Department of Business and Management

Master's Degree Thesis in Corporate Finance

Chair of Cases in Business Law

Decentralized & Digitized Financing for RE Generators: Prompting the Energy Transition through Blockchain-based SPVs

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INDEX

ABSTRACT

It is common to undervalue the role and influence that energy-intensive small and medium-sized businesses (SMEs) may play for boosting the Energy Transition worldwide. Admittedly, for a variety of reasons, the current financing infrastructure now in place for funding RE generators is inadequate to allow such entities' meaningful engagement in this global challenge. In this context, the objective of the present work will be to formulate and describe in depth, making use of the literature so far available, an alternative and avant-garde financing model for Renewable Energy (RE) generators which could eventually be promoted by SMEs: A blockchain-based Special Purpose Vehicle (SPV) built by adopting the standards of Decentralized Autonomous Organizations (DAOs).

The first chapter, for its part, will firstly aim to give a global overview of RE development so far and then to highlight the limitations and challenges of current RE financing mechanisms when dealing with medium and small-sized projects, such as the substantial up-front costs, the factors preventing scaling and the dreaded default risk associated with the volatile and uncertain nature of the renewable sector, as well as the opportunities, with primary reference to Social Based Lending (SBL) Crowdfunding, that could serve a solid foundation for the following arguments inherent in the thesis topic. While reviewing traditional financing channels for renewable-related projects and analyzing the performance effects on the companies who put them in place, bringing to attention the case of the EPA's Fortune 500 Top Green Power Partners list, the congenital risks associated with the sector will be assessed.

The potential of blockchain-based SPVs to improve the current financing architecture and support the Energy Transition will be looked at in the second chapter. The study will be carried out using both fresh research and analysis, as well as a thorough examination of existing case studies and literature. The hypothesis on the operating mechanism of decentralized energy systems in the form of DAOs, in addition to the problems that such an initiative is intended to solve in order to accelerate the Energy Transition by boosting the access to credit for prosumers and democratizing the industry, will be extensively covered in this part. This chapter will indeed emphasize the financial and procedural technicalities related to this argument while extensively comparing the blockchain-based structure to traditional SBL platforms. Consequently, it will be shown how to combine and associate the Initial Coin Offering financing model with both the U.S. and E.U. capital markets legislative framework for guaranteeing investors' protection. Hence, it will be brought to the reader's attention a case study inherent to this aspect: *Slock.it v SEC*.

In the third chapter will reside the heart of the experimentation: an investment simulation in an energy plant promoted by the company "*Centrale Del Latte Del Molise*" via DAO will be simulated according to the Italian and the European legal frameworks.

In this context, the goal will be to follow and explain the process step by step, from project assessment to contract origination and execution among parties, also making use of inputs and suggestions from project's insiders. The case study's results will lead to formulate a definitive answer to the thesis research question: "Are blockchain-based SPVs a feasible and workable investment solution for allowing energy-intensive SMEs to become promoters of RE projects?".

CHAPTER I - The Need to Adapt the Current Financing Architecture in Renewables to Energy-Intensive SMEs

The world is at a crucial juncture in its Energy Transition, where renewable energy has become a central pillar of global energy security, economic growth and environmental protection. Despite significant progress in the deployment of renewable energy sources, the current financing architecture remains limited and hinders the ability to fully realize the potential of renewable energy and the active participation of multiple stakeholders, especially in the form of investors and energy-intensive SMEs as project developers. The aim of this thesis is to address this challenge, which will be fully analyzed in this chapter, by consequently exploring the potential of decentralized and digitized project finance for renewable energy generators, facilitated by blockchain-based Special Purpose Vehicles (SPVs).
As former United Nations Secretary-General Ban Ki-Moon stated, "*The transition to renewable energy is not only necessary for mitigating climate change, but also for securing energy supplies and creating new jobs and business opportunities.*"[1] However, this transition requires a financing architecture that can provide adequate capital to the renewable energy sector, while ensuring secure and transparent transactions. The use of blockchain-based SPVs has been identified as a promising solution to the challenges faced by traditional project finance in the renewable energy sector. By creating a decentralized and digitized platform for project financing, SPVs can reduce transaction costs, increase access to capital, and improve transparency and security. According to Maros Sefcovic, the former vice president of the European Commission, "*To quicken the energy transition and meet our challenging climate goals, we must look for creative solutions. It is imperative to investigate how blockchain-based SPVs could transform project financing in the renewable energy industry.*"[2]
It is known that the integration of renewable energy sources into the energy mix has become increasingly relevant in the face of global energy security, economic growth and environmental protection. Precisely for this reason, it is important to note that the development and operation of proprietary renewable energy (RE) generators is a key factor that can positively impact firm financial performance. This is true regardless of the financing method used, as building and operating proprietary RE generators can bring a range of benefits, such as reducing energy costs, improving energy security and reliability, and enhancing corporate image and reputation.

[1] 8th international Renewable Energy Conference.

[2] Source: *Horizon, The EU research and Innovation Magazine* - 2016.

Developing and operating their own RE generators may be extremely advantageous for energy-intensive SMEs, particularly those in the manufacturing and agri-food industries, who typically face unique challenges in securing funding and finance for renewable energy projects. Moreover, by taking control of their energy supply and generating their own renewable energy, both SMEs and Big Corps may increase their competitiveness and long-term financial stability. There are a number of energy transition objectives to be met in order to create a sustainable, low-carbon, and climate-resilient energy system. Quantitatively, this entails increasing the proportion of renewable energy in the energy mix[3], lowering greenhouse gas emissions[4], enhancing energy efficiency[5], and boosting energy access and security[6]. In order to enhance the total deployment of renewable energy and cut costs, SMEs can play a major role in reaching these goals by incorporating proprietary RE generators.

1.1 Renewable Energy macro-outlook and its effects on firms' financial performance

Recent studies have shown that using renewable energy (RE) has numerous societal and environmental advantages in addition to possible economic gains. Renewable energy sources (RE) are becoming more and more competitive alternatives to conventional fossil fuel energy as federal and state incentives for investments in RE technology have been growing more widespread. Utilizing RE is acknowledged as a crucial part of "green" product innovation that enables businesses to lessen the environmental impact of their production operations, as well as their ecological footprints and energy usage.

The relationship between RE utilization and firm financial performance over time will be investigated using the natural resource-based view of the firm as a framework. Tobin's Q[7], operational margin, and annual ROI are compared with corresponding industry medians during a 7-year period (2007–2013) for significant U.S. enterprises recognized as outstanding users of RE. Post hoc bootstrapping and sensitivity analysis are also carried out to further corroborate the study findings. This paragraph will show how top RE user companies routinely outperformed their sector rivals in terms of financial

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[3] The EU aims to have at least 32% of its final energy consumption come from RE sources by 2030, while the US is promoting the deployment of renewable energy through various policies and initiatives.

[4] The European Union has set a target to reduce its GHG emissions by at least 40% below 1990 levels by 2030, as part of its commitment to the Paris Agreement. The US, on its own, plans to reduce them by 26-28% below its 2005 levels.

[5] The EU is targeting at least 32.5% improvement in energy efficiency by 2030 compared to its base case scenario.

[6] EU and US are both working on diversifying their RE sources while improving the security of energy supply, especially in isolated and rural areas.

[7] It is the ratio between a physical asset's market value and its replacement value.

success. This study will serve as the foundation for the subsequent argument, which will concentrate on the factors that have, up until now, prevented businesses from utilizing and profiting from renewable energy sources.

Before going in depth, it is important to define the framework and types of existing renewable energies and to understand their peculiar influencing factors in order to assess the current countries-specific sector development and their plausible future trends.

1.1.1 RE sources, influencing factors and global trends predictions

By definition, renewable energy (RE) is energy derived from renewable natural resources that are continuously replenished by natural processes. There are six primary categories of renewable energy sources:

I) Sun. Because the sun continuously provides solar energy to the earth, it is a renewable resource. Sun-thermal and photovoltaic technologies are the two most used methods for converting solar energy into electricity. Wafers consisting of silicon or other conductive materials make up photovoltaic systems. A chemical reaction that results from sunlight striking the wafers releases electricity. The sun's rays are focused by mirrors or other reflective materials in solar-thermal systems, which then heat a liquid to produce steam that turns a generator and generates energy;

II) Geothermal. The intense heat stored in the liquid rock, known as magma, within the Earth's core continuously generates geothermal energy beneath the planet's surface. When this heat naturally produces steam or hot water, it can be pumped to the surface and used to power a steam turbine. In order to extract heat from hot, dry rocks, geothermal energy can also be acquired by pumping water underneath. After that, heat is brought back to the surface to power a steam turbine;

III) Biomass. The term "biomass" can be used to refer to a wide range of fuel types from sources including trees, construction, wood, and agricultural wastes, fuel crops, sewage sludge, and manure. Among the things that are considered agricultural wastes are things like maize husks, rice hulls, peanut shells, grass clippings, and leaves. It is possible to quickly replace trees and fuel crops, or plants produced expressly for the production of electricity. Organic wastes created by society will still include manure, sewage sludge, and agricultural waste. Biomass is regarded as a renewable resource due to these factors;

IV) Landfill Gas. When organic waste, such as food scraps and paper, breaks down in landfills, microbes produce landfill gas. Methane accounts for nearly half of landfill gas while the remainder is made up of carbon dioxide and volatile organic compounds (VOCs). If landfill gas isn't captured and burned, it will escape into the atmosphere. Landfill gas is used in boilers, reciprocating engines, and combustion turbines in landfill gas energy projects to create power. How much gas a landfill may produce depends on several factors, including landfill size and age, volume of organic waste, and regional climate. The EPA[8] mandates that sizable landfills gather and burn landfill gas using flares to eliminate VOCs;

V) Wind. Because of the seasons and cloud cover, the sun heats the Earth inequitably, resulting in wind. Warmer air moves toward cooler air as a result of the Earth's rotation and its uneven heating. Two or three long blades are used in wind turbines to capture wind energy and turn it into electricity. When the wind passes over the blades, they begin to spin. As the rotating turbine blades turn a generator, the wind's motional energy is then transformed into electricity. A "wind farm" is a collection of many wind turbine towers that together generate enough electricity to power a town or city;

VI) Hydropower. Because it makes use of the water cycle on Earth to produce electricity, hydropower is regarded as a renewable energy source. Water leaves the surface of the Earth, condenses into clouds, returns to the surface as precipitation, and then travels toward the ocean. Water flowing downstream generates kinetic energy that can be used to generate power. This energy is then transformed into electricity in a hydroelectric power plant by forcing water—often held back at a dam—through a hydraulic turbine that is linked to a generator. After leaving the turbine, the water is channeled back into a stream or riverbed below the dam. High volumes of precipitation and considerable elevation variations are required to create significant amounts of electricity from hydropower, which is primarily dependent on these two factors.

