-based valuation.
6. Delta Factor: The method assumes a delta factor. For this particular calculation delta factor of 0.6 and 1.4 have been considered assuming Novonanmek deviates from Carbon Engineering

by 40% in terms of technology, market, potential, or other relevant factors. The delta factor quantifies how closely the subject company deviates from the benchmark company, allowing for a more accurate estimation of value. Two perfectly same company have a delta factor of 1. If they are 40% different, there comes into the picture two delta factors, Delta (Lower),  $\Delta l = 1 - 0.4 = 0.6$  and Delta (Upper),  $\Delta u = 1 + 0.4 = 1.4$ . Both account for 40% deviation from the benchmark company.

7. Technological Relevance: It assumes that the technology or solution offered by both startups has remained relevant and in demand over the years, supporting growth.
8. Discount Rate: A discount rate of 12% is used in the calculation. This rate reflects the time value of money and the risk associated with the investment. The assumption is that this discount rate is appropriate for adjusting the benchmark valuation to its value when the benchmark company was 4 years old.
9. Consistent Growth Rate: The method assumes that the growth rate in the benchmark startup's valuation remained relatively consistent over the specified period (from the 4th year to the 15th year). This assumption allows for the application of the discount rate in reverse to estimate the value when the startup was 4 years old.
10. Number of Years: The method assumes an 11-year difference between the current valuation of the 15-year-old startup and the estimated valuation when it was 4 years old. This represents the period for which you are estimating the change in valuation.
11. Linear difference Adjustment: The method uses a linear adjustment based on the delta factor. It assumes that the effect of dissimilarity is proportional and linear, meaning that a 40% dissimilarity, positive or negative, results in a 40% adjustment to the benchmark valuation.
12. No Consideration of Other Factors: The method focuses primarily on the delta factor and the discount rate as the main drivers of the valuation estimate. It does not explicitly account for other factors that may have influenced the actual growth of the 15-year-old startup's valuation.
13. We emphasize the substantial growth potential of Novonanmek as it matures and advances toward a similar exit event in the future. This potential growth is a key driver of our valuation assessment.
14. Acknowledging the inherent risks associated with early-stage startups, we have taken these into account in our valuation analysis. We have developed strategies to mitigate these risks, ensuring a balanced and realistic assessment.

## 5. Justifications for 12% Discount Rate

1. Sustainability Focus: Novonanmek operates in the field of Direct Air Capture (DAC), which focuses on addressing pressing environmental challenges, making it a strategic player in the sustainability landscape<sup>4</sup>. The chosen 12% discount rate aligns with Novonanmek's commitment to long-term environmental impact.
2. Environmental and ESG Trends: Novonanmek aligns with Environmental, Social, and Governance (ESG) trends, appealing to investors committed to sustainability

3. **Established Technology:** Novonanmek's technology is an established technology based on calcium looping which is established chemistry. The process is more or less similar to that of Carbon Engineering<sup>3</sup>, the benchmark company. Novonanmek's process is also similar to that of Heirloom's, another US based company in the Direct-Air-Capture (DAC) space<sup>5</sup> with established technology.

Novonanmek's technology involves mineralization which Bill Gates calls "gold standard" in carbon removal.

4. **High Tailwind:** Increasing global focus on environmental sustainability, particularly the urgency surrounding carbon emissions reduction & removal and achieving net-zero targets<sup>6</sup>.
5. **Involvement of Large Multinational Corporations<sup>7,8,9</sup>:** The involvement of the world's largest companies in Direct Air Capture (DAC) initiatives, by either pre-purchasing DAC removal credits or investing to scale up DAC technology, reflects the level of interest and investment by industry leaders in the technology, thereby reducing risk to a very large extent.
6. **Long-Term Potential<sup>4,10</sup>:** DAC projects have long-term sustainability goals, necessitating a lower discount rate to capture sustained growth and returns over a multi-decade horizon. Long term potential indicates a reduced level of risk from an investor's perspective.
7. **Long term Supply-Demand Gap<sup>9,10</sup>:** The expectation of a growing supply-demand gap for DAC removal credits underscores the increasing need for our technology. This market dynamic supports our choice of a 12% discount rate. Demand-supply gap also indicates a reduced level of risk from an investor's perspective.
8. **Market Demand<sup>9,10</sup>:** Huge Market demand of DAC removal credits is commensurate with a discount rate of 12% and again presents a lower level of risk from investment perspective.
9. **Innovation and Technology Advancement:** Novonanmek represents a significant technological advancement in the DAC field, contributing to a lower discount rate.
10. **Market Sentiment<sup>6,10,11</sup>:** The discount rate of 12% considers market sentiment and investor expectations that prioritize long-term sustainability and growth potential over immediate returns.
11. **Intellectual Property Protection:** Novonanmek has filed a provisional patent to protect its technology.

