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Department of Marketing, Operations and General Management

Equity Research: Greenvolt - Renewable Energy, S.A.

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Master in Management

Supervisor:
Prof. Paulo Viegas de Carvalho, Assistant Professor,
ISCTE - IUL

September, 2023

BUSINESS SCHOOL

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To my father, who has always led by example and moulded me into the man I am today.

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This space is dedicated to honoring those who have helped me the most throughout my master's degree.

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I hope I can continue to meet your expectations, both professionally and personally.

Abstract

The objective of this Dissertation is to analyze and value Greenvolt – Renewable Energy S.A.'s stock, using the Discounted Cash-flow and Multiples methodologies, to obtain a fundamental price. The dissertation expands this by exploring the motives for the observed underpricing phenomena of the stock and analyzing the subsequent evolution of the share price based on external events and theories put forward by previous research.

Underpricing, as well as its consequences, have been widely studied and many explanations for both have been put forward. In this Dissertation, several explanations for underpricing are tested. Two valuations of Greenvolt are presented: the first one is dated July 2021 (immediately preceding the Initial Public Offering) and the second one is dated May 2023. To end the analysis, statistical testing of the presence of information asymmetry surrounding Greenvolt stock shall give us an insight into the validity of Information Asymmetry-based explanations for underpricing.

Greenvolt is a Portuguese firm operating in the renewable energy industry, positioned upstream in the value chain, and specializing in the development of renewable energy projects (also producing and selling electricity).

As shown throughout the analyses conducted, I find that Greenvolt stock was undervalued both at the time of the Initial Public Offering (IPO) and as of May 2023. I also observe greater volatility from Greenvolt's stock when compared to its peers, which is plausibly explained by the short lifespan of the firm, its innovative business model, and, as demonstrated in the Dissertation, the subsequent information asymmetry (IA) surrounding the firm.

Keywords: Greenvolt – Renewable Energy, S.A.; Renewable Energy; Company Valuation; Underpricing; Information Asymmetry

JEL Classification: G30; G32

Resumo

O objetivo desta Dissertação é a análise e avaliação das ações de uma empresa, Greenvolt – Energia Renovável neste caso, usando as metodologias de Fluxos de Caixa Descontados e Múltiplos, obtendo um preço fundamental das ações. A dissertação expande este estudo explorando os motivos para o fenómeno de underpricing observado e tentando explicar a subsequente evolução do preço das ações com base em eventos externos e teorias avançadas por pesquisas anteriores.

O fenómeno de underpricing tem sido amplamente estudado. Nesta Dissertação são testadas diversas explicações para o underpricing. Duas avaliações da Greenvolt, em dois momentos diferentes, são realizadas: a primeira datada de julho de 2021 (no momento da Oferta Pública Inicial) e a segunda datada de maio de 2023. Para finalizar a análise, testes estatísticos da presença de assimetrias de informação em torno da Greenvolt oferecem-nos a oportunidade para especular sobre a validade das explicações baseadas em assimetrias de informação para underpricing.

A Greenvolt é uma empresa portuguesa que opera na indústria das energias renováveis, posicionada a montante na cadeia de valor e especializada no desenvolvimento de projetos de energias renováveis (também produz e comercializa eletricidade).

Em conclusão, as ações da Greenvolt foram subvalorizadas, tanto no momento da Oferta Pública Inicial (OPI) como em maio de 2023. Também foi observada uma maior volatilidade das ações da Greenvolt quando comparada aos seus pares, o que é plausivelmente explicado pela curta existência da empresa, modelo de negócios inovador e, conforme demonstrado, a consequente assimetria de informação que rodeia a empresa.

Palavras-chave: Greenvolt – Energias Renováveis, S.A.; Energias Renováveis; Avaliação de empresas; Underpricing; Assimetria de Informação

Classificação JEL: G30; G32

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Glossary

B2B – Business to Business

CAGR – Compounded Annual Growth Rate

CAPEX – Capital Expenditures

CAPM – Capital Asset Pricing Model

CHP – Combined Heat and Power

CPI – Consumer Price Index

CSP – Concentrated Solar Power

DCF – Discounted Cash Flow

EBIT – Earnings before Interest and Tax

EBITDA – Earnings before Interest, Tax, Depreciation, and Amortization

ECB – European Central Bank

EPA – Environmental Protection Agency

EPS – Earnings per Share

EQV – Equity Value

ERIX – European Renewable Energy Index

ESG – Environment, Social, and Governance

EU – European Union

EV – Enterprise Value

FCFE – Free Cash Flow to Equity

FCFF – Free Cash Flow to Firm

FV – Firm Value

FY – Financial Year

GDP – Gross Domestic Product

GHG – Greenhouse Gas

GPEI – Global Price of Energy Index

GW – Gigawatt

IA – Information Asymmetry

IRENA – International Renewable Energy Agency

IPO – Initial Public Offering

LCOE – Levelized Cost of Electricity

MW – Megawatt

MWh – Megawatt per hour

MWp – Megawatt peak

NPV – Net Present Value

OECD – Organization for Economic Cooperation and Development

O&M – Operations and Maintenance

PER – Price-to-Earnings Ratio

PPA – Power Purchase Agreement

PV – Photovoltaic

R&D – Research and Development

$\boldsymbol{R_e}$ – Return on equity required by investors

$\mathbf{R_f}$ – Risk-free rate

$\mathbf{R_M}$ – Return of the market

ROA – Return on Assets

ROE – Return on Equity

ROIC – Return on Invested Capital

RTB – Ready-to-Build

SEC – Securities and Exchange Commission

SEO – Seasoned Equity Offering

T-Bill – Treasury Bill

T-Bond – Treasury Bond

WACC – Weighted Average Cost of Capital

WC – Working Capital

Y/E – Year-end

YoY – Year-on-Year

YTM – Yield-to-Maturity

1. Introduction

Firms often turn to capital markets for raising funding. In some cases, firms issue securities that consistently outperform the market in the short term, leaving analysts wondering if the outstanding performance is due to fundamental or behavioural reasons. This dissertation aims to apply that thought process to the case of Greenvolt – Renewable Energy S.A., a Portuguese firm specialized in the development of renewable energy projects, that first issued securities in July 2021. Greenvolt has been able to outperform market indexes (EUROSTOXX600, PSI, and S&P500 are used as benchmarks) since its first issue, leaving room for the formulation of theory-related motives for such performance.

Greenvolt is an interesting case to base such analysis on for several reasons, the biggest being that it operates in a segment that has been indicated by public authorities as one of the future, and has become more relevant with recent events, such as inflation and the Russia-Ukraine war. In recent years, greater emphasis has been put on renewable energy as the solution for the planet's energy needs for its sustainability, and, more recently, because of its economic viability and geopolitical strategic value. The growing importance of this industry, coupled with the short time of existence of most firms in the sector, makes it an interesting case for an analysis of its stock price evolution. The fact that the firm's Initial Public Offering (IPO) was marked by the phenomenon of underpricing (as further analysis will conclude and attempt to explain) was also factored into the selection process.

This thesis assesses the reasons for Greenvolt's stock price evolution, as well as hypothesize on its sustainability moving forward. The adopted approach begins by analyzing the stock price at the moment of issuance and compares it to *a posteriori* valuation, using figures available at the time of issuance, to determine if any underpricing occurred (and, if it is the case, why it may have occurred). Then, an analysis of the events from the IPO date up until the present sets up the discussion of the current pricing of the stock, for which a valuation of Greenvolt based on updated figures is conducted and shall be referred to. Thus, the thesis aims to explain Greenvolt's outperformance against several stock market indexes since its IPO. The goal is to answer the question "Is Greenvolt stock currently under or overpriced, or is it correctly valued?", whilst offering some insight into the factors that influence the stock's price.

The analysis provided here holds relevance for both scholars and professionals aiming to acquire a fundamental understanding of Greenvolt's stock value and the market dynamics that have shaped its evolution from the IPO until the present. What sets this thesis apart is its comprehensive approach to the study of the company's stock price evolution. In addition to the valuation of the stock and analysis of its price evolution, it delves into various explanatory theories concerning the underpricing phenomenon. Additionally, it investigates the influence of information asymmetry on the progression of the stock price, using existing body of literature in this domain as a point of reference.

2. Literature Review

2.1. Preliminary Concepts

2.1.1. Initial Public Offering (IPO)

According to the Securities and Exchange Commission (SEC), an IPO refers to "the first time a company offers its shares of capital stock to the general public" (*Investing in an IPO*, 2013, p. 1). This is when a company's stock becomes available for the first time. After an IPO, the ownership structure changes, with investors becoming part owners of the firm.

2.1.2. Underpricing

Underpricing is the setting of an initial issue's price below the underlying intrinsic value. Ibbotson (1975) refers to the phenomenon as "the difference between the closing price on the first day of trading and the IPO offer price", without any author specifying a minimum required return or timeframe to characterize it. This phenomenon has happened numerous times in history. In practice, underpricing is said to occur whenever the initial returns of the stock are positive, after one or day or within the first week.

2.1.3. Bookbuilding

The Cambridge Dictionary defines bookbuilding as "a process in which financial advisers ask important investors how many shares they might buy and at what price in order to decide the price at which to sell the shares" (*Bookbuilding*, 2023). The underwriter of an IPO invites several institutional investors to bid on a firm's shares, asking them the price they consider fair.

2.1.4. Underwriter

NASDAQ defines an underwriter as: "a firm, usually an investment bank, that buys an issue of securities from a company and resells it to investors. In general, a party that guarantees the proceeds to the firm from a security sale, thereby in effect taking ownership of the securities".

2.2. Underpricing Theories

2.2.1. Asymmetric Information Models

Winner's Curse

Rock's (1986) model assumes that some investors are better informed than others, namely the issuer, underwriter (an investment bank), and other investors. As such, they will only bid on underpriced IPOs that have greater potential for returns. As for the uninformed investors, they will invest indiscriminately. As a result, they are subject to the so-called "winner’s curse”: in underpriced IPOs, they might be fully rationed out in favour of informed investors, and in overpriced IPOs, they may receive all the allocations. With expected negative returns, these investors may opt not to invest – to attract them to the market (which is assumed to be necessary to sell the entire issue and assure the Primary Market’s stability), the issuer will underprice the IPO. Underpricing is, then, a cost for each firm individually and a benefit for them collectively. Levis (1990), through data collected from the London Stock Exchange, showed that the market-adjusted first day returns on over-subscribed issues were just sufficient to cover investors’ first-day losses from undersubscribed issues, in line with Rock’s assumptions.

Principal-agent Models

Principal-agent models highlight the conflicting interests of the agent (investment bank) and the principal (the issuing firm) – underpricing an issue in exchange for briberies in the form of enlarged commissions paid, side-payments or other future incentives benefits the underwriter, as opposed to safeguarding the issuing firm’s interest of maximizing IPO returns. Thus, underpricing may be, to some extent, a result of corruption by underwriters. Loughran and Ritter (2002) alerted to these situations.

Signalling through Underpricing

Underpricing as a form of signalling was first suggested by Ibbotson (1975). The idea is opposite to Rock’s model (1986) regarding information asymmetry – in this case, the issuer is assumed to have more information regarding itself and the issue (a valid assumption, considering the difficulty for outside parties accessing certain information), leveraging that information asymmetry to underprice the issue. The goal is to “leave a good taste in investor’s mouths”, to stimulate demand for future issues which may be overpriced, thus capitalizing on the good faith previously established with investors. Allen and Faulhaber (1989) contributed to this framework by evidencing the increased regularity of signalling in certain industries and at certain times, only by firms considered as good investments.

2.2.2. Institutional Explanations

Tiniç (1988) argues that underpricing acts as insurance against possible future claims by investors unhappy with poor stock performance. In this prism, a firm needs to equate the costs of underpricing (cost of opportunity) against the legal costs of potential legal action (reputational and financial costs).

Ruud (1993) claims that underpricing isn't the consequence of deliberate action by the issuer or underwriter, but a result of price stabilization – issues are priced correctly, and in the open market the price never falls below the initial offer price because of stabilization on the part of the underwriter. Consequently, the left tail of the return's distribution is eliminated – there are either positive returns or no returns at all.

Several authors have also suggested tax as a contributing factor to underpricing. This argument is valid in situations where the salary is taxed at a higher rate than capital gains and companies might opt to reduce salaries and provide compensation with the more tax-efficient stock options – firms underprice their initial offer so that employees can sell their stock options at a profit with greater certainty. Rydqvist (1997) explores this relationship in Swedish IPOs.

2.2.3. Ownership and Control

Underpricing as a Tool for Ownership Dispersion and Liquidity Promotion

Underpricing is also viewed as a tool for protecting control, deployed by managers and entrepreneurs, according to Brennan and Franks (1997). Underpricing is a way of attracting more investors to the initial issue, thus limiting the equity sold to block investors (individual or institution who holds a minimum of 3% of the issued capital post-IPO, as defined by the authors) and dispersing ownership. This also reduces each individual investor's incentive to produce information, limits the executive control of each investor, and allows for greater secondary market liquidity (Booth & Chua, 1996). Booth and Chua (1996) suggest a model that determines the level of underpricing based on the intended ownership structure and secondary market liquidity. Zheng and Li (2007) present evidence supportive of Booth and Chua (1996) – their results point to a positive correlation between the number of non-block institutional shareholders of a firm, its respective underpricing of stock, and market liquidity. However, the results do not show a correlation between the number of shareholders after the IPO and different liquidity measures. Underpricing is also found to have a positive and direct effect on market liquidity (measured by trading volume), as underpricing attracts more investors. The model has some limitations, as it doesn't consider shareholding blocks formed through pre-issue shareholders keeping their holdings through the IPO (Brennan and Franks assume these investors will sell off their interests immediately at the IPO or immediately after), nor does it consider the anonymity provided by widespread share allocation. Several authors argue that this anonymity allows large investors to build large blocks of shares and to deploy their trading strategies with greater efficiency, since their actions, as anonymous, don't exert influence over the rest of the market (Bolton & von Thadden, 1998; Holström & Tirole, 1993; Maug, 1998).

Underpricing as a Tool for Maximizing IPO Value and Proceeds

On the other hand, Stoughton and Zechner (1998) argue that block ownership is more desirable, as it maximizes IPO value and proceeds. The authors believe that managers may gain more by relinquishing control, contrary to Brennan and Franks' (1997) argument. By allocating a greater portion of shares to a single investor, managers are incentivizing information production and monitoring by such investors – underpricing is the cost of monitoring, instead of an opportunity cost. According to the authors, there is a trade-off between risk and profitability: allocating more shares to small investors allows for greater risk dispersion while allocating shares to large investors allows greater revenues and monitoring efforts. Share rationing and discretion in share allocation limit the shares available to small investors in the IPO – that excess demand will build up until the stock reaches secondary markets and the price increases, rewarding the institutional investors for their monitoring. Lastly, Stoughton and Zechner (1998) assume only institutional investors can invest in monitoring due to their contacts and resources.

2.2.4. Behavioural Explanations

Behavioural theories are also offered to explain underpricing. The field of study is still in its early stages, but there are already several suggestions on the impact of psychology on IPO pricing. The "informational cascades" effect was put forth by Welch (1992), who argues that successful (profitable) issues motivate investors to invest in future issues, regardless of their own information (and vice-versa). As such, investors may "demand" IPO underpricing as the price for their commitment and cascade start-up. However, bookbuilding methods and free communication amongst investors prevent such cascades.

However, other authors suggest that underpricing shouldn't occur when there are investors with optimistic expectations regarding the firm's future – the issuer should take advantage of those expectations and maximize capital gains by holding back stock and controlling the offered amount (Ljungqvist et al., 2006). Eventually, the price will revert to the corresponding value, and long-run returns will be negative. This is in line with empirical evidence from Ritter (1991).

2.3. Information Asymmetry – Measurement and Impact

Information asymmetry is also pointed to as a motive for IPO underpricing and as a determinant of aftermarket performance. Dierkens (1991) offers an analysis of information asymmetry's (IA) impact on equity issues. IA can be market-wide or firm-specific, and with time will eventually be transmitted to the market. Information disclosure moments include earnings, dividends, or equity issue announcements (not the equity issue itself). Four variables are used to measure IA – (i) standard deviation of the market-adjusted, three-day abnormal return at the quarterly earnings announcement; (ii) market-adjusted standard deviation of the firm’s stock daily abnormal returns; (iii) number of public announcements made in the *Wall Street Journal* publication; (iv) the ratio of number of shares traded in the year before the issue and the number of shares outstanding at the end of the fiscal year before the equity announcement.

The study uses cross-sectional, time series, and timing tests. The first aimed at determining the IA explanation power of price drops in equity issues, and confirmed claims made in the previous literature – firms’ IA and price drops in stock issue announcements are positively correlated. The time series tests tested if there is evidence of lower IA after the equity issue announcement, and found that earnings announcements following the equity issue announcement add less information than the ones before the announcement, from which it was concluded that equity issue announcements decrease IA. Furthermore, the residual variance of the daily stock returns, as well as the three-day market-adjusted returns, are lower following the equity issue announcement. These results are more robust in the short term – the decrease in IA is “short-lived” (Dierkens, 1991). Timing tests aimed to gather tendencies in the timing of earnings announcements and equity issues announcements. Once again, findings support the theory – firms should announce equity issues shortly after earnings announcements to reduce issuing costs. Bhagat and Frost (1986) measure issuing costs as the sum of underwriting fees and commissions, issuer expenses, and eventual underpricing (as a cost of opportunity). Empirically, that hypothesis was verified – firms time equity issues shortly after earnings announcements, regardless of the quality of the earnings being announced.

Odders-White and Ready (2006) point out that a firm’s private shocks lead to a linkage between its debt rating and adverse selection of its equity trading. This relationship has gained attention over the last decade due to the financial crisis – the default risk of debt is considered, as well as the impact of debt uncertainty on the stock. He et al. (2010) investigated the connection between a firm’s debt value uncertainty and its stock value uncertainty and found that: (i) debt rating changes are inversely correlated with IA, (ii) rating changes are viewed as signals of firm quality and influence the market’s behaviour, and (iii) IA increases when announcements are negative and decreases when announcements are positive.

2.3.1. Effect on the Cost of Capital

Armstrong et al. (2011) studied the impact of information asymmetry on the cost of capital involved with investment in firms, over the standard risk factors (beyond market risk). In the past, other authors have found a negative correlation between *proxies* for information quality and cost of capital (Easley, Hvidkjaer & O'Hara, 2002; Francis et al., 2005). Armstrong et al. (2011) contribute to existent literature by adding a *proxy* for market competition and factoring it into the analysis. The sample of firms was divided by a proxy for IA and by a *proxy* for market competition – the number of shareholders (a higher number of shareholders represents greater market competition) – and results point to higher excess returns in situations with high IA and low market competition. For firms exhibiting high market competition the excess returns show no difference, regardless of IA levels. In this framework, individual investors are vehicles for IA to manifest itself on the firm's returns and subsequently its risk. Past studies also connect the number of shareholders to the cost of capital, intuitively associating more concentrated share ownership with higher risk (and higher expected returns) (Merton, 1987).

The study used *proxies* for cost of capital (future excess returns), market competition (number of shareholders at the end of the fiscal year), and IA: two market-based (adverse selection component of the bid-ask spread, and the bid-ask spread itself), two accounting based (research and development expenses-to-sales ratio, and scaled accruals quality) and analyst coverage (number of sell-side analysts issuing one-year predictions for earnings-per-share). Results show that with low market competition, firms with high IA show a cost of capital of 5.08% to 12.48% higher when compared to other firms. Additionally, the authors speculate that firms knowingly opt to maintain high IA because of the costs associated with its reduction.

2.3.2. Announcements' Impact on Equity Prices

Paul Asquith and David Mullins (1986) also observed a similar relationship between equity prices and information asymmetry. Their study showed that in 80% of the sampled firms' cases, there was a 2.7% decrease in the equity price on the very same day of the announcement. Furthermore, the total equity of firms reduced by 78% of the value of the proceeds resulting from a second issue. Mikkelson and Partch (1985) had previously observed this phenomenon, concluding that equity prices' reacted negatively to the announcement of issues of common equity and convertible debt; credit agreements were found to have a positive effect when announced.

2.4. Drivers of Profitability for Renewable Energy Firms

Profitability is of the utmost importance for Global Sustainability – to mitigate energy risks and combat climate change there needs to be an alternative to fossil fuel energy. For that to happen, renewable energy firms need to be profitable (Morina et al., 2021). With the intent of identifying profitability drivers for renewable energy firms, Morina et al., (2021) conducted a study to measure the impact of different factors on firms based in European Union countries using data from 2004 through to 2018. Profitability was measured by return on assets (ROA) or by Tobin's q (market capitalization divided by the cost of replacing the firm's every asset).