In order to successfully optimize energy structures, balance supply and demand discrepancies, and safeguard the environment, renewable energy is a crucial part of the energy supply. By 2050, renewable energy must make up two-thirds of the world's total energy supply, according to the International Renewable Energy Agency[9]. In recent years, the development of renewable energy has

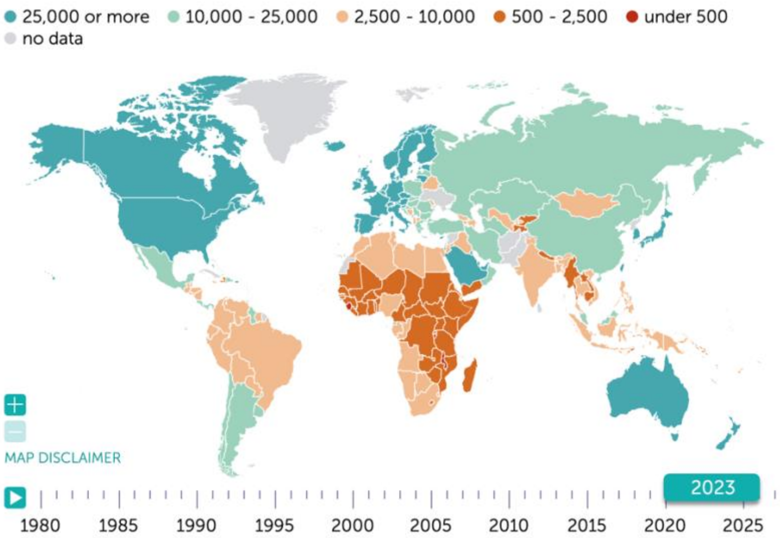
[8] the U.S. Environmental Protection Agency.

[9] Source: "*Global energy transformation: a roadmap to 2050*"- 2018 -International Renewable Energy Agency.

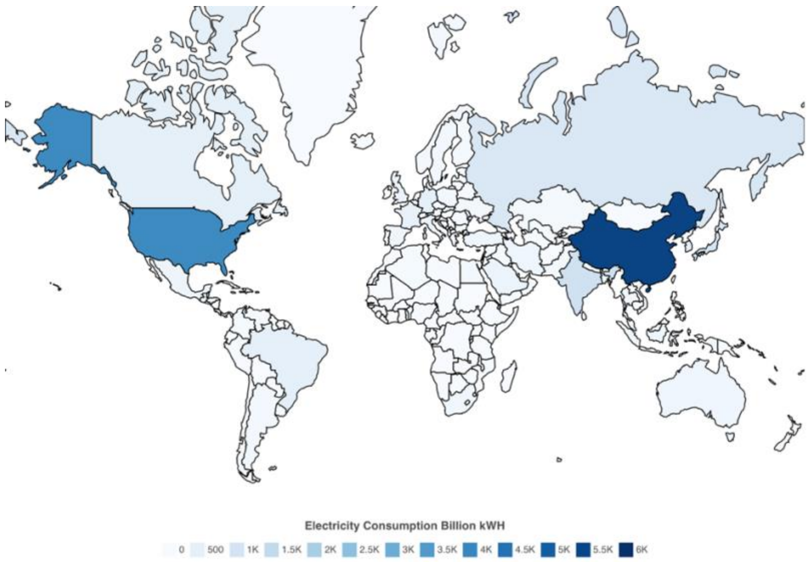
attracted a lot of attention. All nations in the world have come to an agreement and are working together to promote the production and use of renewable energy. Therefore, the use of sustainable energy has increased due to the global acceleration of renewable energy development. Examples include the power sector, fever refrigeration, automotive traffic, communications, logistics. The most popular and representative parameter for assessing the development direction of renewable energy in each region is the renewable energy generation[10]. In order to depict the development of renewable energy in each region fairly, in this paragraph the forecasting findings in the field of renewable energy power generation as a trend are going to be adopted. To do so, however, it will be necessary to include and analyze the various influencing factors related to renewables, contextualizing them to the relevant region. In this context, focus will be addressed on the four main influencing factors of RE growth: economic, technological, political, and social.

The development of renewable energy is directly fueled by the economic prosperity of a nation, which is inextricably linked to the maturity of renewable energy infrastructures. Since there is a two-way causal relationship between economic development and GDP per capita, the growth and consumption of renewable energy are somewhat dependent on per capita income, and the encouragement of economic growth is helpful for the growth of renewable energy. At the same time, financial support is essential to the growth of renewable energy. Economic growth encourages investors' willingness to invest in renewable resources, mitigates the financial risks associated with the development and use of renewable energy, and is advantageous for examining the development potential of renewable energy and ensuring sustainable development in the field of renewable energy generation. As a result, GDP and local resident living standards, measured through the electricity consumption indicator, are used to gauge regional economic development.

[10] Amount of RE produced

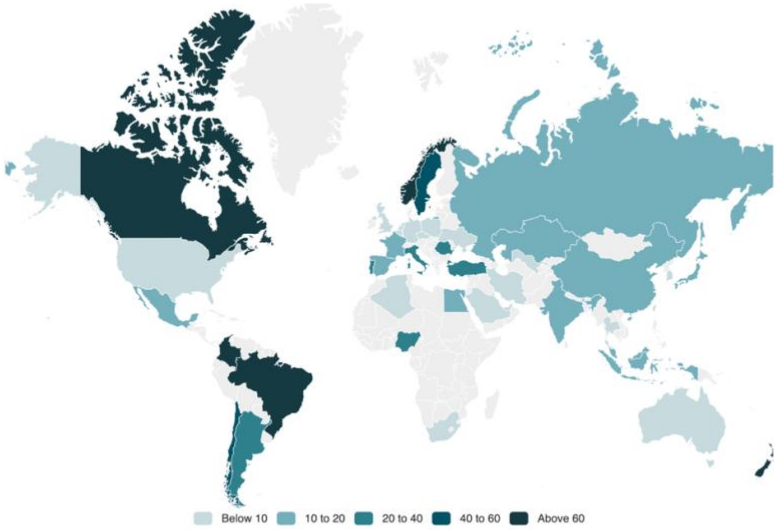


GDP per capita in each region - Source: International Monetary Fund, 2023



Electricity consumption in each region - Source: World Population Review, 2023

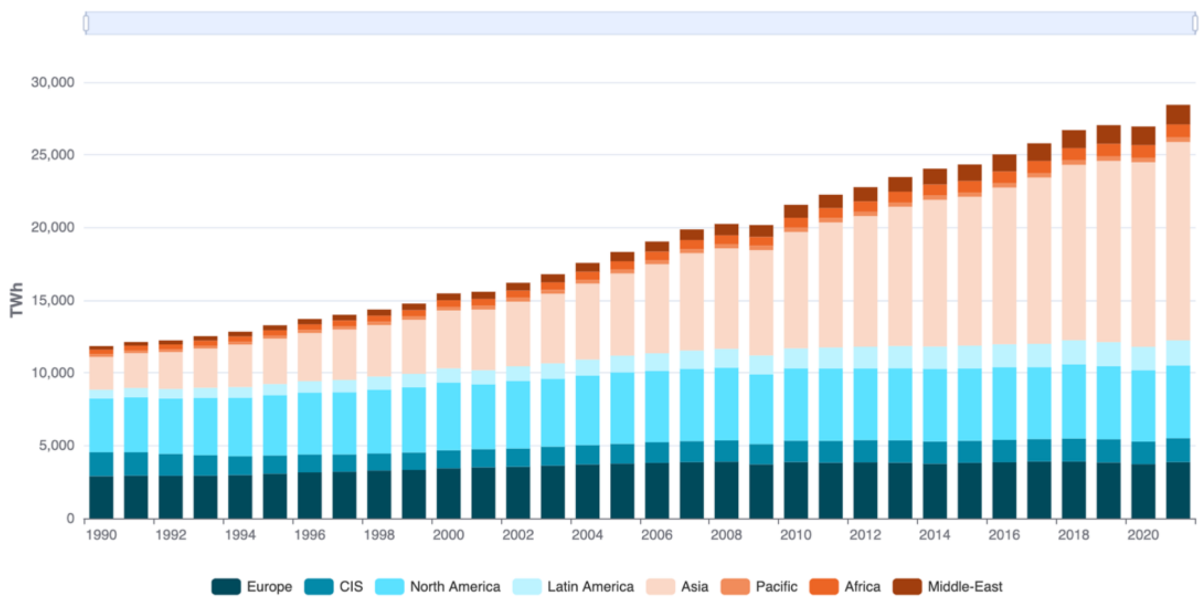
Technologies for producing renewable energy are essential for a competitive, affordable, and sustainable energy supply. Promoting the development of renewable energy technologies will lower development and maintenance costs and increase the energy conversion efficiency of the technologies while also increasing their dependability, application, and reliability. New energy utilization capabilities, power generation capabilities, and R&Ds capacities are all factors that influence technological advancement. New energy utilization means using energy sources other than conventional ones. The amount of growth of renewable energy power generation in distinct regions is indicated by using the ratio between renewable energy generation and overall energy production in each region as a proxy indicator.



Share of renewables in total energy production in each region – Source: Enerdata, 2023

A key component of the efficient supply capacity of renewable energy power is the growth in overall power generation capacity, which matches changes in power demand.

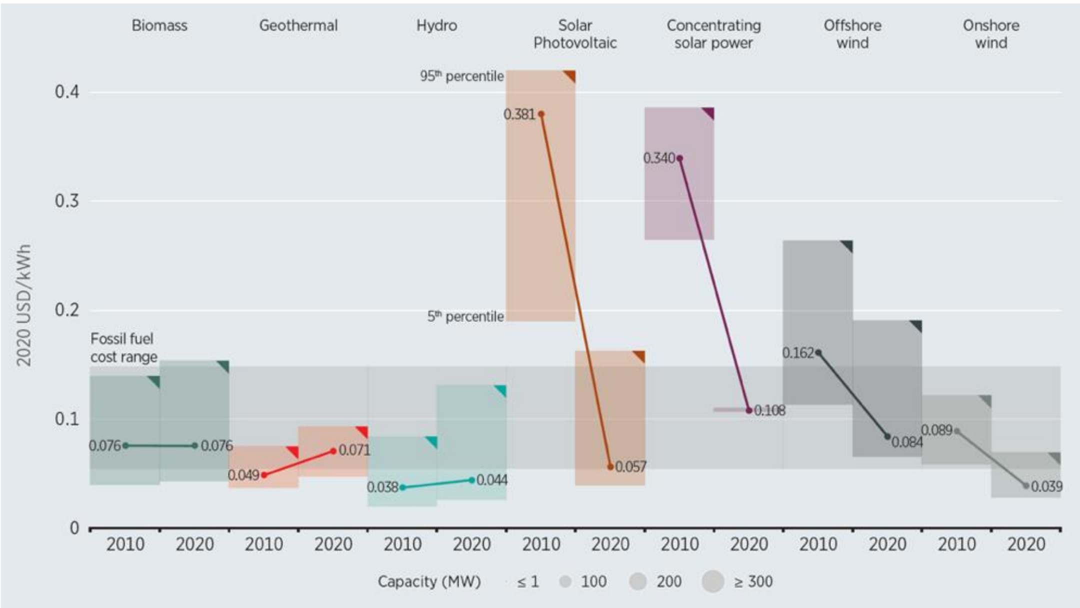
The overall power generating requirement will accelerate the development of renewable energy power generation in line with the worldwide trend of supporting this source of energy. As shown from the figure below, North-America, Europe and Asia have recorded the highest intensification of power generation capacity over time.