## 6. Calculation of Novonanmek's Value:

**Benchmark Value:** This is the known valuation of Carbon Engineering at the time of its exit, which is \$1.1 billion USD. This serves as a benchmark or reference point for comparison.

**Delta Factor (0.6 and 1.4):** The delta factor is a way to account for how closely Novonanmek resembles or deviates from Carbon Engineering in terms of technology, market, potential, or other relevant factors. In this case, it is assumed that Novonanmek has deviated by 40% from the benchmark startup. Thus, the Delta Factors considered for this calculation will be  $\Delta l = 0.6$  and  $\Delta u = 1.4$  as both indicate a deviation of 40% from the benchmark company, Carbon Engineering.

**Discount Rate (12%):** The discount rate is the rate used to calculate the present value of future cash flows or, in this case, the present value of the benchmark startup's valuation at a specific

point in the past. It reflects the time value of money and the risk associated with the investment. Here, a discount rate of 12% is used.

Number of Years (11): This represents the number of years ago you are trying to estimate the valuation for. In this case, you are estimating the value of Carbon Engineering when it was 4 years old, which is an 11-year difference.

Benchmark Value: \$1.1 billion USD.

Applying the Delta Factors  $\Delta I$  &  $\Delta u$ : Multiply the benchmark value by the two delta factors to account for the fact that Novonanmek has deviated by 40% from Carbon Engineering.

$$\$1.1 \text{ billion USD} \times \Delta I = \$1.1 \text{ billion USD} \times 0.6 = \$660 \text{ million USD}$$

$$\$1.1 \text{ billion USD} \times \Delta u = \$1.1 \text{ billion USD} \times 1.4 = \$1540 \text{ million USD}$$

#### **Present Value calculation:**

(1) Based on delta factor  $\Delta I = 0.6$

$$\$1.1 \text{ billion USD} \times 0.6 = \$660 \text{ million USD}$$

Assuming Novonanmek will be valued US\$ 660 Million (applying delta factor of  $\Delta I = 0.6$ ) after 11 years from now, we discount the \$660 million USD back to the 4th year using the discount rate of 12% and the number of years (11).

$$\text{Present Value} = \$660 \text{ million USD} / (1 + 0.12)^{11}$$

**Present Value  $\approx$  \$189.73 million USD**

(2) Based on delta factor of  $\Delta u = 1.4$

$$\$1.1 \text{ billion USD} \times 1.4 = \$1540 \text{ million USD}$$

Assuming Novonanmek will be valued US\$ 1540 Million (applying delta factor of ) after 11 years from now, we discount the 1540 million USD back to the 4th year using the discount rate of 12% and the number of years (11).

$$\text{Present Value} = \$1540 \text{ million USD} / (1 + 0.12)^{11}$$

**Present Value  $\approx$  \$442.71 million USD**

## **7. Conclusion:**

In the pursuit of accurately assessing the valuation of Novonanmek Material Sciences Private Limited, a 4-year-old startup operating in the promising realm of Direct Air Capture (DAC), our valuation methodology has undergone rigorous scrutiny. This methodology relies on the Discounted Cash Flow (DCF) approach, underpinned by a single data point – the highly successful exit event of a 15-year-old DAC startup, Carbon Engineering, valued at \$1.1 billion USD.

Delta Factor - Exploring the Spectrum: One of the key components of our analysis that merits attention is the utilization of the "Delta Factor." We acknowledge the limitations of having only one data point and the inherent uncertainties within startup landscapes. To address this, we

introduced a "Delta Factor" encompassing two scenarios -  $\Delta l = 0.6$  and  $\Delta u = 1.4$ . These scenarios reflect the spectrum of possibilities, from a more conservative outlook (0.6) to an optimistic perspective (1.4). The Delta Factor allows us to account for the range of potential valuations, acknowledging the inherent uncertainty in startup trajectories.

**Discount Rate:** Central to our valuation process is the choice of a 12% discount rate. This discount rate was not chosen arbitrarily. Novonanmek operates in the Direct Air Capture (DAC) sector, a rapidly evolving field that aligns with the pressing demands of environmental sustainability. The significant investments and engagements of the world's largest corporations in DAC initiatives underscore its importance. Given the strong market validation, favourable industry tailwinds, reduced technological and market risks, and alignment with the global thrust toward carbon neutrality, a 12% discount rate was deemed appropriate. This rate strikes a balance between the inherent uncertainties and risks of an early-stage startup and the confidence stemming from the substantial validation and momentum in the DAC landscape.