The study contemplated the impact of firm-specific factors such as size, risk, age, capital intensity, and growth rate; country-specific factors such as the annual change in electricity prices, market concentration, and support schemes offered by governments; macroeconomic factors like the occurrence of a financial crisis, the annual Gross Domestic Product (GDP) growth rate, and the inflation rate.

The results of the study can be found in Appendix A.

2.5. Determinants of Post-IPO Performance

2.5.1. Intended Use of Proceeds

Amor and Kooli (2017) resorted to a quantitative approach to determine the effect of the intended use of proceeds on post-IPO long-term performance. The results show that firms who announce debt repayment or general purposes (with no specific destination for the funds obtained) have a lesser performance in the long run, while firms who state investment as the intended use of proceeds from the IPO have a more favourable long-term performance.

2.5.2. The "Green Effect"

Anderloni and Tanda (2017) set out to compare "green" firms' performance with that of "non-green" ones, in the Energy sector. According to Walker et al. (2015), a firm's initial offer will be more underpriced when evaluating its business is more difficult. Evidence found shows no difference between "green" and "non-green" companies' performance in the long run. However, underpricing seems to be greater for "green" firms – this could be explained by the relative lack of knowledge of investors regarding the new technologies employed in renewable energy firms' operations. IA is less for older non-green firms already established in the market, perhaps due to investors' easier evaluation process. Anderloni and Tanda (2017) suggest the possibility of different returns in the very long term, which is plausible speculation given the Sustainability trends observed recently, especially in legal frameworks.

2.5.3. Impact of Fossil Fuels' Price on Renewable Energy

As direct substitutes, it is expected that renewable and fossil fuel energy have a negative correlation as far as performance goes. Xia et al. (2019) studied this connection, and results varied according to the risk level. Fossil fuel energy was divided into 5 categories (oil, gas, coal, electricity, and carbon) and renewable energy was measured through the European Renewable Energy Index (ERIX), accounting for wind, solar, biomass, and water energy production. Empirical evidence shows renewable energy has the largest mean (positive) with the least volatility, indicating an unanimously bullish expectation regarding renewables. Fossil fuel energy companies show fewer average returns with greater volatility. Kumar et al. (2012) stated that changes in fossil fuel energy prices impacted renewable energy firms through energy substitution mechanisms. This hypothesis is supported by Xia et al. (2019), who found high interdependence between renewable energy returns and fossil fuel energy-related product returns. Findings also reveal that: (i) information spillover between renewable energy and fossil fuel energy is more sensitive to good news, (ii) the changes in negative returns of ERIX are highly impacted by its internal factors and (iii) there is strong competitive substitution between fossil resources and renewable energy.

2.5.4. Historical Long-Run Performance of IPOs

Ibbotson and Ritter, (1995) found that IPO firms tend to underperform in the long term when compared to non-issuing firms. Ritter (1991) observed that the long-run performance of issuing firms was notably less than that of non-issuing firms. Miller (1977) points out the divergence of opinion as the main reason for it – although there are informed investors who only invest if the securities are priced in such a manner that enables them to make a profit, certain uninformed investors will bid regardless of their incorrect information (or none at all), discarding the efficient market hypothesis. In that case, the price will initially be bid up, enhancing the chances of poor long-run performance. Loughran and Ritter (1995) offer another explanation: investment banks deliberately underprice issues to generate publicity and enthusiasm (this is consistent with the negative one-year returns).

2.6. Firm Valuation Methods

2.6.1. Discounted Cash Flow (DCF) Method

The DCF method emanates from the concept of the time value of money (Bilych, 2013). It assumes that the future value of an investment or an asset today depends on its expected future profitability, weighted by its risk and inflation. The method uses the projected cash flows and a discount rate (the investors' expected yield) to determine the present value of the investment (asset). According to this, a firm should be valued by estimating the firm's future cash flows and discounting them at a rate that reflects the investors' profitability demands (Lie & Lie, 2002). According to Mota et al. (2020), the model offers a dynamic estimate of a firm's value because it accounts for its future capability of creating value.

There are two different methodologies under the DCF method – free cash flow to the firm (FCFF) and free cash flow to equity (FCFE). The method reflects transfers of money, and not non-cash expenses and income – using earnings before interest, tax, depreciation, and amortization (EBITDA) or earnings before interest and tax (EBIT) would misrepresent the firm's capacity to generate cash flows (Bilych, 2013).

Free Cash Flow to Firm

This measure accounts for cash inflows and outflows directly resulting from the firm's operational cycle. To compute the inflows, I consider EBIT net of taxes and, because it is calculated on an accrual accounting basis, I will then add depreciation and amortization expenses. The outflows are constituted by capital expenditures (CAPEX) and working capital needs. The formula for the FCFF is as follows, where t is the firm's income tax rate.

$$FCFF_f = EBIT_f * (1 - t) + Amortizations - CAPEX\ Investment - WC\ investment \quad (1)$$

Discount Rate

As previously mentioned, the DCF methods require a discount rate that enables us to transfer the projected cash flows from the future to the present. Such a rate can be calculated in different ways. I opted to use the Weighted Average Cost of Capital (WACC) model to do so.

Weighted Average Cost of Capital (WACC)

The WACC model calculates the discount rate by considering the firm's financial autonomy (percentage of total assets covered by equity) and its debt level (quotient of debt by total assets), both weighted by their respective cost (Lobão, et al., 2021). Equity cost (R_e) is the demanded return by shareholders and cost of debt (R_d) is the interest rate associated with the firm's contracted loans. The model accounts for the “tax shield” provided by interest rate payments – such expenses are deductible at the tax rate paid (t). The WACC is thus given by the following equation:

$$WACC = \frac{Equity}{Equity + Debt} * R_e + \frac{Debt}{Equity + Debt} * R_d * (1 - t) \quad (2)$$

Cost of Debt (R_d)

The cost of debt is the interest rate paid by the firm on loans and other forms of credit. The value can be obtained through the yield on any outstanding issued corporate bonds (as is the case with Greenvolt) or, otherwise through the quotient of the total expenditure with interest and similar expenses by the firm’s total liabilities.

Cost of Equity (R_e)

The cost of equity corresponds to the required return by shareholders to invest in the firm. It is influenced by the business and financial risk associated with the company and can be computed through the Capital Asset Pricing Model (CAPM), as shown below.

Capital Asset Pricing Model

The CAPM is based on several assumptions, namely that markets are efficient, that the relationship between risk and return is stable through time and that investors are averse to risk and demand greater return rates for riskier investments (Lobão et al., 2021). The model considers the firm’s systematic risk – common to all firms and influenced by macroeconomic outlook, environment, or political factors – thus being unavoidable and undiversifiable. The other type of risk is firm-specific: depends on a firm’s idiosyncrasies as far as its competitive position in the sector/industry, financial health and other aspects exclusive to the firm, and can be diluted through diversification. The model requires three inputs: the risk-free rate (R_F), the market expected return (R_M), usually represented by a market index return (i.e., S&P500 or NASDAQ), and the beta of the firm (β_F).

$$R_e = R_f + \beta_F * (R_M - R_F) \quad (3)$$

The difference ($R_M - R_F$) is the market risk premium.

Despite ample criticism to its simplistic assumptions, most notably by Fama and French (2004), the model is considered the best option for determining the cost of equity, R_e.

Risk-free Rate (R_f)

The concept of a risk-free rate is somewhat controversial, with many authors denying its inexistence – every investment/ asset has some level of risk, no matter how small it may be.

Despite such criticism, the model considers that the interest rate paid by Treasury Bills of a country with a top-tier rating is a risk-free rate (usually the securities used are issued by the German Government, be it T-Bills or T-Bonds).

Beta of the Firm ($\boldsymbol{\beta_F}$)

The firm's beta represents the relationship between the firm's stock returns' volatility and the market returns' volatility – it is calculated through the quotient of the covariance of the firm's returns and the market's returns, by the variance of the market's returns.

$$\beta_F = \frac{COVAR(R_F, R_M)}{VAR(R_M)} \tag{4}$$

A positive (negative) beta means that the firm's stock moves in the same (opposite) direction as the market. If the beta is equal to one the security has the same level of risk as the market as a whole; if it is less (more) than one, it is less (more) riskier than the market. The beta of a company is, according to Damodaran (2002), influenced by the type of business it engages in, the level of economic leverage, and the level of financial leverage (both have a negative relation to risk). A levered beta (accounting for the firm's financial leverage) and an unlevered beta (assuming the firm is financed entirely by equity). To lever or "unlever" a beta, one could use Hamada's equation, shown below.

$$\beta_L = \beta_u * \left[1 + \frac{Debt}{Equity} * (1 - t)\right] \tag{5}$$

The beta obtained through the market and firm stock returns is levered. If this is not the case (if beta is obtained from a secondary source), Hamada's equation will be necessary.

Enterprise Value

The business value of the firm is obtained by discounting the projected future cash-flows to the firm (FCFF) at an appropriate discount rate (i.e., WACC).

$$EV_f = \sum_{t=1}^{n} \frac{FCFF_t}{\left(1 + WACC_f\right)^t} \tag{6}$$

Firm Value

Enterprise Value (EV) and Firm Value (FV) are two different concepts. Firm value is calculated by adding non-operating assets to the EV.

$$FV = EV + market\ value\ of\ non - operating\ assets \tag{7}$$

Equity Value

The final step in the FCFF methodology is to account for debt – most companies leverage their growth through external credit, so there is a need to account for the expenses related to debt.

$$Equity\ Value = FV - market\ value\ of\ debt \qquad (8)$$

The Equity Value (EQV) is an estimate of how much the firm is worth to equity holders.

Terminal Value

A firm's valuation assumes that the firm continues to operate past the forecasted horizon. The value referent to the period after the initial horizon is termed "terminal value", and it has a very significant effect on the firm's valuation, especially in industries that rely on large investments to create or enhance long-term cash-flows (Mota et al., 2020). In these cases, the terminal value represents the bigger portion of the firm's present valuation, so there is a need to account for it as accurately as possible.

Usually, it is assumed that cash-flows will continue indefinitely, growing at a steady rate. Bilych (2013) makes the case for two or three-stage DCF models, in which the firm's growth rate changes. This is suitable for when a firm is growing at a higher rate than the rest of the industry and a slowdown of growth is anticipated to eventual happen (two-stage DCF) or when a firm is in its infancy stage, and the growth rate is expected to change twice (three-stage DCF).

Mota et al. (2020) argue that the growth rate should be obtained in one of two ways: (i) the economy's real growth rate plus the inflation rate or (ii) modelled after the return on capital invested, according to the following formula.

$$g = ROIC * (1 - payout\ ratio) \qquad (9)$$

Gama & Torres (2021) propose a sustainable growth rate (g^*) as a benchmark for firm growth. This rate assumes the firm grows only through its retained earnings, while maintaining operational and financial conditions. The sustainable growth rate is then given by the following expression.

$$g^* = ROE * (1 - payout) \qquad (10)$$

where ROE is the firm's return on equity. The only difference between the two presented rates is the measure of the company's profitability.

Free Cash Flow to Equity

The free cash flow to equity (FCFE) method takes a more direct approach to a firm's valuation. It is calculated as the cash-flows available to the shareholders after debt service, payment of taxes and Capex outflows. It can be expressed based on FCFF, as shown below.

$$FCFE = FCFF - Debt\ service + Debt\ obtained \quad (11)$$

This method requires that the discount rate only reflects the cost of equity. The result of the discounted cash-flows will be the equity value. This method is also deployable using dividends received by investors instead of FCFE (results will differ if part of the FCFE is held by the company or non-zero NPV investments are made).

FCFF vs. FCFE

The FCFF methodology is generally more useful from an investor's point of view. It portrays the cash-flows generated by a firm through its operational activities and the enforceability of dividend payments to shareholders (Bilych, 2013). On the other hand, FCFE is the manifestation of such cash-flows' availability to shareholders (Bilych, 2013). As argued by Mota et al. (2020), the FCFF methodology is more advantageous because it separates the operational and financial performance (by explicitly computing the impact of debt service and interest payments separately) and because it assumes a constant debt ratio.

2.6.2. Multiples Method

Another method for firm valuation is through comparison to similar firms. This method uses ratios to expunge the differences in firm size. Valuation through the multiples method is simple and intuitive but is associated with a level of subjectivity in the selection of firms to compare and the ratios to use (Mota et al., 2020). Despite ample usage among practitioners and academics, there is no consensus on the most effective multiple to use in firm valuation through the multiples method (Lie & Lie, 2002). According to Damodaran (2006), comparable firms should present similar growth potential, cash-flows, and risk. It is common practice to resort to firms from the same industry (considered in a broad sense, if necessary).

Choice of Comparable Firm and Multiples

Alford (1992) argues that the selection process should focus on the firm's industry, ideally selecting firms with similar earnings' expected growth and risk. Bhojraj and Lee (2002) argue that the selection should follow economic criteria such as similar profitability, growth, and risk. A third and more recent school of thought proposes a comparison between firms based on search traffic patterns on websites (Lee, Ma & Wang, 2015). Cheng and McNamara (2000) confirmed the combination of industry and profitability yield as the most accurate criteria.

Another choice needs to be made between accrual-based drivers (subject to arbitrary allocation and different accounting methods) and cash flow-based drivers (do not fully reflect the value creation of a firm because of their timeliness). Empirical evidence favours accrual-based multiples (Plenborg & Pimentel, 2016). Also, consideration must be given to the use of reported or forecasted earnings. Kim and Ritter (1999) stated that historical earnings data includes non-recurring events and is not representative of the firm's future performance. Forecasted earnings, however, are forward-looking and reflect a larger information set, providing a more direct estimate. Lastly, complementing forecasted earnings-based multiples with historical earnings-based multiples can increase the accuracy of the valuation output.

2.6.3. DCF vs Multiples

Often, the DCF methodology is abandoned because of the difficulty in estimating future cash flows and a proper discount rate (Lie & Lie, 2002). DCF methods look to determine an asset's intrinsic value while the multiples method attempts to determine its price based on the market's behaviour (Damodaran, 2006). As Damodaran (2002) states, 90% of equity research deploys a multiples approach to valuation. Any valuation method has its limitations, so analysts usually resort to more than one valuation method (Kaplan & Ruback, 1996).

3. Company, Sector and Macroeconomic Overview

3.1. Company History, Structure and General Information

Greenvolt is a subsidiary of the Altri Group. The firm was created in March 2021 from the previously named Bioelétrica da Foz, S.A., a company specializing in electricity production from renewable energy sources, which originally was the result of a partnership between Altri and EDP (Portuguese Energy Firm) named EDP Produção – Bioelétrica, S.A., which came to an end in 2018. Altri purchased EDP's 50% share and became the sole proprietary of the firm now known as Greenvolt (the acquisition was made through one of its subsidiaries – Caima – Indústria de Celulose, S.A.). The firm's vision is to contribute positively to the world through renewable energy, aiming for energy sustainability, innovation, justice, and independence.

Greenvolt operates in three segments: Biomass, Utility-scale Wind and Solar, and Distributed Generation. The biomass business unit receives organic residuals and generates energy from it, playing a role in circular economy. The Wind and Solar Utility-scale segment is focused on developing "utility-scale" solar and wind projects – the firm positions itself upstream in the value chain, where the initial investment required is lower and the differentiating factor is expertise – the so-called "Ready-to-Build" (RTB) stage. However, the firm's aspiration is to integrate downstream in the value chain. The Distributed Generation segment is made up of low-scale projects aimed at commercial or residential self-consumption, where the firm is present throughout the whole value chain, focusing on the business-to-business (B2B) segment, where it believes to have a competitive advantage.

Greenvolt's growth has been mostly inorganic, through acquisitions. As a result, the company holds a portfolio of 8 companies across its three business segments (Figure 3-1). As of November 2022, four brands represent all the entities under Greenvolt's management. The brands established are Greenvolt Biomass (operating in the residual biomass sector, in Portugal and the UK), Greenvolt Power (development of utility-scale solar and wind projects), Greenvolt Next (active in Portugal, Spain and Greece) and Greenvolt Communities (active in Portugal). Greenvolt Communities is a subsegment of the distributed generation aimed at building energy communities, as the name suggests, of decentralized energy production and distribution. A community is made up of producers and consumers (the latter aren´t required to make any investment) – and is only active in Portugal. Greenvolt Next also operates in the Distributed Generation segment.

Greenvolt is present in Portugal, the UK, USA, Mexico, and 12 other European countries (Spain, France, Romania, Italy, Bulgaria, Poland, Greece, Germany, Hungary, Serbia, Denmark, and Iceland). The company went public in July 2021 with its IPO and held a Seasoned Equity Offering (SEO) in June 2022.

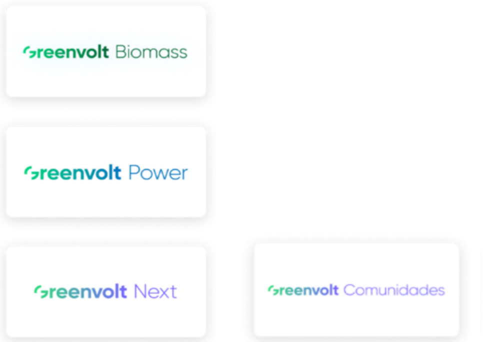


Figure 3-1 Greenvolt's Business Segments

Source: Greenvolt Website (2023)

3.2. Ownership and Performance

Before the capital increase, Greenvolt was a wholly owned subsidiary of the Altri Group. The IPO occurred on July 15th 2021, with BNP Paribas and Caixa Bank as joint global coordinators.

The firm’s financial policy and strategy are based on a solid balance sheet, asset rotation, and sustainability. To maintain financial balance, the focus is on extending the maturity profile of debt and diversifying its sources of funding. Since 2019, the firm has issued Green Bonds three times to finance acquisitions of PP&E and green projects, totalling €300 million. During 2023, an additional €200m of bonds will be issued. The firm’s dividend policy is very conservative, with no dividend distribution until 2025. In addition, Greenvolt resorts to external funding through credit institutions, benefiting from a rating of BBB- and Stable, deemed investment grade, as of May 2023.

Greenvolt was very successful in the last 3 years. The three business units have experienced growth in 2022. The key to this growth is the asset rotation strategy, as stated by the firm, according to which only 20% - 30% of developed projects are kept on the balance sheet.

The biomass segment has registered a slight decrease in energy exported in 1Q2023 (-3%), after a 46% increase in 1Q2022. Availability and load factor are driver of volatility in output, along with scheduled stoppages for maintenance.

The utility-scale segment benefits from a promising pipeline, with 691MW of capacity at least in an RTB stage (of which 460MW are already in building stages). The company’s projections point to an installed capacity of 3.9GW under management by Y/E 2023.

Distributed generation is the fastest growing segment, with a 146% YoY increase as of 1Q2023 as far as installed capacity for the period is concerned (146MWp), and backlog amounting to 151MWp.

Greenvolt currently holds 6 biomass plants (5 in Portugal and 1 in the UK) with plans to add 2 more in Portugal. Energy capacity is 142 megawatts (MW), as of June 2022, having increased 41% from the previous year – this increase is mainly owed to the acquisition of the UK plant in 2022. In 2022, the biomass plants, collectively, injected an additional 1,026GWh of electricity into the grid (+17% YoY growth). The sector also benefits from long-term supply contracts in place.

The total pipeline of the wind and solar segment is 6.9GW, of which 591MW are in RTB, ready to operate, or under construction stages. The largest portion of this pipeline is concentrated in Poland (3.4GW). Of the 6.9GW, 2.9GW are expected to be developed by Y/E 2023. The first sale attached to the asset rotation strategy took place in 2022, with the sale of 50MW of wind assets in Poland. Further asset sales of 200MW should be completed in 2023.

The distributed generation business unit installed 39.4MWp in Iberia (+71% YoY growth), with an additional 149MWp in the pipeline. The insignificant penetration in the domestic self-consumption market is seen as a future opportunity for the firm to extend its reach. The goal for 2023 is to install 150MW of capacity and double the capacity of signed contracts to 300MWp. The segment's strategy is to expand internationally, mainly in Europe.