Total power generation trend in each region from 1990 to 2021 – Source: Enerdata, 2021

As was already noted, one of the major factors influencing the production of renewable energy is the ability to conduct research and development. Low utilization of renewable energy and high development costs due to poor R&D capacity would impede the use of renewable energy generation in applications. Bringing the example of solar and wind power technologies, the decade from 2010 to 2020 represented a spectacular period of global weighted average LCOE[11] decrease.

Renewable electricity from solar and wind power has transitioned from an expensive niche to a head-to-head battle with fossil fuels for new capacity thanks to a combination of targeted policy assistance and industry push. As a result, it is now obvious that renewable energy sources will support the entire electrical grid and contribute to the decarbonization of electricity production.



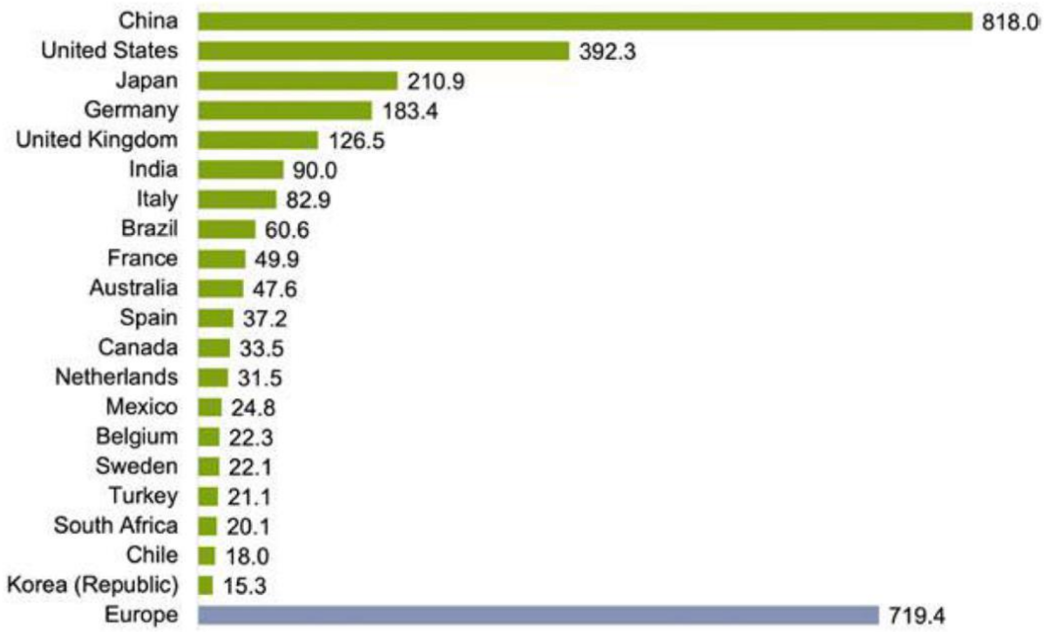
Global LCOEs from renewable power generation technologies – Source: I.R.E.N.A, 2021

Social variables mostly affect how well-informed society is about renewable energy. Public and financial entities' decisions are influenced by their level of social cognition. The development of renewable energy projects is made easier by increasing public awareness of their advantages. Improving funds for the use of raw energy is made easier and more resources can be allocated to the production of renewable energy by raising awareness of financing institutions and power grid firms. The international community has emphasized the significance and sped up the development and use of renewable energy in recent years due to energy and environmental challenges. All regions generally have high levels of social acceptance of renewable energy, which is essential for achieving the Energy Transition targets set for the end of 2050[12].

[11] Levelized Cost of Energy

[12] Transformation of the global energy sector from fossil-based to zero-carbon sources, reducing energy-related CO2 emissions to mitigate climate change and limit global temperature to within 1.5° of pre-industrial levels.

Governments, institutions, and multinational corporations can all promote capital expenditures as a way to gauge social awareness. The amount of US dollars invested globally in the renewable sector between 2010 and 2019 is shown in the graph below:

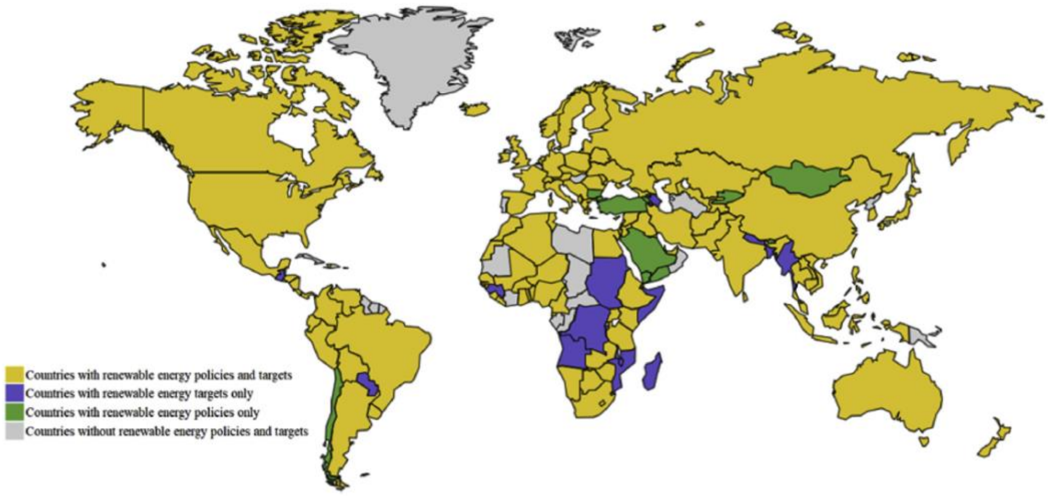


Renewable Energy capacity investment ($BN) from 2010 to 2019, top 20 markets – Source: UNEP, Frankfurt-School - 2021

Policy factors primarily refer to the laws and rules governing the use of power generation and the growth of renewable energy in a certain nation or region. They are the strongest motivating factor for this growth and have a significant influence on the future development trend of a nation's renewable energy. In order to realize the long-term health of renewable energy, the government should actively implement more policies to support it, continuously enhance the renewable energy policy framework, and significantly contribute to the creation of a sustainable energy system.

Governments must simultaneously develop renewable energy development plans to direct the healthy development of renewable energy, realize a diversified and large-scale renewable energy portfolio, and achieve a safe affluence. On the one hand, governments must increase welfare through renewable energy incentives, such as subsidies and on-grid tariffs, clarify investment income, entice investors to invest in renewable energy, and stimulate the development of renewable energy. The majority of nations in the globe have implemented a favorable and preferential policy approach in order to hasten the development and use of renewable energy. Macroeconomic plans, public trust in the administration, and future plans for developing renewable energy sources are some of the specific indicators. Based on the state of development of renewable energy resources and technology, the renewable energy development plan is a comprehensive strategic plan for the development objectives and safety precautions of renewable energy. It is essential to the future development and application of renewable energy.

The planning of national renewable energy policies and targets is depicted in the figure below. The three countries with the most comprehensive renewable energy development strategies and goals are, generally speaking, the United States, Europe, and Canada. There are certain nations in the Asia-Pacific and Latin American regions without definite development goals or programs. In Africa and the Middle East, the entire renewable energy infrastructure is comparatively still inadequate.



Distribution of renewable energy policies by region – Source: Global renewable energy development: Influencing factors, trend predictions and countermeasures – 2019

Based on the above analyzed economical, technical, social and political factors, it can be drawn an overall conclusion highlighting and describing the major trends forecasted for the seven main global regions:

I. In recent years, the area of **Asia-Pacific** has had the fastest economic growth and the biggest demand for power. The growth of renewable energy in the Asia-Pacific area has enormous potential as a result of the more mature state of renewable energy technologies and the perfected policy framework for them. The total power generation is expected to reach 1,001,940.1Gwh in 2025 as a result of technological advancement. The weighted average cost of leveling renewable energy in the Asia-Pacific region has remained stable at the same time. Every year, the costs of developing renewable energy in different nations decrease. Most nations in the Asia-Pacific region have policies and goals for the development of renewable energy that are regarded as social policy. A few nations have plans or goals for only developing renewable energy sources. A good example is China, which recently unveiled its 13th Five-Year Plan for the Development of Renewable Energy.

II. Demand for renewable energy has increased as a result of the Middle Eastern economy. However, the **Middle East**'s sustainable development of renewable energy is not supported by the Middle East's outdated technologies for utilizing renewable energy and its shoddy development plans. Nearly half of the Middle Eastern nations are higher income nations in terms of economic development, but a quarter are low- and middle-income nations. In terms of residential electricity use, the Middle East consistently saw growth rates of 2–3%. However, The Middle East's renewable energy policies and goals still need to be improved in comparison to other regions. The credibility of the majority of Middle Eastern governments also tends to deteriorate over time. There is increased pressure on some regions' political and social environments, which makes it difficult to promote policies involving renewable energy. As a result, it is anticipated that the Middle East's GDP will grow at a slow pace, by 15% in 2025 compared to 2016. In terms of residential electricity use, the Middle East consistently saw growth rates of 2–3%. The Middle East's demand for renewable energy has continued to grow steadily in the absence of outside influences. As a result, it is anticipated that the Middle East will not see much growth in the use of renewable energy over the next few years and that demand will largely remain unchanged.

III. With better relevant policy systems and higher levels of utilization, **Canada** can develop renewable energy earlier. Even though economic growth has been sluggish lately, it has ensured the steady expansion of renewable energy. Based on the growth of currently available renewable energy and the relatively slow development trend, it is anticipated that the development of renewable energy in Canada will increase on a small scale in the future. By 2025, the GDP is expected to be $1,01 billion, and economic growth will be slower than in other sectors, which will have an impact on the development of renewable energy. The power generated by Canadians has fluctuated steadily in recent years between 16,000Gwh and 17,000Gwh; it is anticipated that there will only be a small increase. Renewable energy development won't have much of an incentive in the Canadian economy. The demand for electricity in Canada has remained stable, total power generation has grown slowly, and the production of renewable energy has grown at a relatively high rate in terms of technological development. By 2025, it's anticipated that renewable energy sources will account for more than 70% of energy production.

IV. The **US** economy is expanding steadily, and advances in renewable energy are happening quickly. Effective policy implementation encourages rapid growth. As a result, the US energy structure will gradually change, and renewable energy sources will be used much more frequently. Regarding economic development, the US GDP continues to expand at a comparatively rapid rate. According to projections, the GDP will rise by 24% to 25,368 billion dollars by 2025 from 20,513 billion dollars in 2018. Additionally, with a fluctuation of 1,400,000Gwh, US residents' electricity consumption will essentially not change in the future. The US economy will continue to grow at a moderate rate overall in the future, which will promote the development of renewable energy sources and ensure the country's economic stability. The total demand for power generation in the US has remained constant over the past few years at about 410,000Gwh, while renewable energy production has continued to rise. Coal and gas-fired power generation currently makes up the largest portion of the US power supply structure when social policy is taken into account. Furthermore, according to the Clean Power Plan, which was announced in August 2015, the 2030 US power plant carbon emission target will be reduced by 32% from 2005. This will result in the support of renewable energy and other power generation projects as well as the creation of a number of preferential policies and development plans for renewable energy.