**Balancing Risk and Opportunity:** At a discount rate of 12%, our DCF analysis yields a valuation of approximately \$189.73 million USD under the more conservative scenario (Delta Factor of 0.6). This valuation considers the potential risks associated with early-stage startups, market uncertainties, and the limited data available. It represents a cautious estimate, acknowledging that the path to success may be challenging and fraught with hurdles.

**Optimism in the Outlook:** Conversely, under the optimistic scenario (Delta Factor of 1.4), our DCF analysis projects a valuation of around \$442.71 million USD. This valuation encapsulates a more sanguine perspective, reflecting the potential upside associated with Novonanmek's innovative DAC technology, its alignment with global sustainability goals, and the growing involvement of industry giants in the DAC landscape.

**Embracing Uncertainty:** Our valuation approach does not seek to provide a definitive figure but rather embraces the inherent uncertainties within the startup environment. By introducing the Delta Factor, we acknowledge that Novonanmek's valuation lies within a range, influenced by various factors including market dynamics, technological advancements, and the continued engagement of industry leaders.

**Striking a Balance:** In conclusion, the valuation of Novonanmek Material Sciences Private Limited is a delicate balance between prudence and optimism. The Delta Factor allows us to consider both ends of the spectrum, recognizing that the true value of this innovative DAC startup may lie within this range. We underscore the importance of continued monitoring and adjustment as Novonanmek progresses on its journey, acknowledging that startup valuations are dynamic and subject to change.

**Conclusionary Insights:** Balancing optimism with pragmatism, the valuation of Novonanmek rests within a spectrum. The choice of a 12% discount rate reflects our nuanced understanding of both the challenges and opportunities that lie ahead for Novonanmek. It is a rate that acknowledges the risks but also recognizes the transformative potential of DAC technology and Novonanmek's pivotal role in this landscape.

As we chart Novonanmek's journey forward, we emphasize that our valuation is a dynamic construct. It is grounded in the present but inherently forward-looking, ever-responsive to the changes in the ecosystem. We urge stakeholders to perceive this valuation as both a reflection of Novonanmek's current promise and its potential to redefine the contours of the DAC industry.



## 8. References:

1. Occidental Enters into Agreement to Acquire Direct Air Capture Technology Innovator Carbon Engineering 2: Carbon Engineering
2. Carbon Engineering (<https://medium.com/ipo-2-0/carbon-engineering-19b1ff77004b>)
3. David W. Keith, Geoffrey Holmes, David St. Angelo, Kenton Heidel, A Process for Capturing CO<sub>2</sub> from the Atmosphere, *Joule*, Volume 2, Issue 8, 2018, Pages 1573-1594, ISSN 2542-4351, <https://doi.org/10.1016/j.joule.2018.05.006>.
4. Direct Air Capture – A Key Technology for Net Zero  
[https://iea.blob.core.windows.net/assets/78633715-15c0-44e1-81df-41123c556d57/DirectAirCapture\\_Akeytechnologyfornetzero.pdf](https://iea.blob.core.windows.net/assets/78633715-15c0-44e1-81df-41123c556d57/DirectAirCapture_Akeytechnologyfornetzero.pdf)
5. <https://www.heirloomcarbon.com/technology>
6. The Boston Consulting Group - Shifting the Direct-Air-Capture (DAC) paradigm  
<https://www.bcg.com/publications/2023/solving-direct-air-carbon-capture-challenge>
7. Amazon follows Microsoft, investing big in carbon capture  
<https://www.cnbc.com/2023/09/12/amazon-follows-microsoft-investing-big-in-carbon-capture.html>
8. McKinsey partners with Stripe, Alphabet, Shopify, and Meta on \$925 million carbon removal commitment ([https://www.mckinsey.com/about-us/new-at-mckinsey-blog/mckinsey-partners-with-stripe-alphabet-shopify-and-meta-on-\\$925-million-carbon-removal-commitment](https://www.mckinsey.com/about-us/new-at-mckinsey-blog/mckinsey-partners-with-stripe-alphabet-shopify-and-meta-on-$925-million-carbon-removal-commitment))
9. JPMorgan Chase seeks to scale investment in emerging carbon removal technologies, announces agreements intended to durably remove and store 800,000 tons of carbon (<https://www.jpmorganchase.com/news-stories/jpmorgan-chase-seeks-to-scale-investment-in-emerging-carbon-removal-technologies>)
10. Occidental's Big Buy May Change Course of \$150 Billion Market (<https://about.bnef.com/blog/occidentals-big-buy-may-change-course-of-150-billion-market/>)
11. The Boston Consulting Group - The Time for Carbon Removal Has Come (<https://web-assets.bcg.com/67/f7/0f41cd074a66b49cdb8baf5e59c0/bcg-the-time-for-carbon-removal-has-come-sep-2023-r.pdf>)
12. Provisional Patent Application No: 202331061319