3.3. Financial Analysis

Sales have increased for the last 4 years, mainly inorganically. The 62.4% increase in 2022 was mainly driven by the utility scale (+1330% YoY) and distributed generation (+326% YoY) segments, with biomass also showing a remarkable increase (+54% YoY). EBITDA (43.3%) and EBIT (25.2%) margins have also increased in recent years. Net income has been volatile in absolute value, as well as margin-wise. Nevertheless, the net profit margin increased in 2022 to 12%. Additional detail can be found in Appendix B.

Cash-flow generation has been volatile, with cash-flow from operations exhibiting consecutive decreases from 2020 to 2022; investing activities, as expected, generated cash outflows consistently, reflecting the firm's commitment to investment in fixed assets. Financing activities generated positive cash flows, driven by the firm's financing efforts since 2021. Overall, there is no evident trend in the net change in cash. Appendix C presents the data.

The firm has reinforced its balance sheet, increasing long-term funding sources' coverage of fixed assets. As of Y/E 2022, the balance sheet reflects the company's financial balance, with positive working capital, exceeding its working capital needs. Increased indebtedness has reduced the interest coverage ratio (EBITDA/interest expenses), from a very comfortable 32.4x in 2018 to 2.6x in 2022. Net debt/EBITDA increased in 2022 to 4.9x (from 4.4x). Available cash amounts to €381m (vs. €258.8m), in line with the firm's policy of liquidity maintenance. Available liquidity sources also include available credit lines – commercial paper, factoring and overdrafts are available. Appendix D presents more detail.

Stock Price

Greenvolt's stock price has increased from July 2021 until August 2022, having decreased from August 2022 until May 2023. The maximum price was reached in August 2022, while the minimum registered close price was on July 20th 2021 (€4.475). Further analysis is conducted in the following sections. Figure 3-2 displays the stock price's historical evolution.

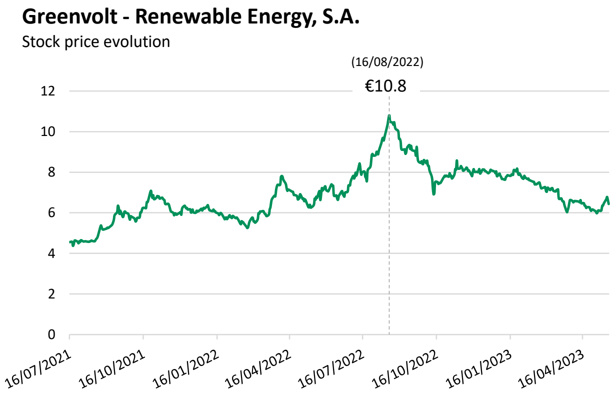


Figure 3-2 Greenvolt Stock Price Evolution *Source: Yahoo Finance*

3.4. Industry Statistical Analysis

Energy use per capita

In Portugal, primary energy use *per capita* increased steadily from 1965 until 2001; from that point on it experienced more volatility, and since 2018 it has gradually decreased. From 1965 until 2001 the increase was of 413%, with approximately constant growth. From 2001 until 2021, primary energy use *per capita* decreased by 10%. The contrast between the two periods' evolution can be explained by the advent of new, more efficient electrical equipment and devices. This evolution is somewhat coincidental with the rest of the countries considered. Iceland stands out as a country with exponential growth in energy use per capita until 2018; in 2019 and 2020 registered reductions in *per capita* energy consumption; however, consumption has picked up slightly in 2021 and is currently more than three times as large as consumption for the rest of the countries/ regions considered. A detailed graph can be found in Appendix E. Appendix F also displays energy use *per capita* in 2021, geographically.

Renewables in Total Energy Consumption

In the last 30 years, renewable energy sources have taken over a larger proportion of total energy consumption; this increase has been more pronounced since 2005. Currently, depending on the country/ region, renewable sources account for between 10% and 40% of total energy consumption. The exception is Iceland, with 81.1% of energy consumption being derived from renewables in 2019. The trend for an increase in the renewables' weight in final consumption is widespread, although not all regions show the same growth rate. In Europe, Iceland, Denmark, and Portugal stand out as having the largest percentages. A graphical representation of this data can be found in Appendix G. In 2022, for the first time, wind and solar (22%) surpassed fossil fuels (20%) in total electricity generation. Distributed generation, in the form of solar photovoltaic (PV), also increased more than expected (45%) – new projections point to 59% of Europe's cumulative installed solar capacity being on rooftops.

The disruption felt in energy markets increased the demand for Power Purchase Agreements (PPAs), while interest rate hikes turned investors to infrastructures (solar and wind parks) already built and in operation. Overall, the instability felt in global markets has had a positive impact on Greenvolt's businesses.

Renewables in Primary Energy Supply

In the countries in which Greenvolt operates, except for Bulgaria, renewables have been increasing their contribution to the supply of primary energy. Iceland is the leader in this group, with 89.9% of the primary energy supply being accounted for by renewables. Iceland, Portugal, and Denmark are also at the forefront of renewable energy supply, mirroring the high percentage of energy consumption enabled by renewables. When you exclude biofuels from the equation (because it is a specific form of energy production not developed by Greenvolt), the reality is very similar – Iceland does not rely on biofuels, while Denmark and Portugal both rely on biofuels for around 50% of their renewable energy supply. The graphs detailing the evolution can be found in Appendix H.

Energy output is measured by a unit of power – in this case, Gigawatts. According to the International Renewable Energy Agency (IRENA), the total energy output generated by renewable energy, worldwide, in 2021, increased by 257GW – Solar PV accounted for 133GW, onshore wind for 72GW, Hydropower 23GW, Bioenergy 10.3GW and Geothermal energy 0.11GW. The portion of total power generation capacity represented by renewables amounted to 81%, from 79% in the previous year. Currently, the installed capacity is 769GW for onshore wind and 843GW for Solar PV. As of the end of 2021, hydro, solar, and wind accounted for 40%, 28%, and 27% of total installed renewables' capacity, respectively.

Levelized Cost of Electricity

The Levelized Cost of Electricity (LCOE) of technology is the "ratio of lifetime costs to lifetime electricity generation" (IRENA, 2022). It's a measure of cost relative to the tech's ability to generate electricity. The ratio is calculated by dividing the present value of lifetime costs by the present value of the lifetime electricity generated. This measure is useful in providing a general overview of the competitiveness of different projects; its flaws are being static (doesn't account for market dynamics), discounting the timeliness of energy production and its relevance in a market where supply and demand can be volatile, disregard alternative revenue and cost sources. LCOE should thus be looked at as a general indicator, and not as a definitive measure of a project's overall competitiveness. Other factors, such as capacity factor, total installed costs, and operating and maintenance costs must be analyzed.

Cost Drivers

Renewable energy projects are subject to costs, as any other project. These costs are impacted by the inputs used and any event that impacts its price. Commodities are an important driver of renewable energy projects – they make up a large proportion of the total installed costs. Solar PV projects are affected by the prices of modules and inverters, racking and mounting systems, cabling, and wiring; onshore wind projects require wind turbines. The aforementioned components are manufactured using commodities such as Nickel, Cobalt, Iron ore, Copper, and Aluminium. On top of these costs are other costs such as labour, legal and financial expenses, distribution, and installation. Appendix I shows that the Energy Transition Metal Index has moved alongside the All-Commodity Price Index. Both Indexes saw a sharp decline in 2020, motivated by the rapid decrease in demand brought on by the pandemic and consequent lockdowns. The decrease was followed by a steep increase that lasted from mid-2020 until mid-2022. The metals mentioned above as critical for projects experienced similar evolutions, although Cobalt and Nickel showed the most volatility. Looking back on the events of the past 3 years, one can argue that the economic landscape set up all the conditions necessary for commodities to appreciate – Covid-19 disrupted supply chains all around the world and diminished demand (as a result of the drop in demand, solar PV modules and wind turbines recorded all-time cost lows, and lead time for projects increased); the end of lockdowns in the aftermath of the pandemic caused a boom in consumer demand as economic activity resumed and stimulated the demand for inputs; fast forward to early 2022, the Russia-Ukraine conflict again disrupted supply chains all around the world and restricted supply of inputs, commodities among them.

Despite the unfavourable economic conjecture for commodity prices, technological efficiency improvements can mitigate the cost increases, to a certain extent. Contributing to the input prices' increase, disruptions in supply chains created a lag in the projects' development, increasing lead time. As a consequence, commodity price increases are expected to be reflected in the coming years' projects. On a global scale, China and India hold a competitive advantage as far as development cost goes.

Costs and Capacity Factor

Two of the most important drivers of renewables' success are their associated cost and their capacity factor. The costs associated with projects are relevant in the sense that they motivate the adoption of renewable energy sources by adding to their value proposition – total installed costs encompass every expense incurred in completing a project (planning, engineering, and construction); operations and maintenance (O&M) costs include all costs associated with the functioning of the infrastructure assembled; the capacity factor represents the efficiency with which energy is produced (percentage of total energy generated, compared to the total maximum annual output). According to IRENA's (International Renewable Energy Agency) "Renewable Power Generation Costs in 2021" report, costs for projects are lower in emerging countries, as opposed to those developed in Organization for Economic Cooperation and Development (OECD) member countries. China and India hold competitive advantages in these markets because of lower costs.

Capacity factors have also increased for wind and solar projects – the increase can be explained by a better geographical allocation of such projects, better tracking, and increased efficiency. The data on total installed costs and capacity factor evolution can be found in Appendices J and K, respectively.

Solar PV

The LCOE for Solar PV projects commissioned in 2021 decreased by 13%, compared to 2020; this decrease was larger than the 11% reduction experienced in 2020. Since 2010, LCOE decreased 88% overall, mirroring the technological improvements that reduced costs – total installed costs decreased by 6% -, especially in modules' prices, and the increasing energy revenues. As far as geographies, it is to be noted that China accounted for 35% of the newly added capacity. The average total installed cost for utility-scale Solar Photovoltaic projects has decreased to a fourth of the cost in 10 years (from 2010 to 2020). This reduction was driven by the rapidly reducing costs of Solar PV modules (in 2021 an increase in this cost was registered, which is attributable to disruptions in supply chains). Over the last decade, optimization of system designs and competitive pressures have combined to reduce O&M costs. Preventive maintenance and module cleaning are the most relevant O&M costs – in the US, they amount to 75% - 90% of total O&M costs, with the rest being made up of component replacement, lease costs, and any unforeseen maintenance.

Onshore wind

The LCOE for commissioned onshore wind projects decreased by 15% in 2021. Once again, China is responsible for 41% of newly added capacity. Utility-scale onshore wind projects' total installed costs weighted average decreased by 35% in 10 years (+5% YoY in 2021). The determinants of the capacity factor for onshore wind projects are two: the wind resource of the location where the farm is situated (most impactful) and the quality of turbines and balance-of-plant technologies. The global weighted average capacity factor for onshore wind increased from 20% to 27%, between 1983 and 2010; from 27% to 39% in the 2010-2021 period, and the factor has remained 36% for 2019 and 2020. China, Brazil, and India have more mature markets, and their cost structure is lower than other countries'. O&M costs for onshore wind projects can reach 30% of the LCOE; recently, the trend is for the reduction of this proportion – increased competition, technological improvements, and an enhanced provider experience are justifications for the decreasing trend.

Bioenergy

For Bioenergy, the LCOE has been somewhat volatile, without a clear trend; from 2010 to 2021 it has decreased by 14%. Power generation through biomass is impacted by the type and supply of feedstock, the process of conversion, and the technology through which power output is generated. According to the European Commission, "Biomass is derived from organic material such as trees, plants, and agricultural and urban waste"; hence, the chemical composition (a cost per unit) of feedstock can vary widely, depending on the species used. Biomass has a low energy density, and logistics (collection and transport) make up for a higher percentage of costs.

Normally, feedstock only represents 20% - 50% of the LCOE. Total installed costs comprise four categories: (i) planning, engineering, and construction, (ii) fuel handling and preparation machinery, (iii) other equipment, and (iv) complementary infrastructure (roads, for instance). Cost trends are similar to that of other renewables, with eastern countries (such as China and India) exhibiting lower costs; however, the more competitive costs are a result of the primary objective of plants – in Europe, they are mostly used as waste management facilities. Further evidence suggests that, although most bioenergy plants are small-scale, there are economies of scale available. Currently, there is a trade-off between reaching the aforementioned economies of scale and supporting the consequent higher logistics costs. When the feedstock supply is stable throughout the year, capacity factors range from 85% to 95%, with plants that rely on biogases having a lesser capacity factor (50% to 60%). Aside from the handling of organic material, generators' average efficiency of 30% (which varies from 25% to 36%); combined heat and power (CHP) plants are more efficient, with overall levels of 85% not uncommon. O&M costs are lower for biomass plants – 2% to 6% of total installed costs.

Distributed Generation

Distributed generation includes "technologies that generate electricity at or near where it will be used, such as solar panels and combined heat and power" (EPA, 2023) and can either serve a single structure or be part of a microgrid. These technologies give rise to the so-called "prosumers" (consumers who also produce energy) and provide advantages such as security towards energy grid malfunctions or shortages, by eliminating the middle element between generation and consumption. When coupled with storage equipment (through batteries or others), distributed generation also provides flexibility to the grid by storing energy surplus and releasing it into the grid during times of peak demand.

Between 2019 and 2021, 167GW of total capacity was added in the form of distributed generation, of which 87GW has commercial/ industrial appliances and 80GW was destined for residential use (IEA, 2022). The International Energy Agency predicts that in 2022, 59GW was added in the form of solar PV. Of the 59GW, 65% was accounted for by China, Europe, and the US. Asides from its advantages, distributed generation in the form of solar PV has also benefited from technological improvements over time (like most renewable energy sources), and as a result, its LCOE has decreased by between 40% and 70%, depending on the region. In 2021, the overall distributed generation market had a size of $74.23B, which is expected to grow to $82.99B in 2022, and $130.26B in 2026 – which would imply a compounded annual growth rate (CAGR) of +11.9%. The European Union (EU) predicts distributed generation to account for 30% of energy consumption by 2030, and its shorter time-to-market and lesser bureaucratic requirements make it a very attractive sector, for Greenvolt in particular.

3.5. Industry Outlook

Energy demand is mostly concentrated in Transport, Manufacturing, and Buildings' appliances. Higher living standards and a growing population are contributing factors, while efficiency improvements mitigate that growth.

Over the next 30 years, energy consumption is expected to increase and level off at 13% higher than today's levels (DNV, 2022), a growth enabled by buildings and manufacturing (compensating for the decrease in energy consumption associated with transportation). On the supply side, the supply chain disruptions caused by a pandemic followed by an armed conflict involving Russia (the main supplier of natural gas to Europe) caused a surge in commodity prices, which will also inflate the costs of renewable energy projects in the following years (due to time lags between the purchase of inputs and the development of projects).

Electrification through renewables

Electrification has become a widespread trend and presents the main alternative to fossil fuels. As the main driver of decarbonization, grid-connected electricity supply is projected to grow by +2.7% yearly until 2050 (DNV). Coal-fired and gas-fired plants should see their share of the electricity supply reduce itself as renewables become more cost-competitive and financing pressures put a stranglehold on the continuation of fossil fuels as energy sources. However, fossil fuels should still play a complementary role in electricity generation, through smaller-scale plants operating on a when-needed base, providing flexibility to the energy supply. DNV projections of electricity generation point to 83% being attributable to renewables and 12% to fossil fuels, by 2050. Of total generation, 38% will be accounted for by solar PV and one-third by wind (75% onshore, 25% offshore). Overall, the output capacity of renewables should grow by a factor of 16 – and volatility of supply by only a factor of 2 to 4. Bioenergy's usage in transport should double, as its share in buildings' consumption decreases. Both solar PV and wind should see a decrease in their LCOE – solar's decrease will be powered by a reduction in investment costs, while wind should do so by increasing capacity factors.

Among renewable energy sources, solar PV should continue to dominate electricity generation due to its cost efficiency, despite losing overall market share. The share of wind in electricity generation should increase the most, from 6% currently to 50%, 40%, and more than 30% in Europe, North and Latin America, and Greater China, respectively. By 2050, Solar PV should increase its capacity by 44-fold. Onshore wind is expected to increase by 8 times its current value over the period 2020-2050.

Geographically, future energy demand should uniformize, with Greater China, the Indian subcontinent, and other emerging regions assuming roles as more significant markets.

Energy intensity is measured as the primary energy consumption by each unit of GDP. Over the next 30 years, energy intensity is expected to decrease by -2.7% per year.

3.6. Economic Outlook

In recent times, the World economy has suffered a series of external shocks – Brexit, Covid-19, and the Russia-Ukraine war. Appendix L presents the evolution of the GDP for the countries/ regions where Greenvolt is present. For most regions, 2020 was a year of economic contraction. In 2021, economies rebounded, and GDP grew in every country presented. Expectations for 2022 are for GDP growth, as economies continue to recover from the pandemic; this GDP growth, however, is propelled by the rampant inflation felt worldwide. Real GDP, despite rebounding in 2021, has slowed its growth and in some regions decreased in early 2022. The Russia-Ukraine conflict continues to fuel inflation and disrupt supply chains – commodity exports from the region slowed down, and financial and commercial sanctions limited energy imports from Russia. For most regions, the scenario is one of stagnation, with real GDP growth hovering near 0% in 2022 and inflation above the most common target of a yearly 2%. The OECD predicts that this reality will continue into 2023 and 2024 for all countries considered in the analysis. Appendix M presents the data.

The 2021 rebound from the pandemic caused a growth in the Consumer Price Index (CPI) for all countries/ regions considered, reversing the historically low inflation recorded in past decades, in most countries. Inflation was furthered in March 2022 by the start of the Russia-Ukraine conflict. Inflation data can be found in Appendix N.

Overall, the last two years created the “perfect” set of circumstances for a recession. In response to the rampant inflation, central banks opted to reduce the number of repurchase agreements and increase the interest rates. The main central banks adopted a contractionary monetary policy, despite the low efficacy of such policies in resolving an external supply shock-driven crisis. In 2021, the European Central Bank (ECB) reviewed its monetary policy strategy and established a clear and cut objective of exactly 2% inflation. To fulfil this objective, it was forced to raise interest rates, after a long period of rates near the zero lower bound. Raises began in July 2022, increasing 2.5 p.p. in just 6 months. Similar increases have been implemented by the Federal Reserve and the Bank of England, with more hikes anticipated, and rates expected to continue at historically high levels until inflation is controlled. Evidence of the interest rates and their evolution can be found in Appendix O.

Unemployment increased in 2020, 2021 and 2022, slightly trailing the economic cycle. Appendix P illustrates the employment rate for selected countries. Appendices Q and R present panel data of nominal and real wages, respectively. With inflation, real wages have stagnated, or decreased in some cases, during 2021 and 2022.

3.7. Porter's "n Forces Model"

A framework for analyzing an industry's attractiveness is offered by Porter's original "5 Forces Model". However, the model was criticized for: (i) not accounting for the different impact each force has on each firm, (ii) the focus on historical information, limiting the model's effectiveness to the short-term, and (iii) only being capable of analyzing one industry at a time, limiting the exercise when a firm is present in several industries. Grant (2005) suggested a sixth force – complementary products – because of its positive effects on the market attractiveness of the analyzed firm. Given the criticism described, I opted to perform an analysis considering 7 Forces, adding "Complementary Products" and "Government and Authorities" to the original model. The analysis will focus on the broad renewable energy market, as the demand and cost drivers are common among the segments.

Threat of new entrants

The threat of new entrants is determined by several factors: access to land, previous due diligence, prospects of a Power Purchase Agreement (PPA) and/or interconnection agreement, and access to capital. Access to real estate can be achieved through either the purchase or the lease of land. Given the present high-rate environment in the geographies where Greenvolt operates, the purchase of real estate is subject to higher financing costs through debt – leasing real estate is also a more accessible option. As far as operating expenditures go, the more pronounced expenses are those associated with specialized servicing required to operate and maintain the projects developed and operated and can vary with the project's size. Due diligence must be done before the development of a project – conducting environmental studies to assess the viability of the said project and obtaining any permits required for the development. High requirements for Capex and specialized knowledge constitute strong barriers to entry.

Threat of substitutes

Regarding substitutes, renewable energy firms benefit from the drop in fossil fuel's share of primary energy. The percentage has been decreasing across countries since 2011, at a steady pace (as shown in Appendix S). Concerning cost competitiveness, in 2021, 73% of newly commissioned renewable energy projects are set to reach a lower cost than the most cost-competitive non-renewable alternative, which increases the attractiveness of the industry.