V. Regarding economic development, **Latin American** nations have underdeveloped economies that will expand by 0.5% annually. It is challenging for these nations to make significant investments in the field of renewable energy to support the development of renewable energy, even though resident power generation will increase year over year. Although Latin American nations' levels of technological development vary, the region's overall total power generation is expanding quickly, creating an oversupply in the region's current power market. In addition, even if almost all countries have developed relevant policies and goals for the development of renewable energy, Latin America suffers a lack in terms of specific implementation plans and preferential policies. Moreover, local governments in all areas have the lowest level of credibility.

VI. In terms of economic development, **Europe**'s economy as a whole is advanced, and advanced nations are comparatively more numerous. The economic growth rate has been a little sluggish lately, and the GDP as a whole has fluctuated. The GDP of Europe is predicted to grow slowly—by comparison to other regions—to 23,084.3 billion dollars by 2025.Despite its recent slow economic growth, Europe actively promotes environmental protection, renewable energy use, and policies for the development of renewable energy sources. Regarding technology, the production of renewable energy is increasing both in quantity and in percentage. One of the areas where renewable energy development is relatively quick is in Europe, where wind power, photovoltaic power generation, and other new energy tools are advanced and have low development costs. As a conclusion, even considering its high political and social stability, Europe will certainly be one of the continents with the highest proportion of renewable energy and the fastest rate of growth in the use of renewable energy in the future.

VII. Due to **Africa'**s fragile economic foundation, underdeveloped technology, and flawed political system, the continent's economy and demand have grown quickly in recent years. However, only a few nations have the capacity to support the rapid development of renewable energy. Because of Africa's low level of economic development, the cost of producing renewable energy is higher than in other regions, which will have an impact on the growth of renewable energy power generation in Africa. In terms of renewable energy utilization, the growth rate of renewable energy generation is much lower than the growth rate of total power generation. Therefore, Africa's development of renewable energy appears to be stagnant at this point.

1.1.2 The tangible benefits of the natural-resource based view for companies

According to the natural resource-based view (NRBV), businesses can gain a competitive edge by carefully utilizing resources that support ecologically friendly economic activities. The resource-based view of the firm (RBV), which holds that a firm's possession of unique, valuable, uncommon, and strategic assets and capabilities contributes to the establishment of competitive advantage, is where the NRBV got its start. The NRBV serves as the theoretical underpinning for a study of the relationship between RE consumption and firm financial performance, with the objective of evaluating the strategic benefits of CSR and proactive environmental management.

The preservation of energy for future societal and environmental well-being as well as long-term profit is linked to the strategic use of natural resources, which is one of the guiding principles of the NRBV. For the goal of ecologically sustainable growth, NRBV promotes the creation of a new set of strategic skills, including pollution prevention, product stewardship, and sustainable development. The difference between pollution prevention and product stewardship and sustainable development is that the former prioritizes today's technologies and markets, while the latter focuses on making incremental changes to today's products and processes. The three strategic competencies of NRBV are nevertheless intertwined, and as a result "*a sustainable development strategy helps and accelerates capability development in pollution prevention and product stewardship and vice versa*".[13]

Due to the nearly minimal emissions produced by RE combustion, RE use has an impact on pollution prevention. As a result, businesses using RE can successfully reduce emissions, effluents, and trash. Because using RE to minimize emissions, effluents, and trash lowers costs for waste disposal and streamlines operations, pursuing pollution prevention enables businesses to maximize productivity and efficiency. Because utilizing natural resources can assist businesses in reducing emissions well below necessary levels, pollution prevention also lowers a company's compliance requirements as well as other liabilities. As a result, using RE to enable pollution control along with the socially difficult implementation process enables businesses to increase cash flow and profitability.

Utilizing RE in production and operations enables businesses to reduce the environmental costs of their products and the operational procedures that support them, which has an impact on product stewardship as well. In order to successfully implement product stewardship principles, internal and external stakeholders must be included in every step of the value chain. Companies also need to create new criteria for RE usage and have priority access to RE. Thus, by incorporating RE use into their production and operational processes, businesses have the chance to gather socially complex resources to outmaneuver rivals and gain performance-based competitive advantages. However, implementing a strategy for sustainable growth like RE usage, which aims to protect natural resources for future and long-term profit, calls for a sizable investment, a long-term outlook, and a long-term commitment to market development. Furthermore, businesses would not be able to use RE to reduce the environmental cost of their growth and development without the technology advancement and infrastructure that permit its use. Therefore, in order to implement significant technology and infrastructure changes, sustainable growth also demands extensive interaction with external parties.

[13] Source*: A natural resource-based view of the firm: Fifteen years after – Journal of Management – 2011*

If such conditions and parameters are met, Due to better exploitation of natural resources and related capabilities established in accordance with firms' different strategic priorities of environmental sustainability, companies recognized for excellent RE use will eventually outperform their respective industry competitors.

Specifically, the standard historical (ROI), a forward-looking (Tobin's Q), and the operating margin are the financial indicators that will be examined and compared among firms recognized as top RE users in the EPA's Fortune 500 Top Green Power Partners list [14] and their industry competitors.
ROI, a crucial and frequently applied financial metric, is computed by comparing profit with the capital utilized to generate that profit. To guide a company's objectives and operational decisions, the financial returns from strategic efforts are frequently examined using ROI. The metric's tendency to push managers to prioritize the short term at the expense of the long term is one of the most commonly cited downsides of ROI, though. Tobin's Q is thus considered in this analysis as a supplemental statistic that serves as a prospective indicator of firm financial performance. Tobin's Q is a helpful metric that acts as a stand-in for the company's value from the viewpoint of investors. Tobin's Q is a standardized performance measure that enables accurate comparisons across businesses and industries because of the relative composition of its constituent elements. Tobin's Q has a positive correlation with investment prospects, growth potential, and general management team quality. Earnings before interest, taxes, depreciation, and amortization (EBITDA) are divided by total sales to arrive at operating margin, a perfect illustration of an efficiency metric for gauging corporate success. The efficiency of operating expenses in comparison to sales is reflected in the operating margin; the higher the ratio, the lower the expenses. Eliminating costs or cutting spending are frequent ways to increase operating efficiency. Increasing efficiency can be achieved in a variety of ways, including outsourcing, cutting back on research and development, and lowering fixed operational costs. Operating margin, an intermediate measure of productivity, has a strong correlation with ROI and other broad indicators of a company's financial performance.

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[14] The Green Power Partnership encourages businesses to voluntarily switch to renewable energy (RE) as an alternative to conventional electricity, which has negative environmental effects. Currently, the Partnership includes over 1300 Partner organizations that voluntarily use billions of kilowatt-hours of green energy each year. A wide range of organizations, including Fortune 500 enterprises, small and medium-sized businesses, local and state government agencies, as well as colleges and universities, are partners. By acquiring RE and assisting in the development of additional RE generation capacity, businesses that take part in The Green Power Partnership help the EPA's initiative to lessen the environmental effects of their power use.

For the purpose of measuring the financial performance of the firm, the operating margin, Tobin's Q, and firm ROI were computed using the Standard & Poor's Compustat Database, which provides easily accessible financial data for many significant U.S. companies.

70 businesses from 45 different four-digit NAICS [15] code industries were identified. However, several of these companies were unable to be included in the final studies since the calculations for ROI, Tobin's Q, and/or operating margin required missing inputs. Thus, the final sample made up of 60 companies representing 40 distinct four-digit NAICS code industries was employed to evaluate the study's assumptions. After having calculated the three above mentioned parameters for the time horizon considered (2007-2013), the 60 Top RE users companies were compared to their respective industry medians. When the ROI, Tobin's Q, and operating margins for companies within the respective industries are listed from lowest to highest, the median is the middle value. Because it is unaffected by extreme measurements, the median is essential. Therefore, by utilizing the median value for each industry, outlier influences that could skew statistical analyses and impede an objective interpretation of the data are removed.

The final sample of 60 leading RE purchasing companies, which was used to test the study's hypotheses and determine the corresponding industry medians, is represented in the tables below by ROI, Tobin's Q, and operating margin:

[15] North American Industry Classification Industry System

NAICS	Top RE user firms	ROI							Industry median ROI						
		2007	2008	2009	2010	2011	2012	2013	2007	2008	2009	2010	2011	2012	2013
3114	ConAgra Foods	10.67	11.96	8.90	10.78	6.33	5.43	2.15	11.30	9.08	12.51	12.82	6.36	7.07	7.71
3119	Pepsi	26.39	25.76	23.94	15.24	15.54	13.45	13.83	5.69	1.22	8.81	7.48	7.95	6.96	6.44
3121	Coca-Cola Co.	23.57	24.57	22.44	26.04	18.81	18.83	16.32	6.74	3.81	8.09	8.74	7.82	8.21	5.49
3122	Altria	36.90	51.00	20.97	22.42	20.17	26.76	24.99	28.72	24.81	15.39	15.59	18.55	22.78	23.45
3162	Nike	22.78	16.28	18.69	21.08	20.95	20.00	22.33	11.38	7.75	4.00	12.14	5.48	7.74	5.18
3221	Kimberly-Clark	16.41	16.61	16.33	15.54	13.83	16.05	20.21	0.85	−2.96	8.00	5.54	4.75	4.04	3.09
3222	3M	25.35	22.28	17.25	20.13	20.97	19.30	20.86	6.59	5.34	6.68	9.10	6.44	6.51	8.52
3252	DuPont Company	17.04	13.21	10.22	15.25	16.70	13.51	17.94	4.07	3.55	2.99	9.55	6.63	4.82	7.14
3252	Dow Chemical	10.17	2.62	1.61	5.34	6.57	2.82	10.66	4.07	3.55	2.99	9.55	6.63	4.82	7.14
3254	Roche	17.08	15.79	17.09	21.93	24.63	27.58	29.64	−36.39	−33.22	−15.32	−9.98	−24.06	−23.98	−28.68
3254	Allergan	9.37	10.25	9.81	0.01	13.65	14.90	11.50	−36.39	−33.22	−15.32	−9.98	−24.06	−23.98	−28.68
3254	Baxter	17.82	21.00	20.30	12.73	19.21	18.52	12.11	−36.39	−33.22	−15.32	−9.98	−24.06	−23.98	−28.68
3254	Biogen Inc.	11.42	11.36	13.21	15.43	16.49	18.04	20.21	−36.39	−33.22	−15.32	−9.98	−24.06	−23.98	−28.68
3254	Johnson & Johnson	20.99	25.58	20.86	20.28	13.81	14.22	15.83	−36.39	−33.22	−15.32	−9.98	−24.06	−23.98	−28.68
3256	The Estee Lauder Companies	19.98	17.18	7.16	15.09	18.80	22.45	22.04	10.55	12.41	10.97	13.21	12.65	12.62	11.10
3279	Owens Corning	1.60	−16.96	1.26	17.55	4.87	−0.34	3.48	6.15	8.28	1.26	8.20	7.24	2.57	1.64
3332	Applied Materials Inc.	21.31	12.40	−4.19	12.12	17.92	1.19	2.83	3.98	3.21	−6.59	11.73	9.00	1.13	0.99
3333	Pitney Bowes	7.59	10.19	9.36	6.59	15.67	10.99	3.73	1.29	0.75	2.23	6.74	7.87	2.97	4.71
3341	Apple Inc.	24.06	22.99	26.03	29.32	33.83	35.30	26.36	−0.84	−2.38	−2.37	4.04	0.24	−1.65	3.58
3341	EMC	10.31	8.00	5.68	10.32	12.28	11.59	9.87	−0.84	−2.38	−2.37	4.04	0.24	−1.65	3.58
3341	Hewlett-Packard	16.69	17.87	14.06	15.63	11.49	−28.35	11.55	−0.84	−2.38	−2.37	4.04	0.24	−1.65	3.58
3342	Cisco Systems Inc.	19.35	19.74	12.53	13.75	10.22	11.90	13.86	4.50	1.56	0.24	3.08	0.88	0.15	0.05
3342	Motorola Inc.	−0.25	−31.21	−0.38	4.80	18.08	17.11	17.88	4.50	1.56	0.24	3.08	0.88	0.15	0.05
3344	Advanced Micro Devices	−40.78	−64.69	6.29	14.71	15.75	−45.94	−3.27	3.17	−1.82	−2.11	8.60	5.35	1.73	2.44
3344	Intel Corporation	15.59	12.92	9.99	22.26	24.42	17.10	13.47	3.17	−1.82	−2.11	8.60	5.35	1.73	2.44
3345	Agilent Technologies	11.99	14.80	−0.57	12.61	16.20	15.80	9.06	2.22	0.94	−1.14	5.01	5.20	4.58	4.90
3345	Medtronic	12.89	11.08	14.37	12.86	14.78	12.20	10.30	2.22	0.94	−1.14	5.01	5.20	4.58	4.90
3345	Raytheon	17.16	14.34	15.77	13.63	14.41	14.61	12.53	2.22	0.94	−1.14	5.01	5.20	4.58	4.90
3363	Autoliv	8.37	4.61	0.31	16.51	16.79	11.13	11.35	4.59	−3.94	−2.34	4.63	8.22	9.19	8.28
3363	Johnson Controls, Inc.	10.19	7.61	−2.70	11.45	10.17	7.10	6.81	4.59	−3.94	−2.34	4.63	8.22	9.19	8.28
3364	Boeing	24.75	47.23	9.08	23.07	29.49	26.10	19.88	12.60	11.65	7.44	7.74	10.04	9.22	7.07
3364	General Dynamics Corp	14.92	18.68	15.36	16.66	14.74	−2.17	12.80	12.60	11.65	7.44	7.74	10.04	9.22	7.07
3364	Lockheed Martin Corporation	21.50	50.05	32.94	33.53	35.59	44.30	26.93	12.60	11.65	7.44	7.74	10.04	9.22	7.07
3391	Becton–Dickinson (BD)	16.74	19.14	18.57	19.01	17.38	14.81	14.68	1.40	0.46	1.89	3.62	2.27	1.77	0.99
4234	Ingram Micro, Inc.	7.23	−13.11	6.10	8.43	6.84	6.72	6.54	8.11	8.23	7.01	9.59	10.02	8.86	7.34
4244	United Natural Foods	10.20	9.00	9.89	10.06	8.81	8.35	8.54	6.03	3.80	9.89	9.17	5.12	7.77	−0.07
4431	Best Buy	27.32	15.97	16.32	15.96	−20.34	−9.06	9.50	7.19	2.79	7.66	10.47	6.12	6.72	3.60
4441	Lowe's	12.96	9.50	7.56	8.15	7.80	8.56	10.42	12.29	8.23	7.56	8.18	10.49	8.63	10.83
4451	Safeway Inc.	7.82	8.40	−11.79	6.34	6.26	7.29	35.59	7.84	7.07	6.94	7.69	6.26	7.02	6.18
4451	Whole Foods Market	8.33	4.70	5.28	8.53	11.39	12.17	14.11	7.84	7.07	6.94	7.69	6.26	7.02	6.18
4521	Kohl's Corp	13.29	10.07	10.01	9.86	10.95	9.39	8.31	4.70	−0.44	−0.44	5.27	4.75	4.46	8.70
4521	Macy's, Inc.	4.70	−35.90	2.66	6.78	9.98	10.38	11.45	4.70	−0.44	−0.44	5.27	4.75	4.46	8.70
4529	Wal-Mart Stores Inc.	12.74	13.13	13.07	14.19	12.74	13.75	12.58	11.14	12.96	10.06	11.79	12.63	13.75	12.59
4532	Staples	16.40	10.61	7.90	9.84	11.42	−2.95	8.68	13.54	−30.65	−12.55	3.62	8.44	−3.99	4.07
4811	Southwest Airlines Co.	7.17	2.11	1.13	5.04	1.78	4.26	7.91	5.11	−5.75	4.02	5.76	6.72	5.66	3.54
4921	FedEx Corp	7.02	0.63	7.65	8.60	12.72	7.75	10.48	7.65	6.17	7.40	8.37	8.84	6.36	5.33
4921	United Parcel Service (UPS)	1.94	20.60	13.15	18.82	20.90	5.10	25.25	7.65	6.17	7.40	8.37	8.84	6.36	5.33
5112	CA Inc.	8.43	12.32	11.84	11.98	14.23	14.20	13.40	3.97	4.06	5.33	5.23	7.21	6.82	3.87
5112	Microsoft	45.23	48.73	33.64	36.70	33.55	22.03	23.88	3.97	4.06	5.33	5.23	7.21	6.82	3.87
5112	Oracle Corp	16.60	16.29	14.36	15.54	17.32	17.17	15.62	3.97	4.06	5.33	5.23	7.21	6.82	3.87
5152	Time Warner Cable	2.79	−20.23	3.42	4.01	5.18	6.64	6.46	3.87	2.08	5.01	6.50	5.21	6.17	7.06
5172	Sprint Corp	−69.65	−6.89	−6.35	−10.47	−9.12	−13.93	−5.24	7.17	6.21	9.29	11.62	6.51	7.58	6.21
5172	AT&T	6.92	8.18	7.50	11.62	2.36	4.57	11.35	7.17	6.21	9.29	11.62	6.51	7.58	6.21
5182	Xerox	6.98	1.67	3.01	2.97	6.65	6.14	5.89	4.15	5.32	7.50	4.51	6.04	8.34	5.08
5191	Google	18.53	14.97	18.11	18.39	15.93	14.37	14.43	5.02	1.30	3.57	4.17	4.28	2.89	0.30
5413	AECOM	7.49	8.00	10.00	7.76	7.79	−1.87	7.56	6.07	5.44	3.68	5.84	2.38	6.95	6.94
5415	IBM Corp	20.23	34.12	30.04	32.95	36.79	38.55	29.55	6.96	7.83	6.92	6.38	5.61	5.26	3.35
6214	DaVita Inc.	6.86	6.52	6.98	6.10	6.67	4.18	4.71	4.63	5.09	5.47	4.97	4.21	4.18	−1.89
7225	McDonald's	10.60	18.30	18.50	18.93	20.75	18.89	18.53	8.42	4.26	7.26	6.95	7.31	6.52	6.23
7225	Starbucks	23.57	10.31	10.84	22.35	25.23	24.43	0.14	8.42	4.26	7.26	6.95	7.31	6.52	6.23

ROI comparison – Source: An assessment of the association between RE utilization and firm financial performance – 2016