Bargaining power of suppliers

Disregarding the possible moderating effects of each project's idiosyncrasies, unfavourable upstream market conditions in 2021 and 2022 are expected to ease in 2023. Solar PV modules and inverters are two of the most important components of solar PV projects, with both accounting for 15% - 54% of total installed costs; for all classes of PV modules, prices have dropped since January 2023, after an increase in 2022. For both solar PV, biomass, and onshore wind projects, increasing upstream competition among suppliers and technological advances have set up the conditions for a reduction in the bargaining power of suppliers.

Bargaining power of buyers

The bulk of customers for the industry are institutional clients, such as public sector companies and investment firms and are thus assumed to be well-informed and aware of the supply characteristics. However, given the geographical importance of energy sources and the decentralization trend recently observed, industry competitiveness is mostly felt among firms operating in geographically close markets. Also, energy demand has risen in recent years and is expected to continue to do so, while Governments find ways to push renewables as the main energy sources. Utility-scale renewable energy projects are also an attractive investment for individual or institutional investors for their decreasing LCOE.

Industry rivalry

Greenvolt had, by April 2023, 142MW of installed capacity in the biomass sector and 691MW in the pipeline for solar and onshore wind projects. For Y/E 2022, that would imply a 1.37% share of capacity for bioenergy (worldwide) and approximately 0.003% of added capacity for solar PV and onshore wind, combined, worldwide. The firm represents a very small proportion of the overall market. To date, NextEra (165.2GW), Vestas Wind (164.3GW), and Siemens Gamesa (122GW) stand out as the main operators in the onshore wind segment; Lightsource (23.6GW), Canadian Solar (23.5GW), and Brookfield Renewables (19.5GW) stand out in the utility-scale-solar solar PV projects. Regarding industry competitiveness, the outlook is challenging for Greenvolt, but it is also an expanding market with opportunities to grow.

Complementary products

Complementary products can be thought of as all devices that require electricity to function. Transportation and buildings stand out as the biggest users of electricity.

Green hydrogen can also be produced using other renewable energy sources. It provides flexibility to the grid by storing the energy generated by renewables that do not always match their supply with demand. Despite its ability to compete with other renewables, its complementary role in the generation process favours other renewables' future adoption and success. It is also worth noting that there are several types of hydrogen, depending on the generation process – in 2021, only 4% of Hydrogen production was done through electrolysis, with 96% being from fossil fuels. To enable hydrogen's potential, the European Union and U.S. have adopted policies such as the "EU Hydrogen Strategy" and the "DOE National Clean Hydrogen Strategy and Roadmap".

Government and Authorities

Governments are invested in promoting renewables as the main energy source. In Europe, the EU has presented the "REPowerEU" program, designed to deal with the increasing difficulties with energy provision. The program's agenda is to decarbonize industries through electrification and reduce energy dependence. Until 2030, 1256GW of total capacity is expected to be installed, and the set objective is for renewables to account for 45% of energy consumption. One of the bottlenecks pointed out by the EU on the projects' development was the licensing, advising Member States to implement legal changes to expedite the process.

In the U.S., policies are State-specific and vary from one region to another. Nevertheless, President Joe Biden signed the Inflation Reduction Act into law in 2022, with a planned investment of $369B in clean energy. Also, in November 2022, the United Nations COP26 event allowed for the pledge to a Global Energy Alliance for People and Planet, by participating countries, intended to bypass fossil fuels and promote renewable energy use in the growth of economies; the Global Methane Pledge, initiated by the EU and the US, aims to reduce methane emissions by 30% until 2030. This pledge was signed by OECD Member States and represents a collective commitment to speed up the energy transition. Overall, the regulatory framework and initiatives adopted by governments and other authorities increase the attractiveness of the industry.

4. IPO Pricing and Underpricing

4.1. Discounted Cash-flow (DCF) Valuation

To determine the appropriateness of the price set for Greenvolt's IPO, a valuation of the stock dated July 2021 is warranted. Such analysis runs the risk of look-ahead bias, as presently most assumptions undertaken in 2021 are verifiable and observable. Nevertheless, given the information available at the time, a valuation conducted using the DCF method yields a stock price valuation between €3.04 (pessimist scenario) and €8.99 (optimist scenario). I arrive at a €5.48 valuation using a geometric mean of all the scenarios' results. The following subsections explore the assumptions and underlying calculations used in the valuation.

4.1.1. Weighted Average Cost of Capital (WACC)

To compute the WACC, I need a cost of debt, a cost of equity, and a capital structure. Starting with the capital structure – as Greenvolt's equity did not have a market value as of June 2021, I shall use Y/E 2020 book values for both equity and debt, arriving at a 34% equity, 66% debt structure. The risk-free rate, obtained from Fernandez's (2021) Annual Survey on Market Risk Premium and Risk-Free Rate was 1.6% for Portugal, and the market risk premium was 7.1%. The unlevered beta (0.69) used was retrieved from professor Damodaran's website, referring to the Renewable Energy sector as of Y/E 2020. Considering the firm's capital structure, the levered beta is 2.2 (levered using Hamada's equation). The cost of debt was estimated by dividing interest expenses for 2020 by the average financial debt during 2020, and the effective interest rate associated with the firm's debt is 1.47%. I obtained a WACC of 6.626%.

4.1.2. Assumptions and Valuation

Sales growth assumptions are based on information available in reports dating from 2021, thus reflecting information known at the time which the valuation refers to. Table 4-1 presents the sales growth considered, computed as a weighted average of each segment's share of total revenue.

Business Segments	CAGR until 2030	CAGR until 2050
Biomass[1]	3.6%	1.2%
Solar PV[2]	21.5%	13.08%
Wind[2]	18%	7.6%
Distributed generation[3]	10.9%	10.9%
Weighted Average	**6,50%**	3,94%

[1]According to IEA's Sep'22 Bioenergy Analysis
[2]According to DNV's Energy Transition Outlook 2022
[3]According to Straits Research

Source: Own estimation

Table 4-1 Projected Growth Rates (and respective sources) as of July 2021

EBITDA margin was obtained by averaging the previous year's margins, thus obtaining a value of 36.3%. Given the stability observed in past years, the mean of margins is an accurate representation of the firm's profitability moving forward. For the add-back tax credit from depreciation, the previous year's depreciation expressed as a percentage of capital expenditures (Capex) was considered – except for 2020 (where Capex was exceptionally low), the average was 32.0% of Capex. The tax rate considered will be 25%, in line with FY19 (25.6%) and FY20 (25.2%), also based on Portugal's income tax on corporations of 21%, to which the municipal tax (+1.5%) is added, along with additional taxes in the form of autonomous taxation (on specific expenditures, as established by the Portuguese tax code). Capital expenditures were assumed to be equal, in terms of percentage of sales, to the average between FY20 and 1H2021 values – the value obtained is 28.1% of sales. Lastly, changes in working capital needs have had a negative average value of -5.1% (expressed in terms of sales), which is assumed to continue moving forward.

With all assumptions established, three scenarios were considered corresponding to different sales future evolution. The optimist scenario considered sales CAGR of +3.94% for perpetuity, assuming continuity of growth past 2050. The neutral scenario considered +2.93%, which is the implied CAGR from 2030 to 2050, thus separating the two periods' rates (which is plausible, assuming a slow-down of growth in the future). The pessimist scenario assumed a CAGR of +1.62%, on par with global real GDP (according to OECD projections for 2050). The resulting valuations are presented in Table 4-2. Assuming all three scenarios are equally probable, the valuation of Greenvolt's stock conducted in July 2021 returns an expected fundamental price of €5.48. Appendix T displays the computation of the estimated share price through the DCF methodology, assuming a neutral scenario.

Using the PER multiple, the price obtained is €5.55. The earnings per share (EPS) considered were the ones reported by each firm in the most recent (at the date of July 2021) earnings release (Appendix U). These values were annualized, assuming earnings would remain constant throughout the whole year. Ratios for two firms were not considered, thus arriving at a trimmed mean of comparable PER. Overall, the valuation returned a price of €5.52.

Scenarios	CAGR until 2050	Stock Price
Optimist[1]	3.94%	**€7.58**
Neutral[2]	2.93%	**€5.24**
Pessimist[3]	1.62%	**€3.61**
		€5.48

[1] Assuming same CAGR of 2022-2050
[2] Assuming same CAGR of 2030-2050
[3] Assuming CAGR of global real GDP, retrieved from OECD Data

Source: Own estimation

Table 4-2 Scenario Analysis of the July 2021 DCFF Valuation

4.2. Underpricing

The literature explored in section 2 offers a simple definition of underpricing – positive returns on the first day of trading in a secondary market. In Greenvolt's case, the daily returns were positive in the first 5 days of trading in a secondary market, as Table 4-3 details.

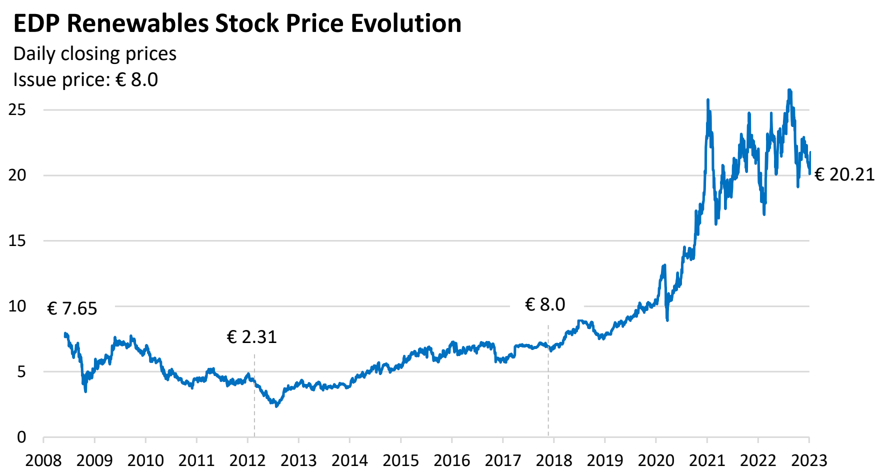
	Daily return	Cumulative return
Day 1	9,6%	9,6%
Day 2	0,2%	9,9%
Day 3	-4,2%	5,3%
Day 4	1,6%	6,9%
Day 5	4,1%	11,3%
Day 6	0,2%	11,5%

Source: Own estimation

Table 4-3 Greenvolt Stock Daily Returns

In the first day, the stock earned a +9.6% return. After 5 days, the cumulative return was +11.5%. I can thus admit that Greenvolt's shares were underpriced at issuance, using both the 1-day and first week periods as reference. However, the price only rose to the value of the valuation previously presented by August 23rd 2021, when it reached €5.4 by close. According to both the initial valuation and the valuation conducted, Greenvolt's issuance was underpriced.

Given the explanatory theories presented in this thesis, I can analyse the validity of such explanations in Greenvolt's specific case. To draw better conclusions, I will refer to the case of EDP Renewables as a comparable case. EDPR is a competitor of Greenvolt, is based in Spain, and has a strong presence in Portugal. Its IPO was held in 2008 and, despite the different economic backdrop, the similarities in industry and geography allow for a somewhat reliable comparison. Unlike Greenvolt, EDPR's stock price experienced a drop immediately after the IPO. With an issuance price of €8.0, the stock price decreased 4.3% over the first trading day, and only reached the issue price again in 2018, almost 10 years after the issue. Between both timeframes, the stock hit an all-time low at €2.31. Figure 4-1 depicts the stock price's evolution.



Source: Yahoo Finance (2023)

Figure 4-1 EDPR Stock Price Evolution

Another example of a renewable energy firm that went public and experienced an immediate rise in its stock price is Neoen, a French producer of renewable energy. Its stock price evolution is similar to that of Greenvolt – the stock showed a +3.6% return on the first day of trading, which turned to +9.0% in the first week, reaching a peak value of €64.03 and then experiencing a long period of instability with an overall drop in price, albeit to a price higher than at issuance. Like Greenvolt, Neoen also displayed underpricing at its IPO, registered a maximum price at one point in time, and then experienced an overall decrease marked by high volatility (Figure 4-2). As it operates in the same sector and had an IPO relatively recently, there is comparability to Greenvolt. Furthermore, both firms have operations concentrated in the European market.

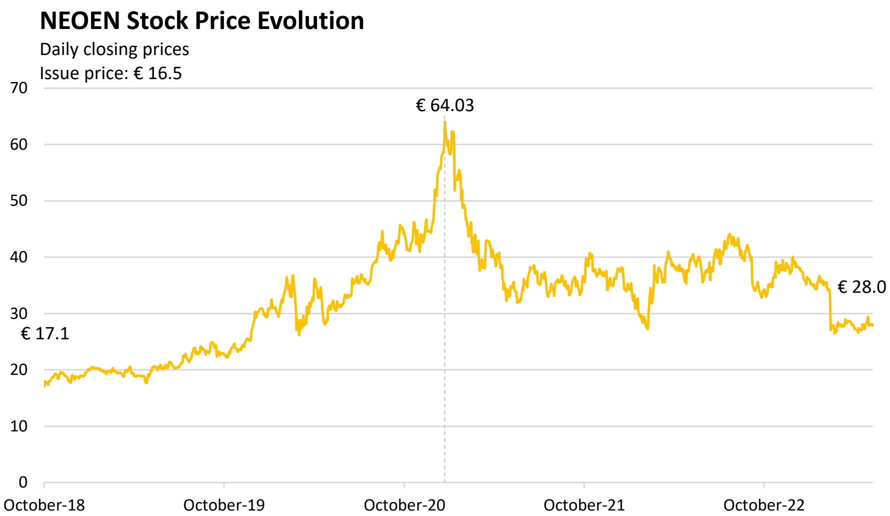


Figure 4-2 Neoen Stock Price Evolution *Source: Yahoo Finance (2023)*

4.2.1. Winner's Curse, Ownership Dispersion and Liquidity

Rock (1986) assumed that one of the motives for IPO underpricing was to motivate uninformed investors to participate, thus dispersing the ownership of the stock and promoting liquidity in financial markets. Underpricing is a cost for every individual firm and benefit for all, collectively. In Greenvolt and Neoen's case, the dispersion of ownership was much more pronounced.

As figures 4-3 and 4-4 detail, Greenvolt's and Neoen's ownership structures, post-IPO, immediately became much more diversified than EDPR's – only 58.7% and 50% (respectively) of ownership were retained by the parent company (vs. 62% in EDPR's case), and no other single shareholder holds more than 10% of the firm's equity. It's also worth noting that *Hidrocantábrico*, although a separate entity, was 97% owned by EDP at the time of the issuance. Fast forward to the present, EDPR's shareholder structure has concentrated further, while Greenvolt and Neoen's ownership is more diversified – free floating of 32.5% and 45.1%, respectively – than EDPR's – 22% free float (Figure 4-5).

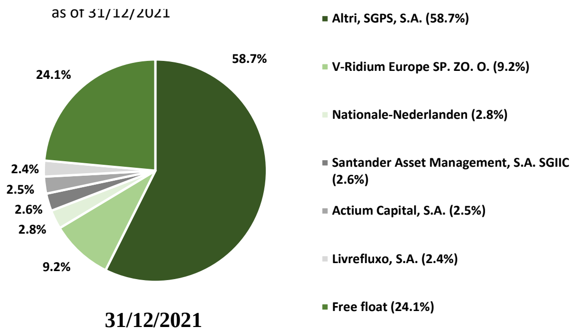
Similar to Greenvolt, Neoen's stock suffered from underpricing (as defined by the literature). Given the outcomes as far as ownership dispersion goes, I can speculate that both Greenvolt and Neoen wished for a more disperse ownership and opted to underprice their issues to pursue that goal.

Thus, Greenvolt's IPO would have been underpriced to diversify the ownership structure, whilst EDPR opted for a more concentrated shareholder structure and hence saw no need to underprice the issue. The possible underlying motives for the assumed goal of Neoen and Greenvolt stem from higher liquidity of the firms' stocks, as well as increased control over operational decisions. Concerning the latter, I highlight the fact that in both cases, the original Group parent company retained at least 50% of ownership immediately after the IPO. However, both parent companies have since relinquished their majority holdings and the possibility of retained control as a motivation for the underpricing can be discarded.

Contrary to Rock (1986), Stoughton and Zechner (1998) argue that block ownership should be desirable to the firm. The rationale is that block owners, given their higher investment, will be more motivated to produce information and monitor the company's performance, thus incurring monitoring costs otherwise bared by the firm. This could be argued as the motivation for EDPR's issue price.

Based on the information available, I can establish that (i) Greenvolt's and Neoen's IPOs were underpriced, whereas EDPR's was not, and (ii) Greenvolt's and Neoen's shareholder structure post-IPO was more diversified than EDPR's, post-IPO. It is worth mentioning that the indicative price range, as announced by Greenvolt before the IPO, was from €4.25 to €5.0, with the firm opting to go with the lower limit. The option of a lower issue price also supports the claim of underpricing having served as a tool to accomplish a set goal.

However, it is recognized that it is not possible to establish a causal relationship between the two facts, nor do these observations serve as confirmation of Rock's (1986) theory. To further investigate this relationship and theory applicability, qualitative research (i.e., management interviews) could yield more adequate and insightful data.



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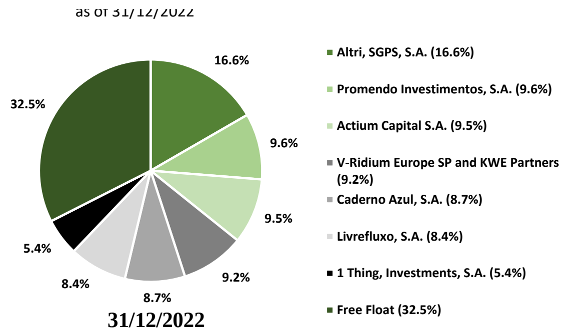

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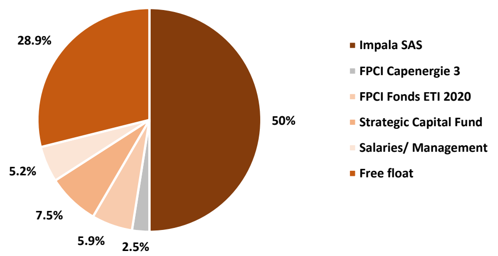
Figure 4-3 Greenvolt Ownership Structure Evolution

Source: Greenvolt Website (2023)



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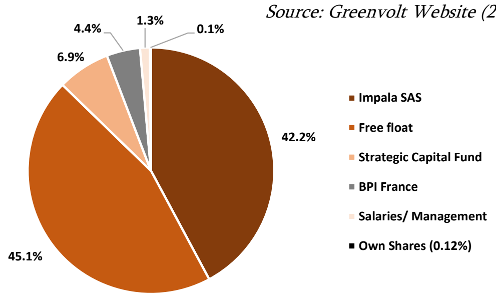

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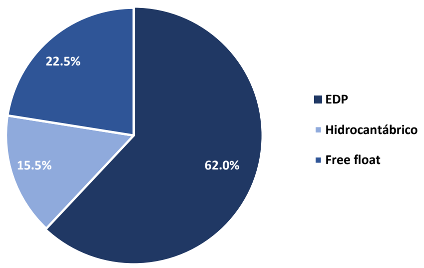
Figure 4-4 Neoen Ownership Structure Evolution

Source: Neoen Annual Report (2023)



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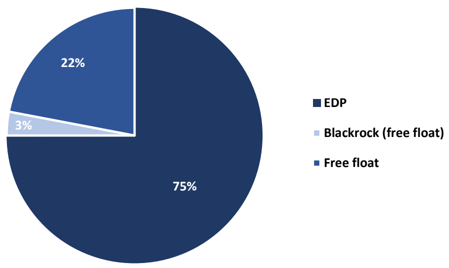

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Source: EDPR Website (2023)

Figure 4-5 EDPR Ownership Structure Evolution

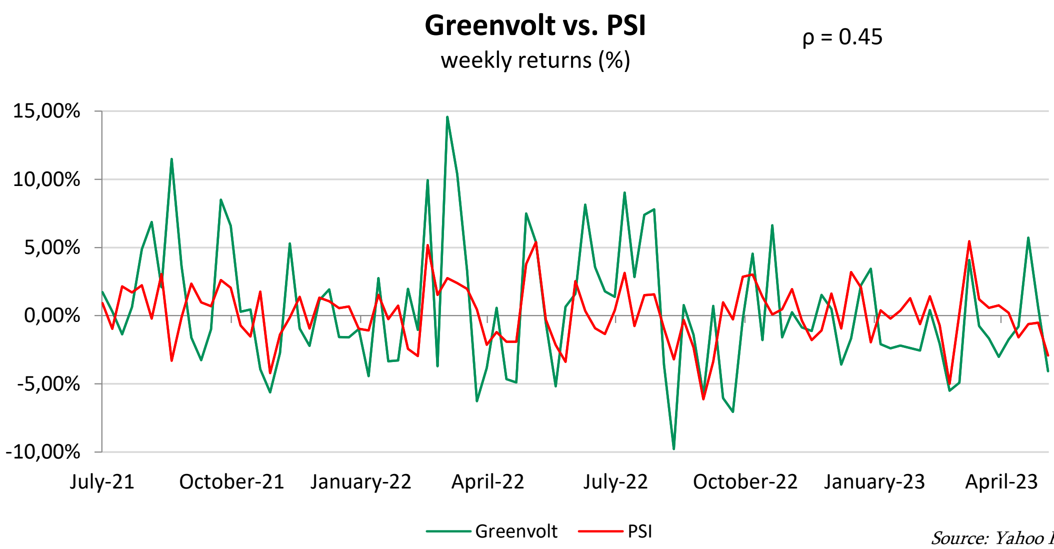
4.2.2. Underpricing as a Signalling Tool for SEO Profit Maximizing

Ibbotson (1975) argues that IPO underpricing can be used to take advantage of investors' favourable views towards the firm – by underpricing an issue, a firm can build "good faith" and a general good feeling towards it, by enticing investors with higher, more probable returns on the stock. The firm can then take advantage of this by, upon an SEO, setting a higher issue price and reaping the benefits in the form of increased issuance profits.