NAICS	Top RE user firms	Tobin's *Q*							Industry median Tobin's *Q*						
		2007	2008	2009	2010	2011	2012	2013	2007	2008	2009	2010	2011	2012	2013
3114	ConAgra Foods	1.05	1.08	1.16	1.17	1.22	1.20	1.19	1.49	1.12	1.27	1.18	1.20	1.11	1.30
3119	Pepsi	3.64	2.60	2.54	1.83	1.77	1.76	1.94	1.63	0.82	1.11	1.27	1.64	1.31	1.95
3121	Coca-Cola Co.	3.44	2.73	2.77	2.25	2.17	2.06	2.23	1.19	0.88	0.96	1.11	1.17	1.39	2.39
3122	Altria	3.04	1.31	1.53	1.77	2.06	2.24	2.66	3.04	1.59	1.62	1.77	2.06	2.24	2.66
3162	Nike	2.49	1.81	2.08	2.35	2.94	2.85	3.41	0.86	0.50	0.53	0.96	0.66	1.07	1.26
3221	Kimberly-Clark	1.89	1.55	1.69	1.62	1.86	2.00	2.47	0.78	0.60	0.71	0.75	0.76	0.82	0.94
3222	3M	2.52	1.74	2.23	2.08	1.83	1.92	2.86	1.04	0.81	0.85	0.98	0.84	0.94	1.26
3252	DuPont Company	1.36	0.85	0.99	1.30	1.13	1.05	1.32	1.25	0.67	0.92	1.18	0.81	1.12	1.32
3252	Dow Chemical	0.93	0.55	0.84	0.89	0.78	0.85	1.00	1.25	0.67	0.92	1.18	0.81	1.12	1.32
3254	Roche	−0.24	−0.23	0.34	0.33	0.27	0.19	0.14	2.08	1.35	2.24	2.46	2.27	2.67	3.29
3254	Allergan	3.05	1.85	2.47	2.44	2.99	2.83	2.97	2.08	1.35	2.24	2.46	2.27	2.67	3.29
3254	Baxter	2.49	2.29	2.16	1.84	1.64	1.98	1.75	2.08	1.35	2.24	2.46	2.27	2.67	3.29
3254	Biogen Inc.	1.96	1.60	1.67	1.98	2.87	3.37	5.55	2.08	1.35	2.24	2.46	2.27	2.67	3.29
3254	Johnson & Johnson	2.37	1.95	1.83	1.55	1.46	1.58	1.88	2.08	1.35	2.24	2.46	2.27	2.67	3.29
3256	The Estee Lauder Companies	2.42	2.00	1.38	2.16	3.36	3.24	3.58	1.61	1.54	1.39	1.40	1.28	1.51	1.85
3279	Owens Corning	0.62	0.65	0.72	0.79	0.73	0.86	0.89	1.33	0.72	0.72	0.93	0.92	1.22	1.40
3332	Applied Materials Inc.	2.27	1.42	1.51	1.30	0.88	1.08	1.80	1.14	0.68	1.02	1.12	0.81	1.08	1.36
3333	Pitney Bowes	1.30	1.09	1.02	1.05	0.91	0.72	1.11	1.39	0.86	1.04	1.39	1.12	1.23	1.35
3341	Apple Inc.	4.80	2.04	3.10	3.19	2.91	3.45	2.02	1.11	0.69	0.84	1.00	0.80	0.86	1.12
3341	EMC	1.69	0.83	1.28	1.55	1.28	1.38	1.14	1.11	0.69	0.84	1.00	0.80	0.86	1.12
3341	Hewlett-Packard	1.56	0.96	1.07	0.88	0.64	0.47	0.61	1.11	0.69	0.84	1.00	0.80	0.86	1.12
3342	Cisco Systems Inc.	3.11	1.96	1.59	1.38	0.74	0.63	1.08	1.07	0.53	0.67	0.75	0.73	0.72	1.05
3342	Motorola Inc.	0.99	0.40	0.61	0.66	0.84	1.11	1.41	1.07	0.53	0.67	0.75	0.73	0.72	1.05
3344	Advanced Micro Devices	0.80	0.85	1.02	1.31	0.87	0.86	1.02	1.20	0.61	0.96	0.54	0.88	0.85	1.17
3344	Intel Corporation	2.61	1.48	1.96	1.57	1.67	1.20	1.38	1.20	0.61	0.96	0.54	0.88	0.85	1.17
3345	Agilent Technologies	1.90	1.16	1.21	1.22	1.32	1.22	1.61	1.61	0.84	1.18	1.21	1.24	1.38	1.77
3345	Medtronic	2.61	1.68	1.84	1.65	1.36	1.29	1.45	1.61	0.84	1.18	1.21	1.24	1.38	1.77
3345	Raytheon	1.20	0.99	0.96	0.85	0.83	0.89	1.28	1.61	0.84	1.18	1.21	1.24	1.38	1.77
3363	Autoliv	0.95	0.54	0.87	1.30	0.79	0.94	1.19	0.75	0.45	0.80	0.94	0.71	0.82	1.07
3363	Johnson Controls, Inc.	1.15	0.89	0.86	0.94	0.79	0.79	1.07	0.75	0.45	0.80	0.94	0.71	0.82	1.07
3364	Boeing	1.45	1.07	1.06	1.15	1.10	1.03	1.50	1.52	0.88	0.84	0.96	0.91	0.93	1.08
3364	General Dynamics Corp	1.59	1.06	1.07	1.01	0.88	0.93	1.12	1.52	0.88	0.84	0.96	0.91	0.93	1.08
3364	Lockheed Martin Corporation	1.66	1.15	0.96	0.85	0.87	0.96	1.50	1.52	0.88	0.84	0.96	0.91	0.93	1.08
3391	Becton–Dickinson (BD)	2.78	2.44	1.75	1.74	1.59	1.51	1.71	1.73	1.04	1.72	1.58	1.38	1.96	2.11
4234	Ingram Micro, Inc.	0.38	0.31	0.33	0.34	0.31	0.32	0.40	0.89	0.44	0.58	0.65	0.45	0.53	0.67
4244	United Natural Foods	1.66	1.08	1.34	1.41	1.54	1.84	1.76	0.86	0.81	1.03	0.98	1.55	0.81	1.76
4431	Best Buy	1.76	1.14	1.11	0.98	0.90	0.71	0.86	0.72	0.52	0.65	0.72	0.56	0.59	0.63
4441	Lowe's	1.65	1.19	1.27	1.35	1.39	1.77	2.00	1.65	1.26	1.54	1.89	1.52	2.29	3.14
4451	Safeway Inc.	1.34	1.03	1.04	1.01	0.94	0.86	0.63	1.21	1.09	1.08	1.11	1.08	1.15	1.20
4451	Whole Foods Market	2.48	1.22	1.42	1.71	2.67	3.27	3.85	1.21	1.09	1.08	1.11	1.08	1.15	1.20
4521	Kohl's Corp	1.62	1.25	1.32	1.25	1.17	1.17	1.16	0.84	0.58	0.74	0.88	0.83	1.04	1.00
4521	Macy's, Inc.	0.89	0.71	0.81	0.95	1.05	1.17	1.33	0.84	0.58	0.74	0.88	0.83	1.04	1.00
4529	Wal-Mart Stores Inc.	1.72	1.59	1.63	1.57	1.58	1.62	1.66	1.36	1.09	1.31	1.37	1.58	1.73	1.81
4532	Staples	1.92	1.14	1.42	1.31	0.89	0.86	0.90	1.33	0.79	1.04	0.99	0.69	0.71	0.76
4811	Southwest Airlines Co.	0.70	0.70	0.80	0.77	0.57	0.61	0.88	0.66	0.67	0.64	0.65	0.59	0.64	0.78
4921	FedEx Corp	1.11	0.70	1.03	1.04	0.88	0.84	1.28	0.91	0.64	0.74	0.77	0.63	0.60	1.04
4921	United Parcel Service (UPS)	2.02	1.95	1.97	2.29	2.19	1.92	2.82	0.91	0.64	0.74	0.77	0.63	0.60	1.04
5112	CA Inc.	1.15	0.91	1.11	1.05	1.16	1.01	1.18	1.63	1.00	1.40	1.78	1.97	1.99	2.91
5112	Microsoft	4.13	3.29	2.49	2.04	1.70	1.78	1.67	1.63	1.00	1.40	1.78	1.97	1.99	2.91
5112	Oracle Corp	2.53	2.06	1.83	2.22	1.52	1.80	1.96	1.63	1.00	1.40	1.78	1.97	1.99	2.91
5152	Time Warner Cable	0.75	0.73	0.87	0.99	0.90	1.10	1.33	1.23	0.91	0.96	1.03	1.00	1.15	1.41
5172	Sprint Corp	0.92	0.42	0.54	0.58	0.49	0.72	0.85	1.47	0.95	0.87	1.05	0.85	0.83	0.96
5172	AT&T	1.18	0.94	0.91	0.92	0.92	0.97	0.96	1.47	0.95	0.87	1.05	0.85	0.83	0.96
5182	Xerox	0.82	0.57	0.50	0.75	0.58	0.49	0.68	1.31	1.02	1.20	1.18	1.17	1.26	1.40
5191	Google	7.94	2.49	4.21	2.75	2.33	2.03	2.90	2.11	1.02	1.48	1.80	2.03	2.39	3.22
5413	AECOM	1.17	0.63	0.66	0.50	0.34	0.37	0.53	1.23	0.80	0.71	0.70	0.60	0.72	0.97
5415	IBM Corp	1.38	1.20	1.67	1.74	1.98	1.97	1.76	1.23	0.76	1.16	1.12	1.14	1.34	1.66
6214	DaVita Inc.	1.28	1.08	1.11	1.14	1.18	1.20	1.21	1.21	0.95	0.89	0.94	0.83	1.10	2.45
7225	McDonald's	2.62	2.76	2.56	2.85	3.45	2.85	2.96	1.41	0.96	1.11	1.20	1.38	1.49	1.72
7225	Starbucks	3.94	2.22	2.89	2.99	3.75	4.60	5.24	1.41	0.96	1.11	1.20	1.38	1.49	1.72

Tobin's Q comparison – Source: An assessment of the association between RE utilization and firm financial performance – 2016