In Greenvolt's case, the SEO was announced to have a stock price of €5.62 per share, at a time the stock traded at €7.33 per share. Furthermore, the target price of the stock was €8.14 (according to *MarketScreener* website). As such, I can safely assume that Greenvolt did not take advantage of this strategy, making it unlikely to be the motivation for the IPO underpricing. The argument could be made, however, that the firm can extract its benefit from a future SEO. A similar situation occurred with Neoen – the SEO, announced on March 7th 2023, will be priced at €20.45 per new share, whereas at the time the market price was €27.63. Qualitative data obtained from management could prove useful in assessing the truthfulness of this theory.

4.3. Post-IPO and Long-Run Performance

Since its IPO, Greenvolt stock has outperformed several market indexes. Over that period, it has exhibited a cumulative +37% return, outperforming the PSI index by +22 p.p., the STOXX600 by +36 p.p., and the S&P 500 by +40 p.p. To better understand this performance, I will analyze the evolution of the stock price in comparison to an index's evolution. The option to compare Greenvolt's returns to a European Index is driven by (i) the relatively small dimension of the Portuguese Stock Index (PSI), making it closely related to, and influenced by, Greenvolt's stock price evolution, and (ii) the international scope of Greenvolt's activities, presently concentrated in Europe. Figure 4-6 displays the comparison between the weekly returns of Greenvolt's stock and the PSI index. When overlapping Greenvolt's weekly returns against the index's, the closeness in variation is evident – Greenvolt exhibits a greater variation, which is to be expected given that the index is a composite of several companies from different industries, thus displaying lower volatility.



Source: Yahoo Finance (2023)

Figure 4-6 Comparison of Greenvolt and PSI index weekly returns

Given the obtained coefficient of correlation (0.45) and, by extension, the low explanatory power of the relationship between Greenvolt and the index's stock returns, I shall consider a larger, less correlated (coefficient of 0.29) index – the Euro Stoxx 600 Index. The comparison is shown in Appendix V. Figure 4-7 displays the evolution of the difference between the returns of the two. To also separate between industry-specific and firm-specific factors affecting stock price evolution, a comparison is drawn between Greenvolt's stock and that of compatible firms (EDPR, Neoen, and Iberdrola) – Figure 4-8 displays the difference between weekly returns.

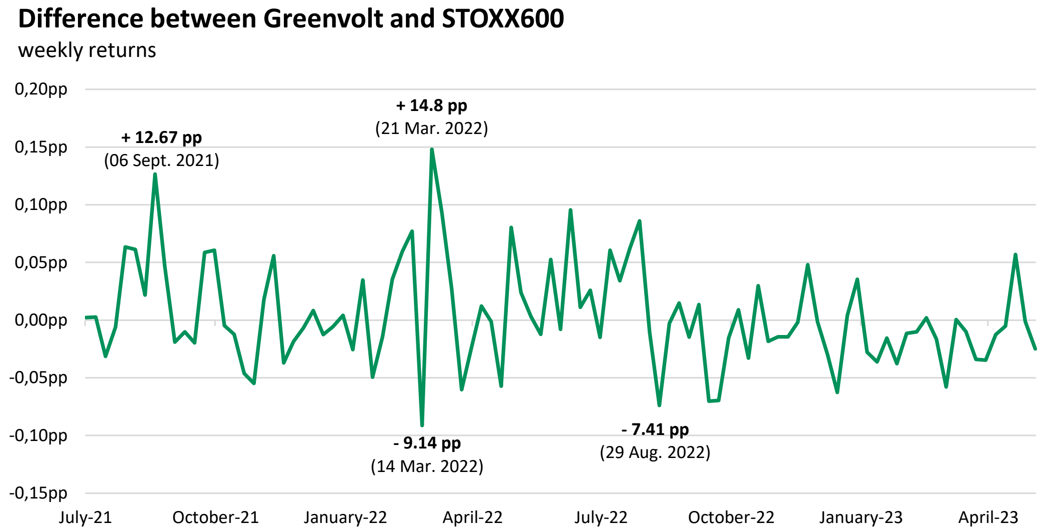


Figure 4-7 Difference between Greenvolt and STOXX600 index's weekly returns *Source: Yahoo Finance (2023)*

Over the three months from August to October 2021, energy price indexes were amid a period of increases – the Average European Wholesale Energy Price rose 80%, while the Global Price of Energy Index (GPEI) rose 41.5%. In November, the GPEI decreased for the first time in 19 months (while average Wholesale energy prices' growth slowed down). These variations in energy prices are thought to have significantly impacted Greenvolt stock, both in the initial growth period and the subsequent deceleration. However, Greenvolt stock appears to have also outperformed its comparable firms. Over that period, Greenvolt stock price grew +45%, while the index grew +1.2%; comparable firms grew +16%.

From September 2021 until March 2022, Greenvolt (+10.5%) outperformed both the index (-3.7%) and comparable firms (+1%). During this period, commodity prices experienced an increase, specifically Cobalt, Nickel, and Copper, which are all important inputs in electrification and the energy transition, and major cost drivers for the renewable energy industry. However, commodity prices do not seem to have had an impact on the share price of Greenvolt or any of the comparable firms – the Global Energy Price Index experienced a 55.8%

increase during that timeframe, which could have offset the increasing cost base and fuelled more optimistic expectations.

Greenvolt's stock performance seems to not have been hampered by the beginning of the Russia-Ukraine military conflict (which started in the last week of February), but rather favoured, as the stock grew 33.9% in the month of March 2022. Comparable firms also increased 17.3% over the month of March, while the index grew 8.7%. The interpretation can be that the bottlenecks created in the natural gas supply, coupled with the overall rise in the price of energy, affected renewable energy positively, as it is the main substitute to the current European energy imports. Renewable energy stocks continued to grow from March 2023 until mid-August 2022 – with Greenvolt (+48%) continuing to outperform comparable firms (+18%) and the index (-6%). Greenvolt reached its all-time maximum price of €10.8 on August 16th. This period of growth was accompanied by an increase in energy prices and a decrease in commodity prices.

From mid-August 2022 until May 2023, the roles were reversed with renewable energy firms underperforming against the index (-31.6% for Greenvolt; -21.2% for comparable firms, +10.6% for the index). In that timeframe, energy prices started to decline, and commodity prices stabilized. Further analysis shows that Greenvolt's pattern of immediate overperformance towards an all-time high price, followed by underperformance (against the index) is mirrored by Neoen – all-time maximum price of €64 in January 2021, followed by a 56.5% decrease from January 2021 to May 2023. This pattern is in line with Ibbotson and Ritter's (1975) hypothesis of long-run underperformance by firms with underpriced IPOs. However, we note that in Greenvolt's case, the underperformance relative to the index is currently only in the medium-term – more data is needed to extrapolate the conclusion to the long-term.

Overall, Greenvolt's returns have been in line with comparable firms', despite having displayed higher volatility. The increased volatility may be driven by higher IA surrounding the firm, stemming from the innovative business model and short time of existence.

To assess whether the price decrease was driven by fundamental factors, I shall perform a second valuation, dated May 2023.

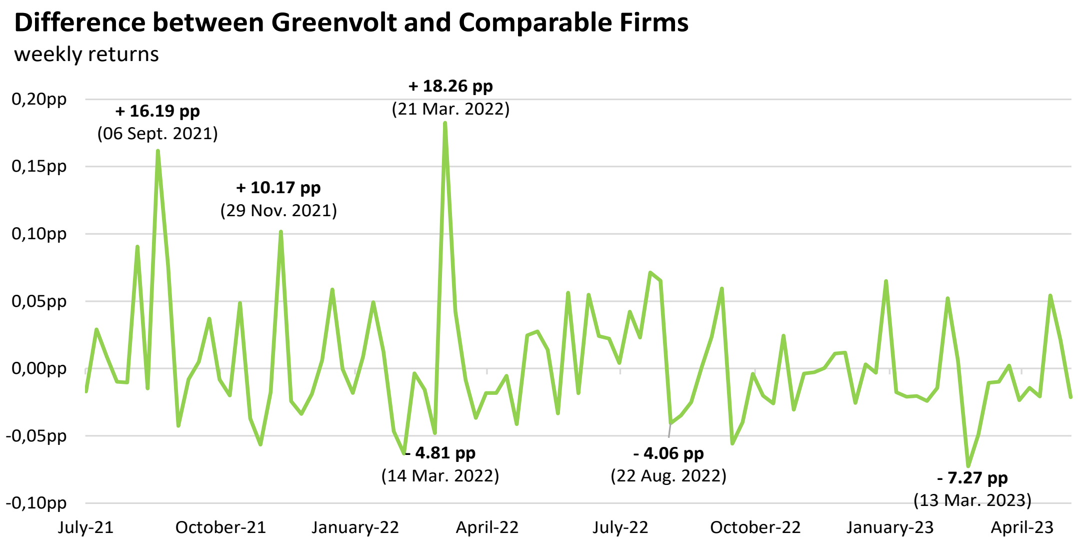


Figure 4-8 Difference between Greenvolt and Comparable Firms' weekly returns *Source: Yahoo Finance (2023)*

4.4. Valuation as of May 2023

Application of the DCF method will require forecasts of the firm' FCFF, which will be done for 2 periods: the first will be 8 years (from 2023 to 2030), and the second will assume a perpetual timeframe – both will be forecasted through historical financial information (published by the entity itself, using data from 2018 to 2022) and market outlooks for the company's three specific segments. Discounting the forecasted FCFFs will require a discount rate; in this case, the WACC will be used, which in turn requires the computation of a (i) cost of debt, (ii) cost of equity, (iii) tax rate, and (iv) relative weightings of debt and equity. The cost of debt will be obtained through the implicit yield of the company's issued and tradeable bonds. To determine the cost of equity, the Capital Asset Pricing Model (CAPM) will be used, which will require a market risk premium, a risk-free rate, and a beta. Both the risk-free rate and the market risk premium used are those available for consult on online platforms.

For the Multiples methodology, widely used multiples, PER, and EV/ EBITDA ratios will be resorted to, to reach a second valuation. All values computed and presented can be found in detail in Appendix W, assuming the neutral scenario.

4.4.1. DCF Valuation

WACC

As previously stated, WACC computation requires the cost of debt, the cost of equity, and the relative proportion of equity and debt in the company's funding. Using WACC as a discount rate enables us to account for the different funding costs, thus considering the cost of capital for both debtholders and shareholders.

The WACC obtained is 5.743%. Details on the computation of this value can be found in the following subsections. The applicable corporate tax rate is 25%.

Cost of Debt

Obtaining the cost of debt can be hard to do, especially when the firm resorts to different debt sources, with different interest rates associated. To reach the market value of debt, the pricing of the firm's bond issues can be used to compute an approximated value. Considering the market's pricing of the bonds, its yield-to-maturity can be extracted, which can be thought of as the cost of the firm's debt in financial markets. Currently, Greenvolt has 3 bonds priced, as detailed in Appendix X. To reflect the cost of debt more comprehensively, a weighted average of the different yield-to-maturities (considering each bond's nominal value, as retrieved from Bloomberg) shall be considered. As of May 6th 2023, the value obtained is 4.97%.

Cost of Equity

The risk-free used in the CAPM shall be the yield of German 10-year Treasury Bonds, to factor in the country's risk premium. The value of the yield on May 7th 2023 was 2.275% (according to the website "Trading Economics").

The beta for the company can be calculated by the following equation.

$$\beta = \frac{Cov(R_e, R_m)}{Var(R_m)} \tag{12}$$

The expected market return can be that of the DAX Index. Both returns have been computed using daily values, from July 15th 2021 until April 26th 2023. The obtained value was approximately 0.39.

Finally, several possibilities for the calculation of the equity and country risk premium were considered. This information is provided directly by some sources (Professor Damodaran's website), and this thesis will consider those values. This method provides us with a value of 5.94% for Germany's equity risk premium and 3.29% for Portugal's country risk premium.

The final value of the return on equity (levered) was 7.856%.

Capital Structure

Equity market value is computed by multiplying the number of shares outstanding by the stock's price. As of May 6th, 2023, 129,858,410 common stocks were outstanding, at an individual price of €6.11 – Greenvolt's equity market is thus €793,434,855. Part of the firm's debt is not traded and consequently not priced in markets. Nevertheless, the current pricing of the firm's issued bonds (average of 100.52) allows us to estimate the market value of debt – app. €833m. The firm's capital structure will then be: 48.8% equity and 51.2% debt.

Sales and profitability

Future sales will be computed using the market outlook for each of the firm's segments. The capacity of Solar PV and onshore Wind are expected to increase, respectively, 44 and 9 times their current values, until 2050. Projections for 2030 point to solar PV increasing 7-fold (according to DNV's Energy Transition Outlook). These figures imply the CAGRs presented in Table 4-5. Market outlooks for the distributed generation sector point to a CAGR of +10.9% from 2022 to 2030 (Straits Research). Given the lack of forward-looking information available, this rate of growth is assumed to continue until 2050. The worldwide biomass market is expected to exhibit a +3.6% CAGR until 2030, with demand and supply levelling off after that – the CAGR until 2050 is +1.2% (DNV's Energy Transition Outlook). According to the FY22 reported results, biomass and structure accounted for 73% of Greenvolt's revenue, while the utility-scale project development and distributed generation sectors account for 10.5% and 16.5% of Greenvolt's revenue, respectively. Considering the firm's current revenue structure and the detailed projected annual growth rates, a weighted average enables the estimation of the sales growth for the firm until 2050. Two periods are thus considered: (i) the period between 2023 and 2030, and (ii) the perpetuity starting in 2031 (assuming the growth rates projected until 2050 will continue). The information is presented in Table 4-4.

Profitability will be assessed and forecasted based on EBITDA margin, as it is a good approximation of cash generation from operations – for the period analyzed, it remained between 33.5% and 40%. The average margin during that timeframe was 36.5%.

Business Segments	CAGR until 2030	CAGR until 2050
Biomass[1]	3.6%	1.2%
Solar PV[2]	21.5%	13.08%
Wind[2]	18%	7.6%
Distributed generation[3]	10.9%	10.9%
Weighted Average	**6,50%**	3,94%

[1]According to IEA's Sep'22 Bioenergy Analysis

[2]According to DNV's Energy Transition Outlook 2022

[3]According to Straits Research

Source: Own estimation

Table 4-4 Projected Growth Rates (and respective sources) as of May 2023

Working Capital Needs, Capex, and Depreciation

The firm's working capital management has deteriorated since its inception. Operational activities have gone from being able to free up short-term resources through negative working capital to requiring working capital investment. Working capital needs' variation, as a percentage of sales, increased from 2019 to 2022, with the average change being +2.8% from 2020 to 2022. Values for previous years were not considered, given the observed trend of increasing working capital needs. Thus, I shall consider constant working capital needs (2.8%) for the upcoming periods.

Capex has been volatile as a percentage of sales. Excluding the first two years, for which Capex was substantially higher than the remaining periods, the average value for Capex/ sales was 23.8%. Future Capex outflows are assumed to be consistent with this ratio.

Depreciation, as a percentage of Capex, assumed an average value of 41.7% in the years considered – excluding 2020, as the value was substantially higher than in years past (196.7%) – and the assumption is that this rate will continue moving forward.

The tax rate is assumed to be 25% for the short and long-term. This value is derived from the base corporate tax rate in Portugal (21%), to which are added the municipal tax rate (which is 1.5% in Porto, where Greenvolt is headquartered), other taxable income not included in EBT, and in the case of Greenvolt, CESE contributions (specific to the energy sector). Furthermore, this tax rate is close to the average effective tax rate over the period 2018-2022 (25.3%).

Valuation outcome

The obtained valuation was of €11.17 (Table 4-5). The average price, obtained through scenario analysis, is computed using a geometric mean, to limit the effect of the more extreme values.

Scenarios	CAGR until 2050	Stock Price
Optimist[1]	3.94%	**€18.72**
Neutral[2]	2.93%	**€9.42**
Pessimist[3]	1.62%	**€5.37**
		€11.17

[1]Assuming same CAGR of 2022-2050

[2]Assuming same CAGR of 2030-2050

[3]Assuming CAGR of global real GDP, retrieved from OECD Data

Source: Own estimation

Table 4-5 Scenario Analysis of the May 2023 DCFF Valuation

4.4.2. Multiples Valuation

For comparison, firms operating in the renewable energy market will be considered. Regarding the multiples to be used, Fernández (2001) identified the most used multiples in valuation – the PER, followed by the EV/EBITDA. In this valuation, both will be used.

$$PER = \frac{Price\ per\ share}{Earnings\ per\ share} \tag{13}$$

$$\frac{EV}{EBITDA} = \frac{Enterprise\ Value}{EBITDA} \tag{14}$$

Data for the comparable firms is retrieved from Yahoo Finance (on May 6th, 2023).

The last step in determining the estimated share price is to solve the equality between the comparable firms' average ratios and Greenvolt's ratio, solving for the share price as the following equation illustrates.

$$P_{GV} = \left(\frac{Price_{per\ share}}{Earnings_{per\ share}}\right)_{average} * Earnings_{per\ share_{GV}} \tag{15}$$

Results show a €2.91 valuation using PER, a €6.2 valuation using EV/EBITDA, and a €15.67 price through the Price-to-Book ratio. Appendix Y details the firms used and the results. The average valuation of the stock is thus €8.26, using the Multiples method. Considering both valuation methods, I arrive at a valuation interval of € $[8.26; 11.17]$ with an average price of €9.72. Considering the current stock price of €6.11 (May 6th, 2023), and the trend of underperformance observed over the last few months, the recommendation is to Hold Greenvolt stock. Out of the analysts covering Greenvolt, the most optimistic valuation was €11.0, and the most pessimist was €7.5. My valuation is thus in line with other analysts'.

4.5. Overall Opinion

Having analyzed the stock price's evolution from the IPO until the present, I conclude the following: (i) Greenvolt's issue was underpriced, (ii) the underpricing resulted, as suggested by the literature, in "long-run" underperformance of the stock (data available only allows for the conclusion to be made regarding the medium term), and (iii) according to the several valuation methods used, the stock still seems to be undervalued by the market.

Most underpricing theories rely on assumptions, often regarding behavioural characteristics of individuals; to explore these theories from an academic standpoint requires such assumptions to be made and, given the difficulty and uncertainty associated with verifying them, I shall focus on a more easily testable hypothesis regarding the cause of underpricing – information asymmetry. To fully assess its explanatory power of underpricing, I would need to have data on IA before the IPO, which is inexistent given the absence of pre-IPO stock price data. Instead, I will focus on proving IA's impact post-IPO, following Dierkens' (1991) hypothesis. By doing so, I can then speculate on the part IA may have played in Greenvolt's IPO.

5. Impact of the SEO announcement on stock price evolution

5.1. Market Model

To perform event studies such as the ones proposed, I am required to obtain estimates of the stock's excess returns. To do so, there are several methods/ benchmarks against which it is possible to derive the abnormal portion of the returns. In this thesis, I resort to the Market Model (MM). The MM divides returns into a systematic component (correlation to market returns) and an unsystematic component (the excess return). The correspondent equation is as follows.

$$R_{ij} = \alpha_j + \beta_{ij} * R_m + \varepsilon_{ij} \quad (16)$$

Thus, the excess returns, measured by the error of the estimate ε_{ij}, are assumed to be uncorrelated with the market return. The option to employ the MM is justified by its widespread usage and the smaller variances for abnormal returns it provides (Strong, 1992). The market return used will be calculated through the PSI index's daily values over Greenvolt's stock lifespan. The output of the model can be found in Appendix Z.

5.2. Statistical Assumptions

The following section is dedicated to studying the effect of the SEO, announced publicly on June 9th 2022, on Greenvolt's stock price returns. Asquith and Mullins (1986) stated that firms' excess (abnormal) stock returns were impacted negatively by an SEO, and that the average excess return was, on average, -2.7% on announcement day, and statistically significant.

Their research shows that this phenomenon was observed in 80% of the sample used. Furthermore, the study shows that before an SEO, firms would outperform the market by +33%, while after the SEO they underperformed by -6% (average values). Furthermore, Dierkens (1991) stated that the announcement of an SEO reduces, for some time, the information asymmetry surrounding a firm; the reduction in information asymmetry was measured by a significant reduction in the stock excess returns' variance in the periods surrounding results announcements thereafter. The goal of this subsection is to verify the applicability of these hypotheses in Greenvolt's context. To conduct the following analysis, assumptions need to be made and verified. The first is the normality of the underlying variable.

The presented graph displays the distribution of the firm's excess returns over the period considered. Visually, I can consider the variable to be approximately normal, positively skewed, and slightly platykurtic (Figure 5-1). Using a Kolmogorov-Smirnov test for normality (the null hypothesis is the normality of the probability distribution), I obtain a test statistic of

0.96. For a sample of 464 observations and a significance level of 5%, the critical value is 1.36. As such, I fail to reject the null hypothesis – I can assume the excess returns of Greenvolt stock price assume a normal distribution. The second assumption I must verify is the independence of returns – that daily excess returns are not influenced by previous days' excess returns. The usual assumption made is that stock prices are autocorrelated – Lewellen (2002) and Schwartz (1977). This hypothesis is based on the momentum phenomenon, where winners continue to outperform losers in the stock market over a 3 to 12-month period, falling in price thereafter. In general, past expectations regarding the stock's evolution will influence present and future investor sentiment. Nevertheless, I must objectively test for autocorrelation, using a Durbin-Watson test. The respective test statistic is calculated as follows.

$$d = \frac{\sum_{t=2}^{T}(e_t - e_{t-1})^2}{\sum_{t=2}^{T} e_t^2} \tag{17}$$

The test statistic obtained, as Appendix AA details, is 2.009. Since the value of the statistic is very close to 2.0, I can proceed under the assumption that the daily excess returns are not autocorrelated.

As far as homogeneity is concerned, Levene's test reveals no difference between the excess returns before and after the SEO announcement. Test results proved significant at a 5% significance level – p-value of 0.91 – validating the assumption of homoscedasticity.

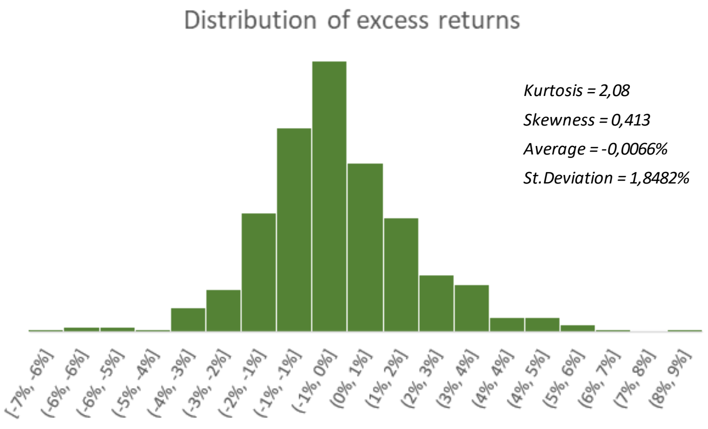


Figure 5-1 Probability Distribution of the Excess Returns *Source: Own estimation*

5.3. SEO announcement same-day excess return

Regarding the first hypothesis, using a market model (and the PSI index as a benchmark) I can ascertain that the average excess return for Greenvolt stock on June 9th and 10th of 2022 was -1.3%. To assess if this difference is statistically significant, I will refer to the so-called Cumulative Abnormal Returns (CAR).

$$CAR = \frac{1}{N}\sum_{i=1}^{N} \hat{u}_i \tag{18}$$

To test this hypothesis is to test the difference between the excess return on the day after the SEO announcement – $\mu_{day\ after\ SEO}$ – and the mean excess daily returns up until the SEO announcement – $\mu_{up\ to\ SEO}$.

The hypothesis under testing is as follows.

$$H_0: \mu_{up\ to\ SEO} = \mu_{day\ after\ SEO}$$

Using a t-test, the test statistic is the following:

$$t = \frac{\left(\mu_{day\ after\ SEO} - \mu_{up\ to\ SEO}\right)}{\frac{\sigma_{up\ to\ SEO}}{\sqrt{n}}} \tag{19}$$

As displayed in Appendix AB, the test statistic's value is -821.6 and the critical value (with a 5% significance level) is 2.256. Thus, I reject the null hypothesis, confirming Asquith and Mullins' (1986) findings – the daily return after the SEO announcement is both negative and statistically significant at a 95% level of confidence.

5.4. Impact of SEO announcement on excess returns

To assess the relationship between the returns of the two periods, I shall use a two-sample t-test to evaluate the statistical significance of the difference between the excess returns (i) before and (ii) after the SEO announcement. The selection of this test is explained by the fact (i) the two samples are uncorrelated (independence has been proven), (ii) the samples have different sizes, and (iii) the samples have the same variance (homoscedasticity has been proven). The hypothesis under testing is the following.

$$H_0: \mu_{before} = \mu_{after}$$

I begin by arranging returns as they occurred – before and after the SEO announcement. Given that there are 231 daily returns before the SEO, I shall consider the period starting on July 19th 2021, and ending on May 3rd 2023, thus giving us 464 daily returns. Before the announcement, I consider 231 observations (ending June 8th 2022); after the announcement. I consider 233 observations (ending May 5th 2023). The test statistic is calculated as follows.

$$t = \frac{\mu_{before} - \mu_{after}}{s_p * \sqrt{\frac{1}{n_{before}} + \frac{1}{n_{after}}}} \tag{20}$$

The obtained test statistic is 0.882. This value is below the 2.25 critical value (at a 95% confidence interval). As such, I fail to reject the null hypothesis and can conclude that the difference between the average excess returns of Greenvolt's share price before and after the announcement of the SEO is statistically insignificant. Appendix AC displays the relevant data. These results do not replicate the findings of the study conducted by Asquith and Mullins (1986). Despite this, a negative average excess return is observed after the announcement, while before the average excess return is positive (in line with the authors' hypothesis).

5.5. Impact of an SEO Announcement on Information Asymmetry

Dierkens (1991) hypothesized that the announcement of an SEO reduces the impact, for a limited period, of IA between a company's management and external stakeholders. This reduction in IA is measured by the variance of excess returns (of the company's stock) in the period surrounding announcements to investors. In this thesis, I will consider a 3-day period (the day before, the day of, and the day after an announcement), and only consider earnings and results announcements. A 3-day window is used to account for information leakages that may lead to early action by some investors that hold an informational advantage and to include the possibility of lagged responses by the market. Considering the variances of the stock's excess returns in each of these periods altogether, the null hypothesis being tested is the following.

$$H_0: \sigma_b^2 = \sigma_a^2$$

Where σ_b^2 is the variance of excess returns before and σ_a^2 is the variance surrounding results announcements in the period after the announcement of the SEO. Using an F-test, the test statistic is computed as follows.

$$F = \frac{\sigma_b^2}{\sigma_a^2} \tag{21}$$

All the events considered, and the statistical testing, are described in Appendices AD and AE, respectively. I obtained a test statistic of 6.91 and a critical value (at a 95% confidence interval) of 3.31. As such, I reject the null hypothesis and can state that the average variance of excess returns around the announcement of earnings is different after the SEO, compared to before. This difference is statistically significant, and thus consistent with the hypothesis put forward by Dierkens (1991) – the values computed show that the variance of daily excess returns surrounding an announcement is smaller after the SEO announcement.

6. Conclusion

The goal of this thesis is to analyze Greenvolt's stock price and deconstruct its evolution. I began by verifying the underpricing of the IPO – documenting the positive returns of the stock over the first day and week of trading. The first valuation conducted (dated July 2021) supported the underpricing claim – an average price of €5.52 was obtained. Having confirmed underpricing, I explored theories such as the "winner's curse" and signaling through underpricing. Based on the evidence collected, and using Neoen and EDP Renewables as similar cases for comparison, I concluded that ownership dispersion is a plausible motivation for the IPO underpricing. To date, the remaining theories mentioned are not considered valid.

Next, an analysis of the stock's historical performance to date was conducted, comparing the firm's weekly returns with those of the Stoxx600 index and of comparable firms. Greenvolt outperformed the index until August 2022 and underperformed it from then on. The underperformance can be attributable to (i) the continuing adverse macroeconomic context and/ or (ii) the original underpricing-driven returns, which became unsustainable in the medium term. Cross-sectional analysis exhibited similarities between Greenvolt's, and comparable firms' returns. In both comparisons, Greenvolt displayed greater volatility, likely reflecting a higher level of uncertainty from investors. A second valuation (dated May 2023) concluded that Greenvolt stock was still undervalued by the market – the obtained fundamental price was €9.72. Based on this and considering: (i) the uncertainty surrounding Greenvolt, (ii) the promise of the sector, and the innovative business model, I issue a recommendation to hold the stock.

Lastly, I delved into the impact of IA on the stock's price and volatility. I found that same-day excess returns on the SEO announcement date were negative and different from the mean excess returns to date, with statistical significance. The same result was found for the impact of the SEO announcement on excess returns in the post-announcement period. However, I uncovered a statistically significant difference between the volatility of stock returns in the three-day periods surrounding an announcement made by the firm, when comparing the periods before and after the SEO announcement – I found that the variance of excess returns is smaller after the SEO announcement than it was before. According to Dierkens (1991), this is because IA is lower after the SEO announcement, which constitutes an opportunity for narrowing the informational gap between internal and external stakeholders.

This dissertation sheds some light on Greenvolt stock's evolution – why it has captured the attention of investors and what has fueled its early success – and what impact did IA play. It also explores the role of IA in that evolution.

Regardless, this dissertation lacks applicability to other cases and is limited by (i) the relatively small amount of time series data available on Greenvolt, as far as both financial statements and stock price evolution are concerned, by (ii) a lack of qualitative data, due to time and resource constraints, that would prove useful in analyzing and confirming (or rejecting) the underpricing theories explored, and (iii) is very firm-specific in its analysis of IA and its impact, not enabling the generalization of findings.

For future research, it would be interesting to analyze Greenvolt's stock performance against the market and comparable firms over the long term, as well as the pricing dynamics surrounding any future SEO. As far as underpricing is concerned, a qualitative data-driven study (e.g., using interviews with market participants) into its motives would be better suited, given the potential of the existing behavioral theories and the limitations of a quantitative approach in the study of a phenomenon believed to be as influenced by human behavior as underpricing. Lastly, concerning IA and its impact, the research limitations involved with using proxy variables are acknowledged. Nevertheless, it would be beneficial to study its role in market dynamics using panel data from a broad set of firms, covering different geographical regions and industries, in an attempt to draw conclusions with higher applicability and thus more useful for market participants and information users. Additionally, future research should focus on analyzing potential causal relationships between the variables presented and events considered, as opposed to analyzing changes in variables' observed values given said events.

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Appendices

Appendix A

Growth Drivers for Renewable Energy Firms

Driver	Measuring Variable	Significance	Correlation with dependent variable
Firm-Specific Factors			
Size	Natural logarithm of market capitalization	Significant	Positive
Risk	Debt-to-assets ratio	Significant	Positive
Age	In years	Insignificant	-
Capital Intensity	Natural logarithm of CAPEX divided by sales)	Insignificant	-
Growth	Annual sales growth	Significant	Positive
Country-Specific Factors			
Change in electricity prices	Natural logarithm of the electricity price for industrial customers in the EU	Insignificant	-
Market Concentration	Share of largest electricity generation divided by total generation	Insignificant	-
Tradeable Green Certificate (dummy)	Available / Not available	Significant	Positive
Macroeconomic Factors			
Financial Crisis	Observations divided into pre and post financial crisis	Significant	Negative
GDP growth	Annual growth rate	Significant	Positive
Inflation	CPI	Insignificant	

Source: Morina et al. (2021)

Appendix B

Profitability Metrics for Greenvolt

EUR th	2018	2019	2020	2021	2022
Revenue	50 538	64 283	89 878	140 645	255 380
YoY Growth	*na*	*27%*	*40%*	*56%*	*82%*
EBIT	6 834	12 078	27 208	29 854	53 564
EBIT margin	*13,5%*	*18,8%*	*30,3%*	*21,2%*	*21,0%*
Net Income	5 204	6 792	17 926	12 253	25 492
net margin	*10,3%*	*10,6%*	*19,9%*	*8,7%*	*10,0%*

Source: Greenvolt Annual Reports (2018-2023)

Appendix C

Cash-flow Generation Metrics for Greenvolt

EUR	2018	2019	2020	2021	2022
Cash-flow from operating activities	9 180 027	30 337 547	28 643 596	28 203 613	21 770 989
Cash-flown from investing activities	-43 394 845	-31 847 231	-3 777 216	-235 932 517	-220 234 798
Cash-flown from financing activities	27 776 856	10 909 494	-26 872 981	450 719 568	326 063 338
Net Change in cash	-6 437 962	9 399 810	-2 006 601	242 990 664	127 599 529

Source: Greenvolt Annual Reports (2018-2023)

Appendix D

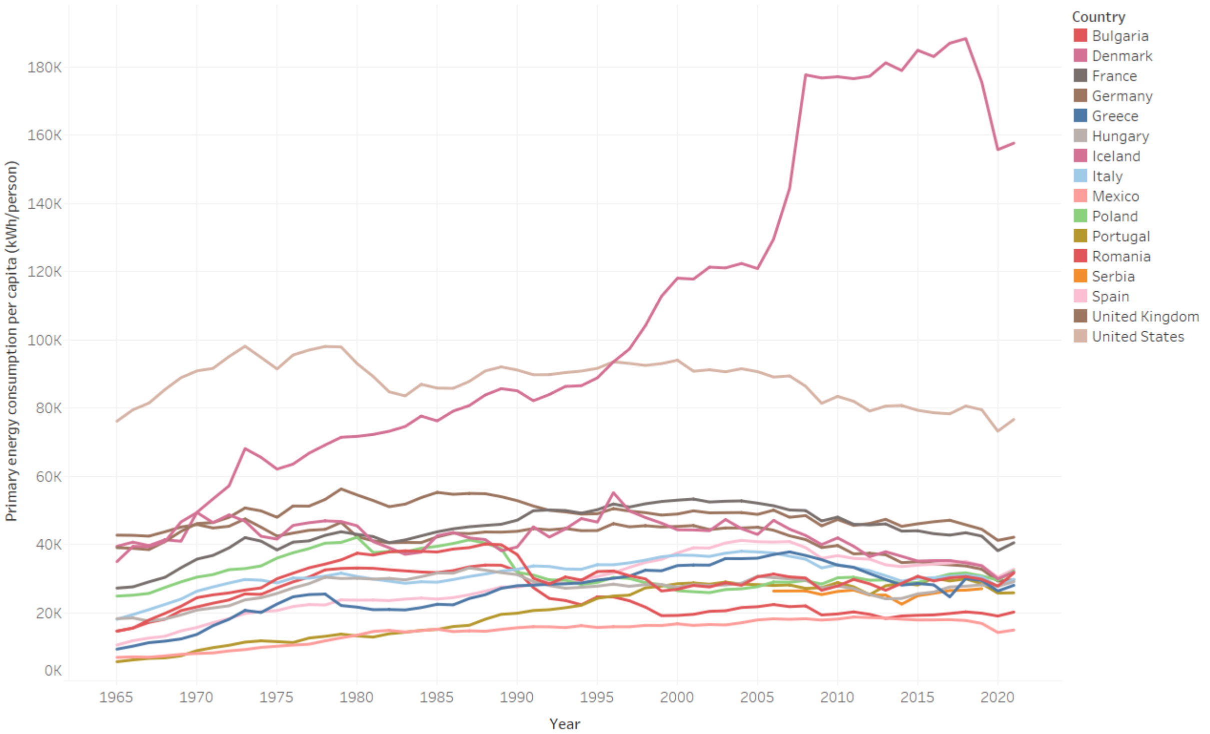
Breakdown of Greenvolt's Balance Sheet

Amounts in €m	2018	2019	2020	2021	2022
Non-current libilities + Equity	46.8	110.6	137.8	933.7	1315.3
Fixed Assets	148.8	176.5	174.2	679.2	974.9
Working Capital	-102,0	(65.8)	(36.3)	(254.5)	340.4
Cyclical resources	6.9	11.9	8.5	17.9	34.5
Cyclical needs	1.5	3.0	0.02	14.0	48.7
Working Capital needs	5.4	8.9	8.5	3.9	(14.2)
WC - WC needs	(107.4)	(74.7)	(44.9)	250.6	354.6
Cash & cash equivalents	6.7	16.1	14.1	258.8	381.0
EBITDA/Int. expenses	**32.4x**	**12.1x**	**18.4x**	**6.2x**	**2.6x**
Net debt/EBITDA	**5.2x**	**5.1x**	**2.5x**	**4.4x**	**4.9x**

Source: Greenvolt Annual Reports (2018-2023)

Appendix E

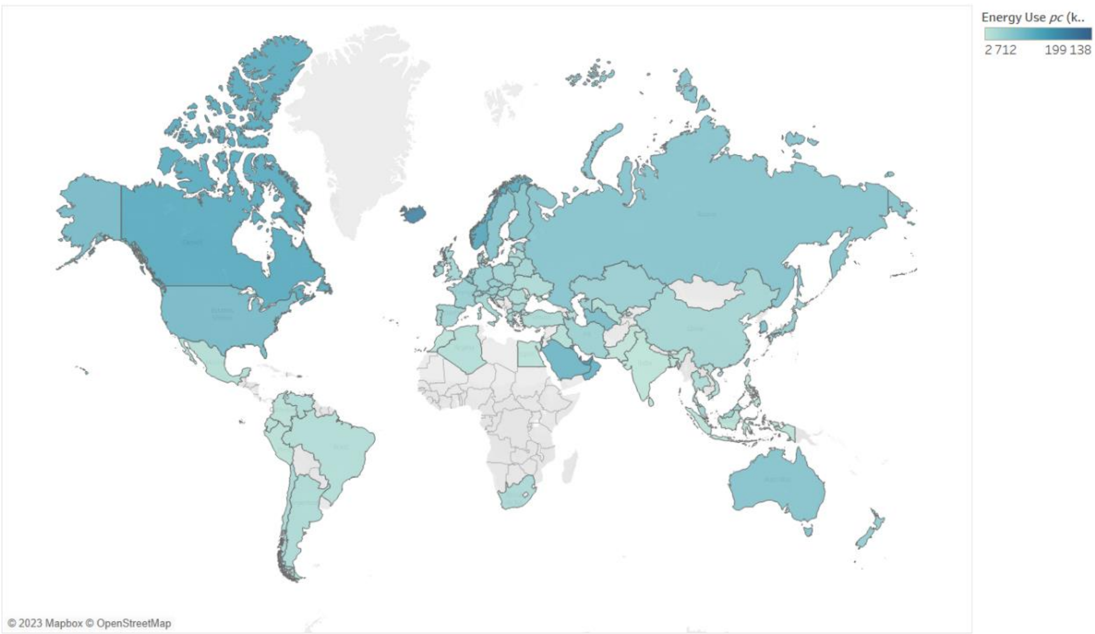
Energy use, *per capita*



Source: World Bank Database (2023)