NAICS	Top RE user firms	Operating margin							Industry median operating margin						
		2007	2008	2009	2010	2011	2012	2013	2007	2008	2009	2010	2011	2012	2013
3114	ConAgra Foods	0.11	0.12	0.14	0.14	0.09	0.13	0.13	0.10	0.11	0.13	0.16	0.14	0.13	0.15
3119	Pepsi	0.22	0.21	0.22	0.21	0.20	0.19	0.19	0.10	0.10	0.12	0.11	0.11	0.05	0.10
3121	Coca-Cola Co.	0.30	0.31	0.31	0.31	0.27	0.27	0.28	0.18	0.16	0.16	0.16	0.15	0.14	0.13
3122	Altria	0.39	0.33	0.38	0.39	0.41	0.43	0.47	0.41	0.34	0.35	0.36	0.38	0.39	0.40
3162	Nike	0.15	0.15	0.15	0.15	0.14	0.15	0.15	0.09	0.08	0.07	0.11	0.08	0.11	0.12
3221	Kimberly-Clark	0.19	0.18	0.20	0.19	0.19	0.19	0.20	0.11	0.10	0.11	0.11	0.11	0.12	0.11
3222	3M	0.27	0.26	0.27	0.26	0.25	0.26	0.26	0.13	0.12	0.13	0.13	0.12	0.12	0.13
3252	DuPont Company	0.18	0.15	0.15	0.16	0.17	0.18	0.16	0.05	0.08	0.08	0.11	0.10	0.08	0.11
3252	Dow Chemical	0.11	0.08	0.10	0.11	0.12	0.12	0.12	0.05	0.08	0.08	0.11	0.10	0.08	0.11
3254	Roche	0.36	0.35	0.35	0.37	0.38	0.39	0.40	−0.83	−0.66	−0.32	−0.38	−0.50	−0.79	−0.94
3254	Allergan	0.21	0.22	0.23	0.22	0.24	0.21	0.24	−0.83	−0.66	−0.32	−0.38	−0.50	−0.79	−0.94
3254	Baxter	0.26	0.27	0.29	0.28	0.28	0.27	0.27	−0.83	−0.66	−0.32	−0.38	−0.50	−0.79	−0.94
3254	Biogen Inc.	0.40	0.45	0.44	0.47	0.49	0.46	0.45	−0.83	−0.66	−0.32	−0.38	−0.50	−0.79	−0.94
3254	Johnson & Johnson	0.29	0.30	0.32	0.32	0.30	0.31	0.32	−0.83	−0.66	−0.32	−0.38	−0.50	−0.79	−0.94
3256	The Estee Lauder Companies	0.14	0.13	0.11	0.15	0.17	0.17	0.19	0.11	0.09	0.10	0.11	0.14	0.12	0.10
3279	Owens Corning	0.13	0.10	0.12	0.14	0.14	0.11	0.14	0.13	0.10	0.09	0.14	0.13	0.06	0.10
3332	Applied Materials Inc.	0.28	0.21	0.01	0.20	0.25	0.18	0.17	0.06	0.06	−0.01	0.13	0.12	0.08	0.04
3333	Pitney Bowes	0.24	0.24	0.23	0.23	0.22	0.22	0.23	0.05	−0.01	0.06	0.09	0.10	0.08	0.09
3341	Apple Inc.	0.20	0.21	0.29	0.30	0.33	0.37	0.33	0.01	0.04	0.04	0.06	0.06	0.03	0.03
3341	EMC	0.20	0.20	0.20	0.24	0.25	0.26	0.26	0.01	0.04	0.04	0.06	0.06	0.03	0.03
3341	Hewlett-Packard	0.11	0.12	0.14	0.14	0.13	0.12	0.12	0.01	0.04	0.04	0.06	0.06	0.03	0.03
3342	Cisco Systems Inc.	0.29	0.28	0.25	0.27	0.25	0.27	0.28	0.16	0.16	0.15	0.23	0.07	0.05	0.05
3342	Motorola Inc.	0.04	0.02	0.05	0.07	0.17	0.17	0.18	0.16	0.16	0.15	0.23	0.07	0.05	0.05
3344	Advanced Micro Devices	0.02	0.04	0.11	0.12	0.11	0.04	0.05	0.09	0.07	0.06	0.14	0.11	0.08	0.06
3344	Intel Corporation	0.36	0.38	0.39	0.47	0.44	0.42	0.39	0.09	0.07	0.06	0.14	0.11	0.08	0.06
3345	Agilent Technologies	0.15	0.17	0.10	0.19	0.22	0.22	0.21	0.05	0.05	0.03	0.09	0.07	0.05	0.02
3345	Medtronic	0.33	0.34	0.35	0.34	0.35	0.34	0.34	0.05	0.05	0.03	0.09	0.07	0.05	0.02
3345	Raytheon	0.13	0.13	0.14	0.13	0.14	0.14	0.14	0.05	0.05	0.03	0.09	0.07	0.05	0.02
3363	Autoliv	0.13	0.11	0.10	0.16	0.14	0.13	0.12	0.08	0.07	0.06	0.09	0.08	0.08	0.10
3363	Johnson Controls, Inc.	0.07	0.07	0.04	0.07	0.07	0.06	0.09	0.08	0.07	0.06	0.09	0.08	0.08	0.10
3364	Boeing	0.11	0.08	0.05	0.10	0.10	0.09	0.10	0.12	0.13	0.11	0.11	0.12	0.12	0.12
3364	General Dynamics Corp	0.13	0.14	0.13	0.14	0.14	0.13	0.14	0.12	0.13	0.11	0.11	0.12	0.12	0.12
3364	Lockheed Martin Corporation	0.12	0.13	0.12	0.11	0.10	0.11	0.12	0.12	0.13	0.11	0.11	0.12	0.12	0.12
3391	Becton–Dickinson (BD)	0.28	0.28	0.29	0.29	0.28	0.26	0.26	0.06	0.04	0.09	0.09	0.08	0.00	0.37
4234	Ingram Micro, Inc.	0.02	0.01	0.01	0.02	0.01	0.01	0.02	0.03	0.03	0.03	0.05	0.04	0.03	0.03
4244	United Natural Foods	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.04	0.04	0.04	0.04	0.03
4431	Best Buy	0.07	0.06	0.07	0.07	0.06	0.05	0.04	0.06	0.06	0.06	0.06	0.05	0.04	0.04
4441	Lowe's	0.13	0.11	0.10	0.11	0.09	0.10	0.11	0.08	0.09	0.10	0.10	0.09	0.10	0.08
4451	Safeway Inc.	0.07	0.07	0.06	0.06	0.05	0.05	0.04	0.06	0.06	0.06	0.06	0.06	0.06	0.06
4451	Whole Foods Market	0.07	0.06	0.07	0.08	0.08	0.09	0.09	0.06	0.06	0.06	0.06	0.06	0.06	0.06
4521	Kohl's Corp	0.14	0.13	0.13	0.15	0.16	0.14	0.19	0.09	0.08	0.07	0.09	0.09	0.09	0.08
4521	Macy's, Inc.	0.12	0.11	0.11	0.12	0.13	0.13	0.13	0.09	0.08	0.07	0.09	0.09	0.09	0.08
4529	Wal-Mart Stores Inc.	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.07	0.07	0.08	0.08	0.08
4532	Staples	0.10	0.09	0.08	0.09	0.08	0.08	0.07	0.08	0.05	0.05	0.05	0.06	0.06	0.05
4811	Southwest Airlines Co.	0.14	0.10	0.09	0.13	0.10	0.10	0.13	0.13	0.02	0.10	0.17	0.13	0.12	0.10
4921	FedEx Corp	0.13	0.11	0.11	0.12	0.13	0.13	0.13	0.09	0.09	0.10	0.11	0.12	0.08	0.11
4921	United Parcel Service (UPS)	0.18	0.15	0.13	0.15	0.15	0.08	0.16	0.09	0.09	0.10	0.11	0.12	0.08	0.11
5112	CA Inc.	0.29	0.35	0.37	0.37	0.38	0.40	0.38	0.08	0.06	0.11	0.10	0.09	0.07	0.05
5112	Microsoft	0.39	0.43	0.39	0.43	0.42	0.42	0.40	0.08	0.06	0.11	0.10	0.09	0.07	0.05
5112	Oracle Corp	0.42	0.45	0.45	0.43	0.46	0.46	0.47	0.08	0.06	0.11	0.10	0.09	0.07	0.05
5152	Time Warner Cable	0.36	0.36	0.36	0.36	0.37	0.37	0.36	0.26	0.28	0.30	0.30	0.32	0.27	0.26
5172	Sprint Corp	0.27	0.22	0.20	0.17	0.15	0.14	0.12	0.32	0.34	0.33	0.33	0.31	0.30	0.30
5172	AT&T	0.35	0.35	0.33	0.31	0.27	0.24	0.38	0.32	0.34	0.33	0.33	0.31	0.30	0.30
5182	Xerox	0.15	0.14	0.13	0.14	0.14	0.14	0.14	0.12	0.15	0.18	0.19	0.15	0.13	0.12
5191	Google	0.36	0.38	0.42	0.40	0.37	0.32	0.30	0.08	0.08	0.09	0.09	0.07	0.05	0.02
5413	AECOM	0.04	0.05	0.06	0.06	0.06	0.05	0.05	0.08	0.08	0.06	0.07	0.09	0.10	0.08
5415	IBM Corp	0.20	0.21	0.24	0.24	0.24	0.25	0.24	0.06	0.08	0.08	0.08	0.07	0.06	0.05
6214	DaVita Inc.	0.20	0.19	0.19	0.19	0.20	0.21	0.19	0.09	0.10	0.11	0.11	0.10	0.13	0.11
7225	McDonald's	0.29	0.32	0.34	0.35	0.36	0.35	0.36	0.11	0.09	0.10	0.10	0.11	0.11	0.11
7225	Starbucks	0.15	0.12	0.14	0.17	0.18	0.18	0.19	0.11	0.09	0.10	0.10	0.11	0.11	0.11

Operating margin comparison – Source: An assessment of the association between RE utilization and firm financial performance – 2016

The results of the analysis showed that for each of the seven years that were looked at, the top RE partner businesses in our sample had parameter scores that were significantly higher than the industry medians. It is crucial to comprehend the relationship between RE usage and economic performance in light of the significant attention given to the development and utilization of RE as an increasingly viable, environmentally friendly, and moral business strategy for large firms, and potentially even for SMEs, to increase their investments in RE. By making significant investments in RE, a long-term approach to corporate social responsibility can be accomplished, using the NRBV as the theoretical framework. However, at this point, it's crucial to comprehend how businesses, particularly medium-sized and small ones, can finance such massive initiatives that can revolutionize the production cycle with a green approach while also making them active participants in the energy market and the overall Energy Transition process.

1.2 RE generators financing: a "State of the art" review

During the past several years, there has been a significant shift in favor of renewable energy sources. To reduce carbon emissions and combat the consequences of climate change, businesses and governments are increasing their investments in renewable energy projects in both the public and private sectors. According to a research conducted by IRENA[16], over $300 billion was spent in the global renewable energy market in 2018, with the majority going to solar and wind power.

In Europe, with almost €1.2 billion in funding provided for renewable energy projects in 2019 alone, the EIB[17] has played a vital role in advancing these initiatives. By 2030, the EIB seeks to generate €1 trillion in investments for environmental sustainability and climate change.

The DOE[18] has also played a significant role in the promotion of renewable energy projects in the US. The Energy Transitions Initiative Partnership Project, announced by the DOE in 2020, intends to hasten the adoption of energy-efficient and renewable energy technology in low- and middle-income nations. By the year 2050, the DOE wants to attain net-zero emissions.

The NRBV for businesses demonstrated the need of integrating renewable energy into the production and supply chain in the context of the Energy Transition objectives. As a result, businesses may not only lower their carbon emissions but also improve their long-term stability by investing in renewable energy projects. Technologies for producing renewable energy, such solar and wind power, are

[16] International Renewable Energy Agency.

[17] European Investment Bank.

[18] Department of Energy.

getting cheaper, and businesses may use government subsidies and financing alternatives to invest in these projects.

The paragraph that follows emphasizes how several channels and methodologies can be used to finance a renewable energy facility. Before settling on a specific financing plan, businesses must carefully weigh their alternatives because every financing method has unique advantages and hazards. Many parties, including the developers, investors, and regulators, are often involved in the planning and funding of a renewable energy project. There are several aspects that can influence the result of the project, including regulatory and policy changes, project risks, and market circumstances. Each stakeholder has a responsibility to play in ensuring the project's success.

Hence, the various financing options for renewable energy projects as well as the responsibilities played by various stakeholders in their development and financing will be studied, along with the benefits and drawbacks of investing in such projects. The purpose is to offer direction on where and how businesses may effectively navigate the challenging world of renewable energy finance.

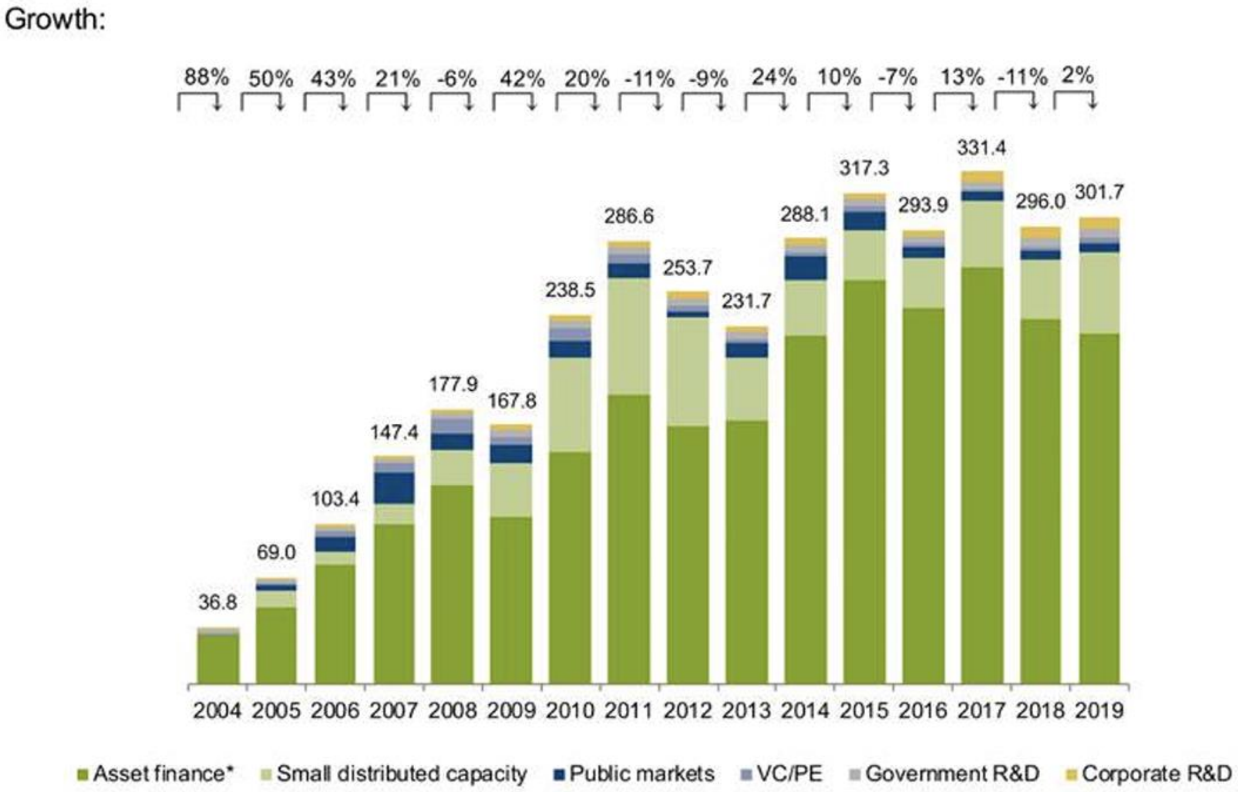
1.2.1 Funding Stages and Channels in RE

Up until around 2000, scientists and industry experts agreed that a lack of appropriate financing channels was the key barrier to increased use of and investment in the renewable energy sector globally (particularly in developing economies). Yet, a survey by IRENA indicates that since 2004, finance for renewable energy has been rising. In the report, IRENA Director-General Adnan Z. Amin stated, "*Renewable energy has become the technology of choice for new power generation capacity in many countries around the world, and the trend is continuing. The rapid growth of renewables is driven by factors such as improved technology, falling costs, and the need to address climate change and other environmental challenges.*"[19]

In order to fulfill the world's energy demand and cut greenhouse gas emissions, the report emphasizes the critical role that funding plays in fostering the expansion of renewable energy sources.