Appendix F

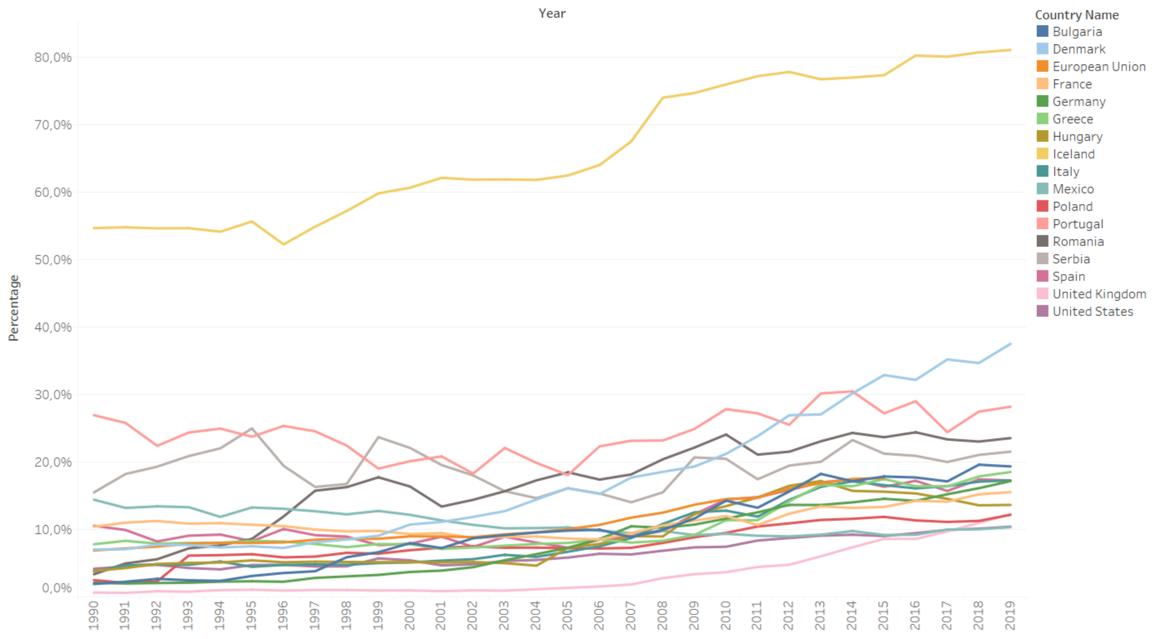
Energy use, *per capita*



Source: World Bank Database (2023)

Appendix G

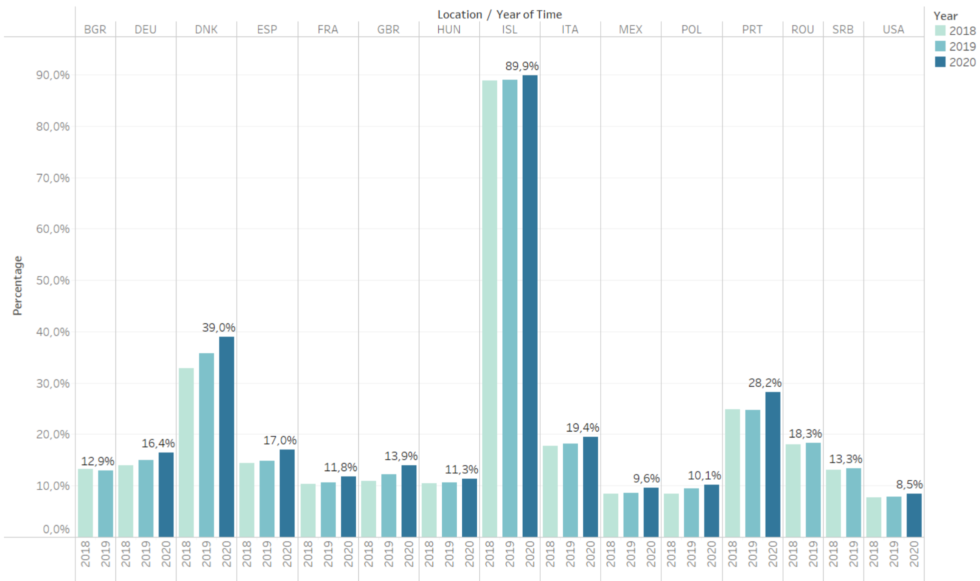
Percentage of Renewable Energy Sources in Energy Consumption



Source: OECD Data (2023)

Appendix H

Percentage of Renewable Energy Sources in Primary Energy Supply



Source: OECD Data (2023)

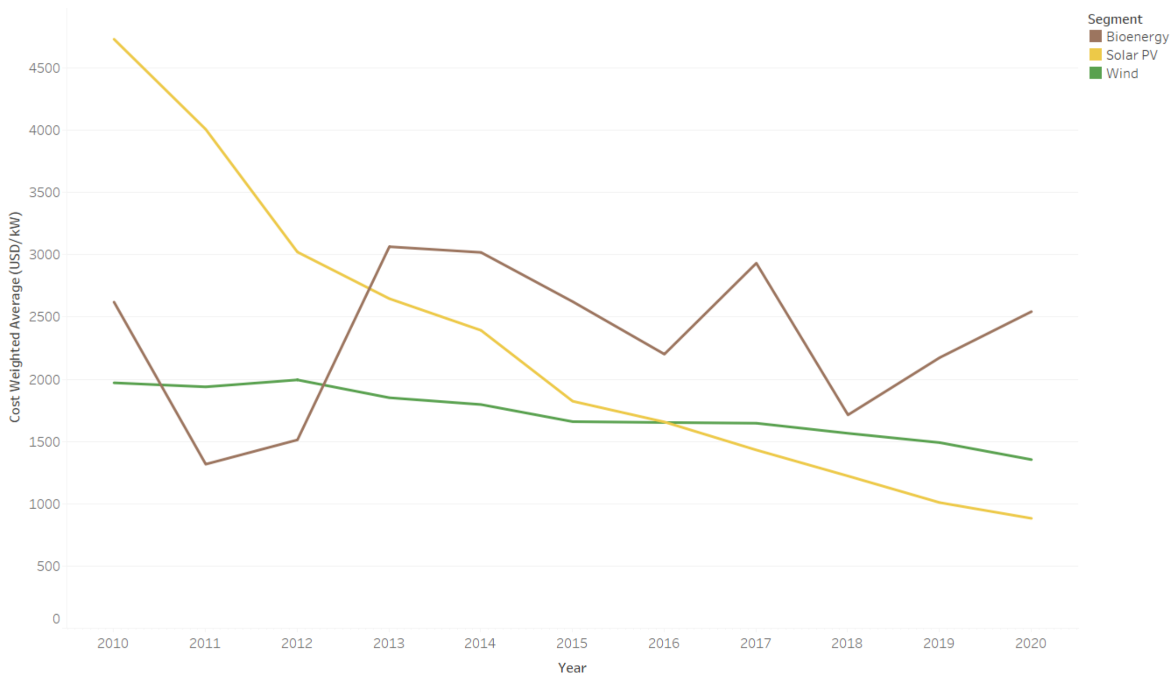
Appendix I

Commodity Indexes (2016=100)

Source: IMF Primary Commodities Prices Database (2023)

Appendix J

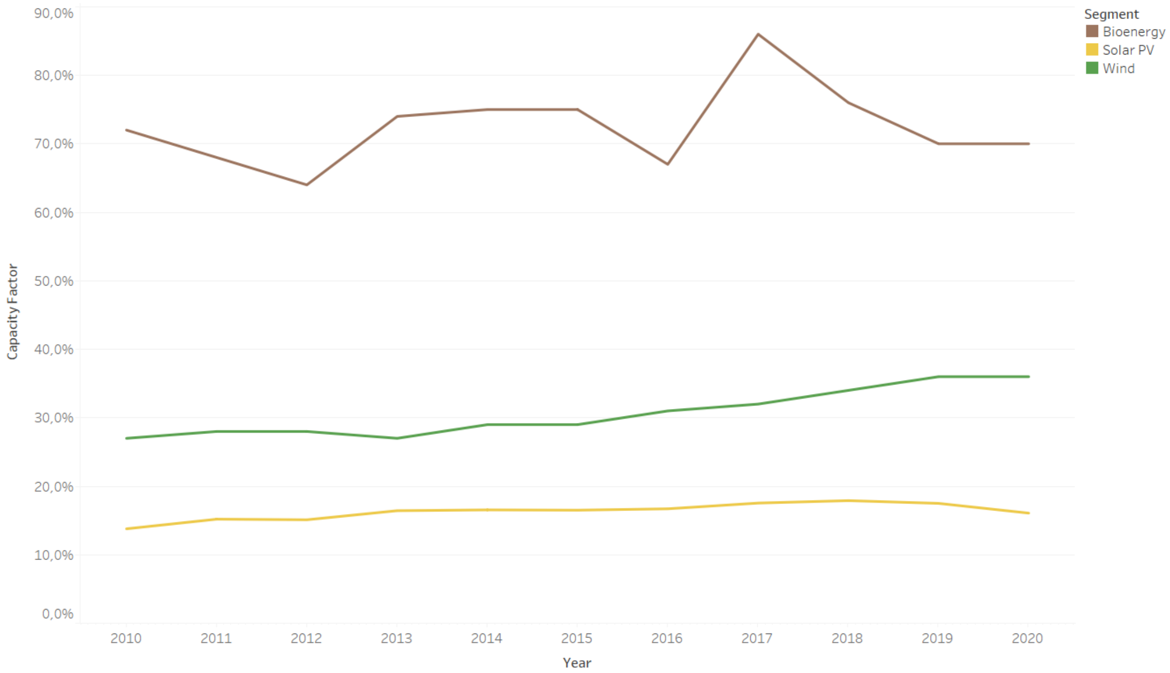
Total Installed Costs Weighted Average, by Segment



Source: IRENASTAT (2023)

Appendix K

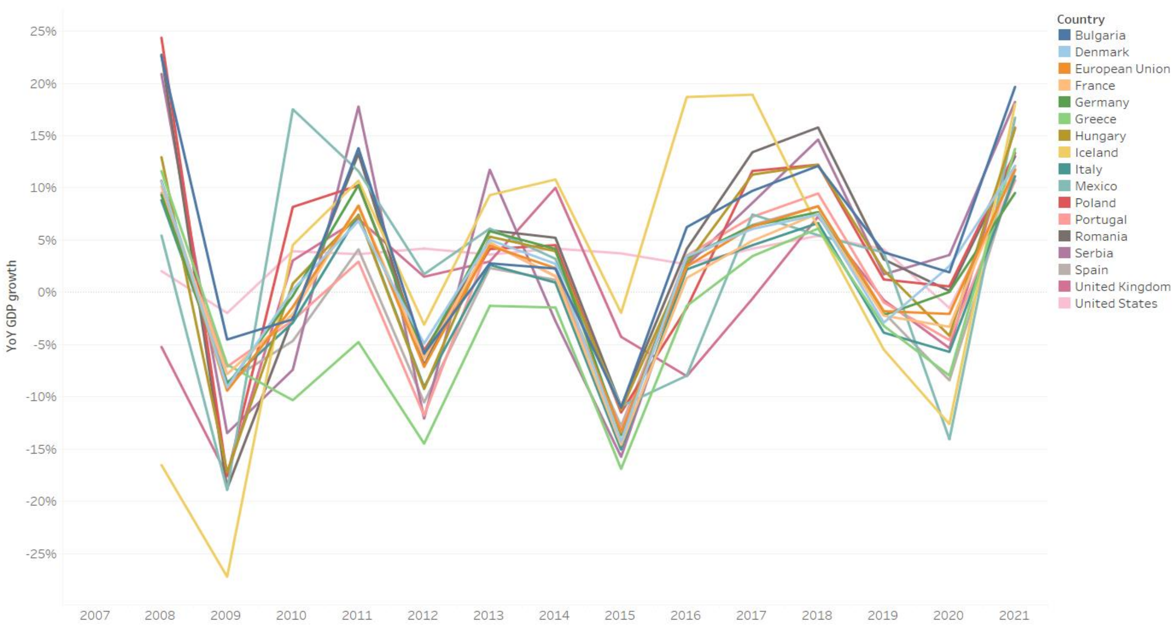
Capacity Factor Weighted Average, by Segment



Source: IRENASTAT (2023)

Appendix L

GDP Evolution



Source: World Bank Database (2023)

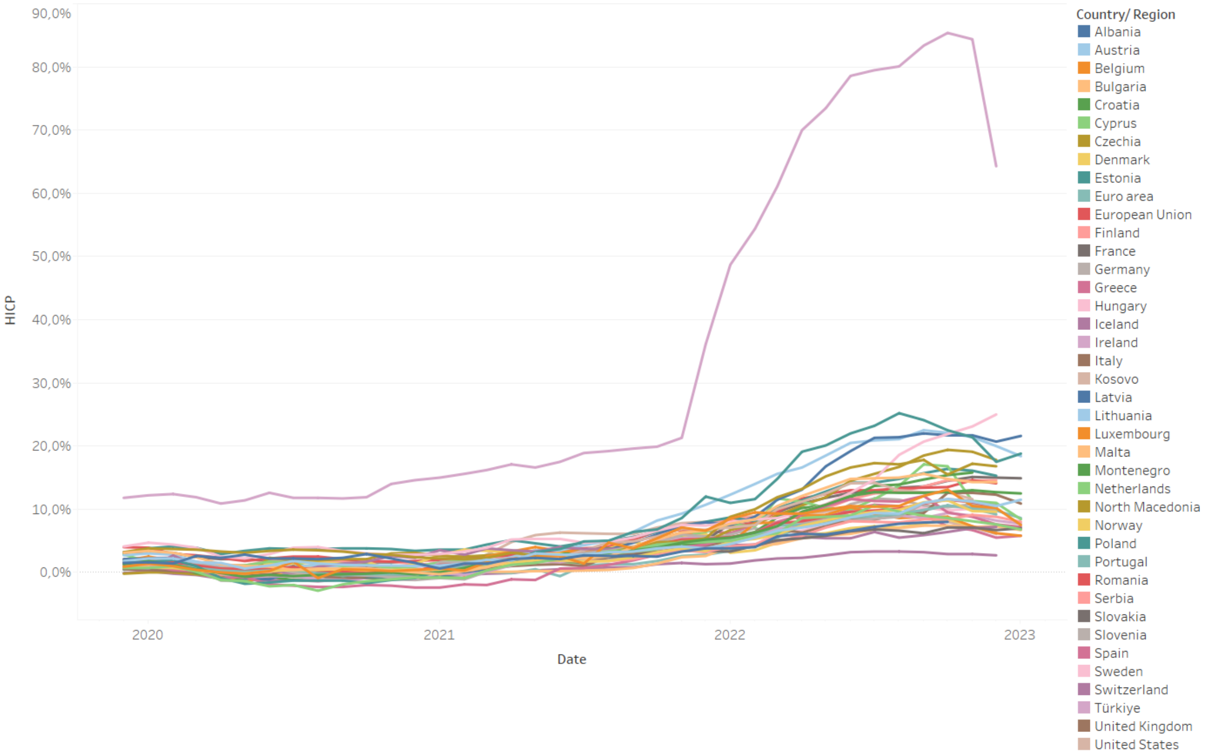
Appendix M

Real GDP Projection

Source: OECD Data (2023)

Appendix N

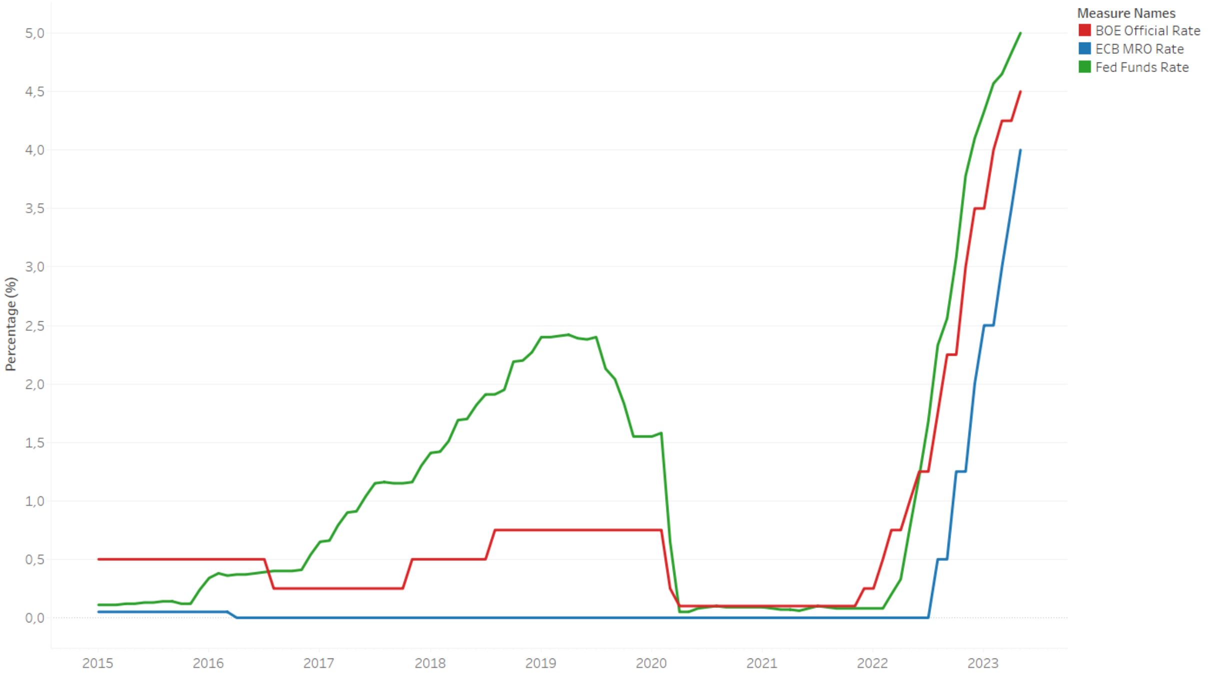
Harmonized Index of Consumer Prices



Source: OECD Data (2023)

Appendix O

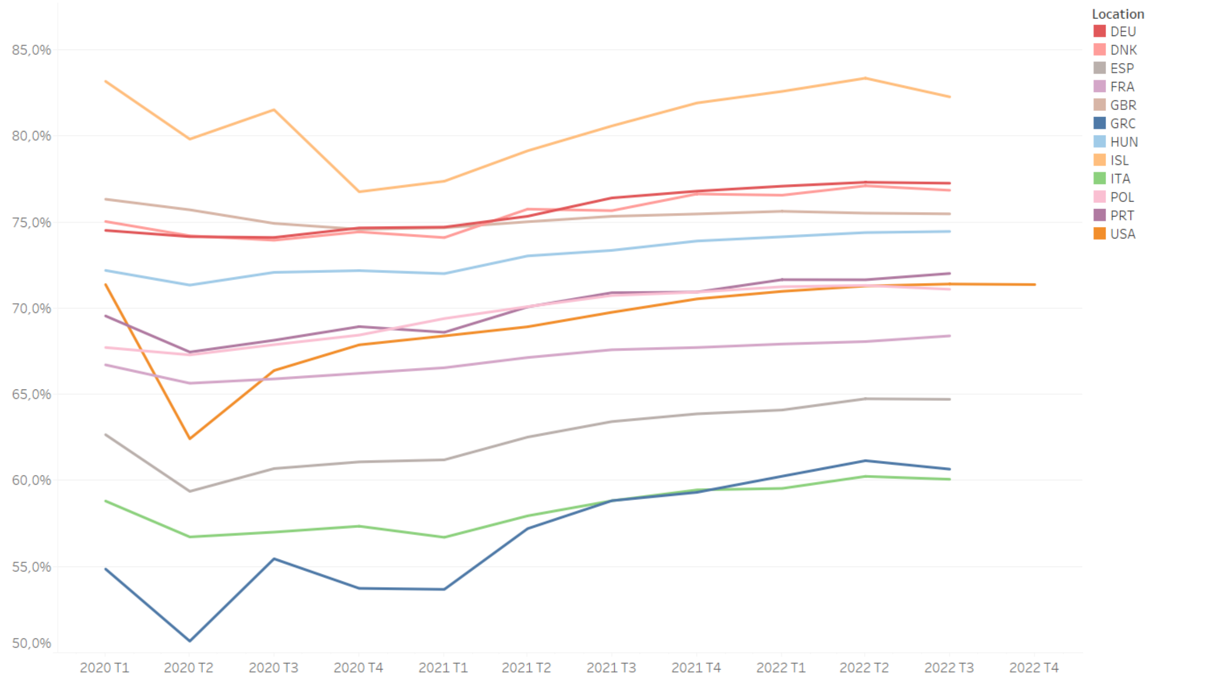
Interest Rates' Evolution



Source: FRED, ECB website, BOE website (2023)

Appendix P

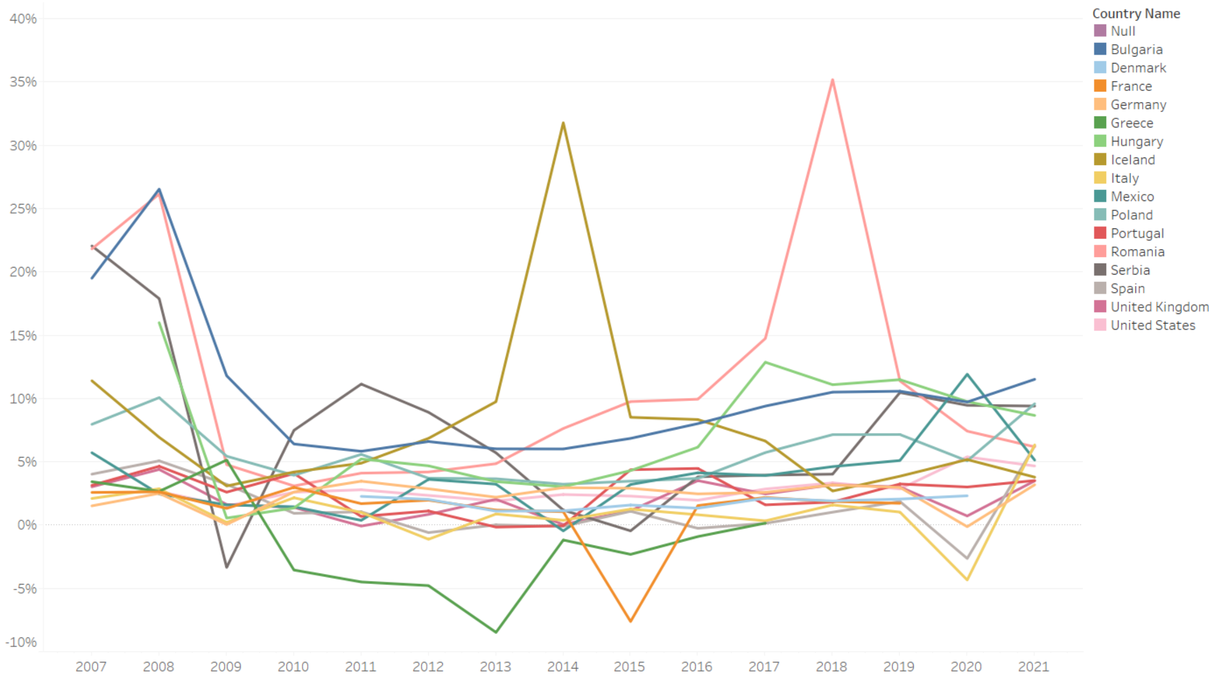
Employment Rate



Source: OECD Data (2023)

Appendix Q

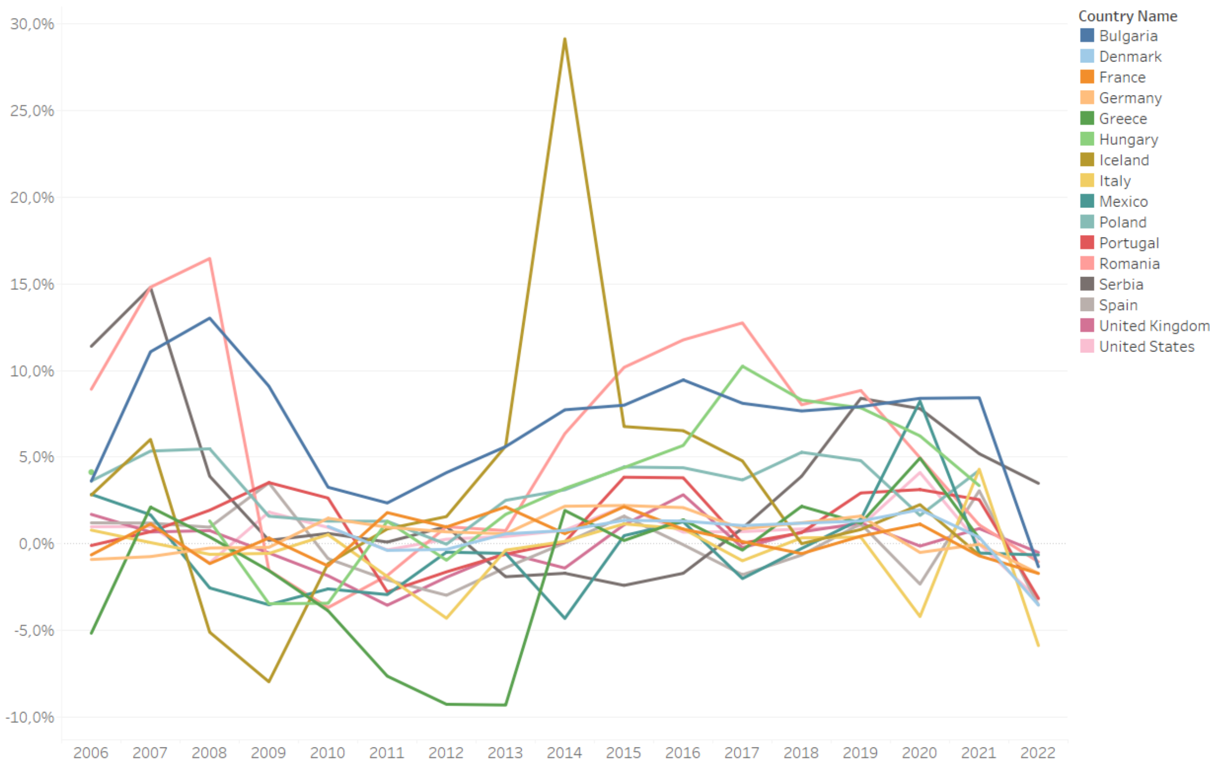
YoY Growth of Average Nominal Wage



Source: OECD Data (2023)

Appendix R

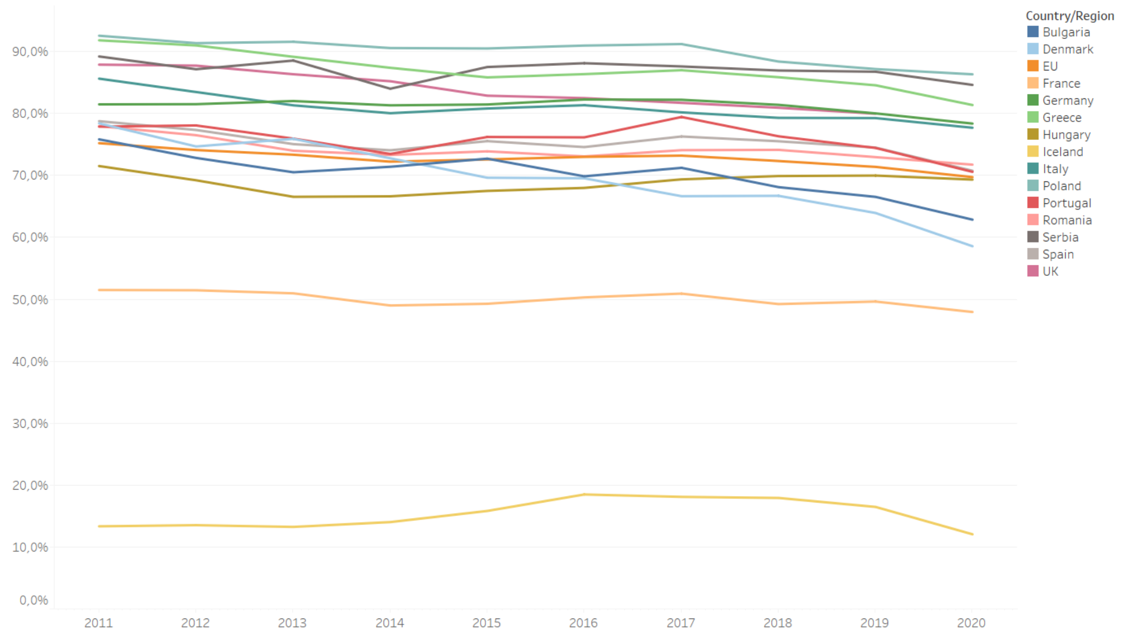
YoY Growth of Average Real Wage



Source: OECD Data (2023)

Appendix S

Percentage of Fossil Fuels in Available Primary Energy



Source: International Energy Agency (2023)

Appendix T

Valuation through DCF (July 2021)

Amounts in €m	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Sales	53 850 471,00 €	65 134 803,00 €	90 100 056,00 €	95 956 559,64 €	102 193 736,02 €	108 836 328,86 €	115 910 690,23 €	123 444 885,10 €	131 468 802,63 €	140 014 274,80 €	149 115 202,66 €	158 807 690,84 €	169 130 190,74 €
EBITDA	20 099 063,00 €	22 700 855,00 €	33 021 107,00 €	34 808 346,33 €	37 070 888,84 €	39 480 496,62 €	42 046 728,90 €	44 779 766,28 €	47 690 451,09 €	50 790 330,41 €	54 091 701,88 €	57 607 662,50 €	61 352 160,57 €
Depreciation*t	2 156 682,40 €	2 723 562,18 €	1 466 540,07 €	2 155 158,75 €	2 295 244,07 €	2 444 434,93 €	2 603 323,20 €	2 772 539,21 €	2 952 754,26 €	3 144 683,29 €	3 349 087,70 €	3 566 778,40 €	3 798 619,00 €
WC needs Var.	3 239 016,00 €	8 858 232,00 €	3 129 639,00 €	4 858 438,74 €	5 174 237,26 €	5 510 562,68 €	5 868 749,25 €	6 250 217,95 €	6 656 482,12 €	7 089 153,46 €	7 549 948,43 €	8 040 695,08 €	8 563 340,26 €
Tax rate	16,3%	25,6%	25,2%	25,0%	25,0%	25,0%	25,0%	25,0%	25,0%	25,0%	25,0%	25,0%	25,0%
CAPEX	43 395 327,00 €	31 829 710,00 €	2 955 492,00 €	26 963 793,26 €	28 716 439,82 €	30 583 008,41 €	32 570 903,96 €	34 688 012,71 €	36 942 733,54 €	39 344 011,22 €	41 901 371,95 €	44 624 961,12 €	47 525 583,60 €
FCFF	21 168 441,25 €	3 367 051,25 €	20 071 335,78 €	6 156 063,98 €	6 556 208,14 €	6 982 361,67 €	7 436 215,17 €	7 919 569,16 €	8 434 341,16 €	8 982 573,33 €	9 566 440,60 €	10 188 259,24 €	10 850 496,09 €
Enterprise Value	**235 711 655 €**											**PV Perpetuity**	302 170 835,88 €
debt	75 915 586 €												
Value	**159 796 069 €**												
price	**5,24 €**												

Source: Own estimation

Appendix U

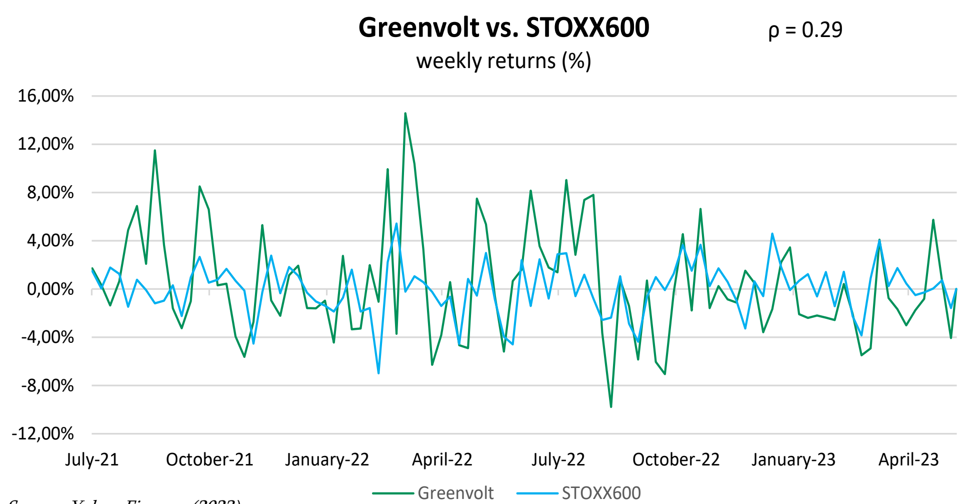
Valuation through the Multiples Methodology

Comparable Firms	PER
Orsted AS	29,03
Enphase Energy, Inc.	155,94
Adani Green Energy Limited	803,06
Eni S.p.A.	38,83
Longi Green Energy Technol	35,76
Iberdrola S.A.	17,66
The Southern Company	44,76
Duke Energy Corporation	N/A
Enbridge, Inc.	24,06
Equinor ASA	8,50
TotalEnergies SE	10,58
NexEra Energy, Inc.	27,83
Average	**42,72**
Valuation	€5.55

Source: Yahoo Finance (2023) and own estimation

Appendix V

Comparison of Greenvolt and STOXX600 index weekly returns



Source: Yahoo Finance (2023)

Appendix W

Valuation through DCF (May 2023)

Amounts in €m	2018	2019	2020	2021	2022	2023
Sales	53 850 471,00 €	65 134 803,00 €	90 100 056,00 €	141 506 540,00 €	274 739 824,00 €	292 597 912,56 €
EBITDA	20 099 063,00 €	22 700 855,00 €	33 021 107,00 €	56 541 177,00 €	91 964 246,00 €	106 654 936,03 €
Depreciation*t	2 156 682,40 €	2 723 562,18 €	1 466 540,07 €	10 078 302,61 €	8 377 942,16 €	12 421 366,58 €
WC needs Var.	3 239 016,00 €	8 858 232,00 €	3 129 639,00 €	2 842 596,00 €	7 906 478,00 €	3 832 824,23 €
Tax rate	16,3%	25,6%	25,2%	37,8%	21,8%	25,0%
CAPEX	43 395 327,00 €	31 829 710,00 €	2 955 492,00 €	14 951 141,00 €	84 425 482,00 €	68 352 780,96 €
FCFF	21 168 441,25 €	3 367 051,25 €	20 071 335,78 €	27 472 802,86 €	12 054 063,68 €	27 892 611,87 €

Amounts in €m	2024	2025	2026	2027	2028	2029	2030
Sales	311 616 776,88 €	331 871 867,37 €	353 443 538,75 €	376 417 368,77 €	400 884 497,74 €	426 941 990,09 €	454 693 219,45 €
EBITDA	113 587 506,87 €	120 970 694,82 €	128 833 789,99 €	137 207 986,33 €	146 126 505,45 €	155 624 728,30 €	165 740 335,64 €
Depreciation*t	13 228 755,40 €	14 088 624,50 €	15 004 385,10 €	15 979 670,13 €	17 018 348,69 €	18 124 541,35 €	19 302 636,54 €
WC needs Var.	4 081 957,80 €	4 347 285,06 €	4 629 858,59 €	4 930 799,40 €	5 251 301,36 €	5 592 635,95 €	5 956 157,28 €
Tax rate	25,0%	25,0%	25,0%	25,0%	25,0%	25,0%	25,0%
CAPEX	72 795 711,72 €	77 527 432,99 €	82 566 716,13 €	87 933 552,68 €	93 649 233,60 €	99 736 433,79 €	106 219 301,98 €
FCFF	29 705 631,64 €	31 636 497,69 €	33 692 870,04 €	35 882 906,60 €	38 215 295,53 €	40 699 289,73 €	43 344 743,57 €

Enterprise Value	1 594 557 587 €
- net debt	371 504 633 €
Equity Value	1 223 052 954 €
Share price	9,42 €
PV Perpetuity	2 044 712 940,00 €

Source: Own estimation

Appendix X

Estimation of Greenvolt's cost of public debt

Maturity	Nominal Value (€m)	Price (06/05/2023)	YTM
2025	35	99,931	4,945782%
2027	150	101,98	4,929875%
2028	15	87,269	5,465985%

Retrieved from Bloomberg on May 6th

Weighted average	100,5181	**4,972867%**

Source: Own estimation

Appendix Y

Valuation through Multiples Method

	Ratios		
Comparable Firms	**PER**	**EV/EBITDA**	**PBV**
Orsted AS	18,86	9,67	2,84
Enphase Energy, Inc.	48,23	46,22	31,16
Adani Green Energy Limited	310,41	53,56	22,13
Eni S.p.A.	3,46	1,71	0,8
Longi Green Energy Technol	20,22	12,57	4,02
Iberdrola S.A.	16,39	8,45	1,78
The Southern Company	24,33	13,21	2,64
Duke Energy Corporation	20,78	12,47	1,62
Enbridge, Inc.	42,02	11,95	2,04
Equinor ASA	3,34	0,97	1,67
TotalEnergies SE	7,63	2,99	1,27
NexEra Energy, Inc.	22,34	16,99	3,67
Average	**22,41**	**13,62**	**4,37**
Valuation	€2.91	€6.2	€15.67
Average valuation		**€8.26**	

Source: Yahoo Finance (2023)

Appendix Z

Market Model Output (using Microsoft Excel)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,495911792
R Square	0,245928505
Adjusted R Square	0,244296316
Standard Error	0,018629464
Observations	464

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,052292455	0,052292455	150,6740012	3,57642E-30
Residual	462	0,160340298	0,000347057		
Total	463	0,212632754			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0,000144592	0,000865597	0,167042641	0,867409584	-0,0015564	0,001845587	-0,001556404	0,001845587
RMARKET	1,049507585	0,08550006	12,27493386	3,57642E-30	0,881490388	1,217524781	0,881490388	1,217524781

Source: Own estimation

Appendix AA

Durbin-Watson Test Statistic

Durbin Watson Test	
Test Statistic	**2,009**

Source: Own estimation

Appendix AB

Test of the difference between abnormal returns up to, and in the first day after, the SEO announcement

ıte	Announcement	Type of announcement	Excess same-day retun	t -statistic	critical value
/2022	GV announces SEO	Presentation/ Report	-3,3%	-821,648	2,249

Appendix AC

Test of the difference in excess returns before and after the SEO announcement

	N=231	*N=233*
	Before SEO	**After SEO**
Average excess return	0,077%	-0,076%
Standard deviation	1,924%	1,797%
	Differences between paired observations	
Average	0,15%	
Standard deviation	2,689%	
t-statistic	**0,882138489**	
Critical value	**2,248731961**	

Source: Own estimation

Appendix AD

List of selected company announcements

All-time variance	0,000346307	Average excess return	0%

Date	Announcement	Type of announcement	Same day return	3-day abnormal return variance	F-Stat	Statistically Significant (95% Conf. Lvl.)	Average 3-day Abnormal Return	t-statistic (H_0: AR=0)	Statistically Significant (95% Conf. Lvl.)
30/09/2021	GV announces Report and Accounts for the First Half of 2021	Presentation/ Report	2,08%	0,000569083	1,6433	No	-0,417%	-0,17	Yes
19/10/2021	GV announces potential private offering for the subscription of notes	Market Debt Issuance	-1,13%	0,000410367	1,1850	No	0,832%	0,41	Yes
16/11/2021	GV announces 3Q2021 results	Presentation/ Report	2,14%	0,000428847	1,2383	No	-0,106%	-0,05	No
16/03/2022	GV announces results for the 4th Quarter and 2021 financial year	Presentation/ Report	-2,23%	0,000039247	8,8237	No	-1,617%	-2,58	Yes
24/05/2022	GV announces 1Q2022 results	Presentation/ Report	-7,32%	0,00324035	0,1069	No	-0,773%	-0,14	Yes
09/06/2022	GV announces SEO	Presentation/ Report	0,67%	0,000495376	1,4305	No	-1,897%	-0,85	Yes
06/09/2022	GV announces 1H2022 results	Presentation/ Report	0,65%	0,000161996	2,1378	No	-0,437%	-0,34	Yes
22/11/2022	GV releases 9M2022 results presentation	Presentation/ Report	-0,74%	0,000151214	2,2902	No	-0,193%	-0,16	Yes
23/03/2023	GV releases 2022 results presentation	Presentation/ Report	0,40%	0,000102945	3,3640	No	-0,420%	-0,41	Yes

Source: Greenvolt website (2023)

Appendix AE

Test of the difference in variance surrounding announcement dates, before and after the SEO announcement

	Average 3-day period variance	F-stat	Critical Value (95% conf. Lvl)
Before	0,096%	**6,91**	**3,312950657**
After	0,014%		

Source: Own estimation