Experts have noticed that the introduction and development of appropriate finance channels and instruments for both end users and industry were among the factors affecting increased investment. The chart and table that follow show the trend of investments in RE projects through the year 2019, broken down by asset class. The shown data sheds light on how money is distributed across various renewable energy technologies and projects, including wind, solar, and hydropower. It is feasible to spot trends in investment behavior and the technologies that have received the most financing over the past 15 years by classifying investments by asset class.

[19] Source: *Energy Transition Driven by Renewables* – IRENA - 2017



RE investments trend by asset class – Source: Frankfurt School for Climate & Sustainable Finance– 2020

Category (Year / Unit)	2004 $bn	2005 $bn	2006 $bn	2007 $bn	2008 $bn	2009 $bn	2010 $bn	2011 $bn	2012 $bn	2013 $bn	2014 $bn	2015 $bn	2016 $bn	2017 $bn	2018 $bn	2019 $bn	2018-19 Growth %	2004-19 CAGR %
1 Total Investment																		
1.1 New investment	36.8	69.0	103.4	147.4	177.9	167.8	238.5	286.6	253.7	231.7	288.1	317.3	293.9	331.4	296.0	301.7	2%	15%
1.2 Total transactions	45.2	95.2	136.9	204.3	236.2	229.3	295.8	361.6	319.3	298.7	376.9	425.4	427.8	477.7	437.4	402.4	-8%	16%
2 New Investment by Value Chain																		
2.1 Technology development																		
2.1.1 Venture capital	0.4	0.6	1.2	2.1	3.3	1.6	2.6	2.6	2.4	0.8	1.0	1.4	0.8	0.8	0.2	1.2	508%	9%
2.1.2 Government R&D	1.9	2.0	2.2	2.7	2.8	5.4	4.9	4.8	4.7	5.2	4.5	4.4	5.1	5.1	5.5	5.7	4%	8%
2.1.3 Corporate R&D	1.9	1.9	2.2	2.3	3.3	3.3	3.8	4.3	4.1	4.0	4.3	4.1	4.3	6.9	7.8	7.7	-1%	10%
2.2 Scale-up																		
2.2.1 Private equity expansion capital	0.3	1.0	2.9	3.5	6.7	3.0	5.3	2.4	1.6	1.3	1.7	1.8	1.7	0.7	2.2	1.8	-22%	12%
2.2.2 Public markets	0.3	3.6	8.9	19.7	10.5	11.7	10.6	9.9	3.8	9.8	14.9	12.0	6.2	5.6	6.0	6.6	11%	24%
2.3 Projects																		
2.3.1 Asset finance	32.1	50.0	79.2	106.3	133.5	111.8	152.2	189.6	170.1	171.5	228.4	267.7	247.5	272.6	242.0	230.1	-5%	14%
Of which re-invested equity	-0.1	-0.2	-2.2	-3.1	-4.4	-3.7	-1.8	-2.1	-2.9	-1.2	-3.5	-6.7	-4.1	-2.9	-5.8	-3.4	-41%	26%
2.3.3 Small distributed capacity	8.0	10.1	9.0	13.9	22.2	34.7	60.9	75.1	69.9	40.2	36.7	32.6	32.5	42.5	38.2	52.1	37%	13%
Total Financial Investment	32.9	55.0	90.0	128.5	149.6	124.4	169.0	202.4	174.9	182.2	242.6	276.1	252.1	276.9	244.6	236.3	-3%	14%
Gov't R&D, corporate RD&D, small projects	11.9	14.0	13.4	18.9	28.4	43.4	69.5	84.1	78.8	49.4	45.5	41.1	41.8	54.5	51.4	65.5	27%	12%
Total New Investment	44.8	69.0	103.4	147.4	177.9	167.8	238.5	286.6	253.7	231.7	288.1	317.3	293.9	331.4	296.0	301.7	2%	14%
3 M&A Transactions																		
3.1 Private equity buy-outs	0.8	3.7	1.8	3.3	5.1	1.9	1.9	2.9	3.0	0.5	4.1	3.6	3.2	10.6	13.0	3.2	-76%	10%
3.2 Public markets investor exits	0.4	2.3	2.6	3.9	0.9	2.4	4.8	0.2	0.4	1.7	1.6	1.5	6.4	2.8	0.1		-100%	-100%
3.3 Corporate M&A	2.2	7.6	10.3	19.8	16.5	22.4	18.7	29.6	9.3	16.2	11.2	18.4	29.5	13.3	14.6	13.7	-6%	13%
3.4 Project acquisition & refinancing	5.1	12.5	18.7	29.9	35.8	34.9	32.0	42.3	53.0	48.7	71.9	84.6	94.8	119.6	123.8	83.8	-32%	21%
4 New Investment by Sector																		
4.1 Wind	18.4	26.3	35.4	58.8	73.9	72.5	97.8	83.3	78.3	83.3	111.1	119.7	123.5	133.4	132.7	142.7	8%	15%
4.2 Solar	10.7	15.3	21.6	37.5	60.5	63.6	102.0	160.1	144.0	120.4	147.8	176.6	145.9	180.8	143.5	141.0	-2%	19%
4.3 Biofuels	3.9	9.8	26.3	26.4	17.6	9.4	10.1	10.5	7.7	5.1	5.5	3.6	2.1	3.3	3.3	3.0	-10%	-2%
4.4 Biomass & w-t-e	7.9	9.3	12.0	15.9	16.4	13.4	17.3	20.9	15.4	14.6	13.1	10.4	15.2	7.4	11.5	11.2	-2%	2%
4.5 Small hydro	2.8	7.5	6.8	6.5	7.6	6.0	8.2	7.7	6.3	5.7	7.4	4.2	4.3	4.0	2.3	2.5	6%	-1%
4.6 Geothermal	1.1	0.8	1.3	1.7	1.7	2.5	2.8	3.8	1.7	2.4	2.9	2.5	2.7	2.4	2.5	1.2	-50%	1%
4.7 Marine	0.0	0.1	0.1	0.7	0.2	0.3	0.3	0.3	0.3	0.2	0.4	0.2	0.2	0.2	0.2	0.2	-8%	12%
Total	44.8	69.0	103.4	147.4	177.9	167.8	238.5	286.6	253.7	231.7	288.1	317.3	293.9	331.4	296.0	301.7	2%	14%
5 New Investment by Geography																		
5.1 United States	6.0	11.3	28.5	30.5	34.7	23.0	34.6	50.3	40.7	36.1	38.4	46.9	44.4	48.6	47.1	59.0	25%	16%
5.2 Brazil	0.7	2.4	4.1	9.9	11.1	6.9	7.2	10.2	7.8	3.9	7.7	6.4	5.7	6.2	3.8	6.8	78%	16%
5.3 AMER (excl. US & Brazil)	1.7	3.7	3.5	4.8	5.6	5.0	12.0	9.8	10.4	12.5	15.2	11.5	6.5	13.2	10.7	12.8	20%	14%
5.4 Europe	23.3	31.6	40.7	64.5	79.1	76.5	112.2	131.7	91.1	57.7	68.7	61.1	71.5	49.1	60.8	58.4	-4%	6%
5.5 Middle East & Africa	0.6	0.8	1.2	1.8	2.2	1.5	4.0	3.1	9.9	7.2	8.4	11.6	7.1	10.7	16.5	15.4	-7%	24%
5.6 China	3.0	8.5	10.5	17.2	25.8	36.7	42.4	45.7	56.6	63.4	88.7	121.1	105.6	148.4	95.9	90.1	-6%	25%
5.7 India	2.7	3.0	4.8	6.1	5.3	4.3	7.7	12.4	6.7	5.0	7.4	8.0	12.5	13.7	11.6	11.2	-4%	10%
5.8 ASOC (excl. China & India)	6.7	7.6	10.0	12.6	14.1	13.9	18.5	23.5	30.4	45.8	53.7	50.6	40.7	41.6	49.6	48.2	-3%	14%
Total	44.8	69.0	103.4	147.4	177.9	167.8	238.5	286.6	253.7	231.7	288.1	317.3	293.9	331.4	296.0	301.7	2%	14%

RE investments trend by asset class – Source: Frankfurt School for Climate & Sustainable Finance– 2020

As illustrated above, asset finance is the most commonly adopted source of funding as it offers several benefits over other sources of financing. Economists have studied the benefits of asset finance for renewable energy projects and have commented on the advantages it offers.

One reason why asset finance is considered the best alternative and the most commonly used source of funding for renewable energy projects is that it provides a lower cost of capital; "*Asset-backed finance has the advantage of lower interest rates due to the secure collateral, making it a more attractive option for developers.*"[20] This is because the renewable energy assets being used as collateral provide a secure source of repayment for the lender, reducing their risk and allowing them to offer more favorable terms.

Another advantage of asset finance for renewable energy projects is that it offers flexibility in terms of repayment terms, payment schedules, and interest rates. Economist Dr. Ernesto Macías-Gómez explains that "asset finance for renewable energy projects is highly adaptable to the specific characteristics of the project, which allows the financing to be tailored to the needs of the borrower." This flexibility makes asset finance a popular source of funding for renewable energy projects, as it can be structured in a way that meets the unique needs of each project. Additionally, asset finance provides a lower financial risk for lenders, as renewable energy assets have a predictable and stable revenue stream over a long period of time; "*Investing in renewable energy assets as collateral reduces the risk of default for lenders, making asset finance an attractive option for financing renewable energy projects.*"[21] This lower financial risk allows lenders to offer more favorable terms and interest rates, making asset finance a cost-effective source of funding for renewable energy projects.

Overall, economists agree that asset finance is a highly effective and popular source of funding for renewable energy projects. It provides a lower cost of capital, flexibility in repayment terms, lower financial risk for lenders and scalability[22], making it an attractive alternative to other sources of funding.

Under a technical point of view, asset finance is a method of financing renewable energy projects by using the project's assets as collateral.

The assets in renewable energy projects include equipment, such as solar panels, wind turbines, and batteries, which are used to generate renewable energy. Asset finance is used to fund the purchase or lease of these assets, and the financing is typically structured so that the assets serve as security for

[20] Economist Dr. Tobias Bischof-Niemz

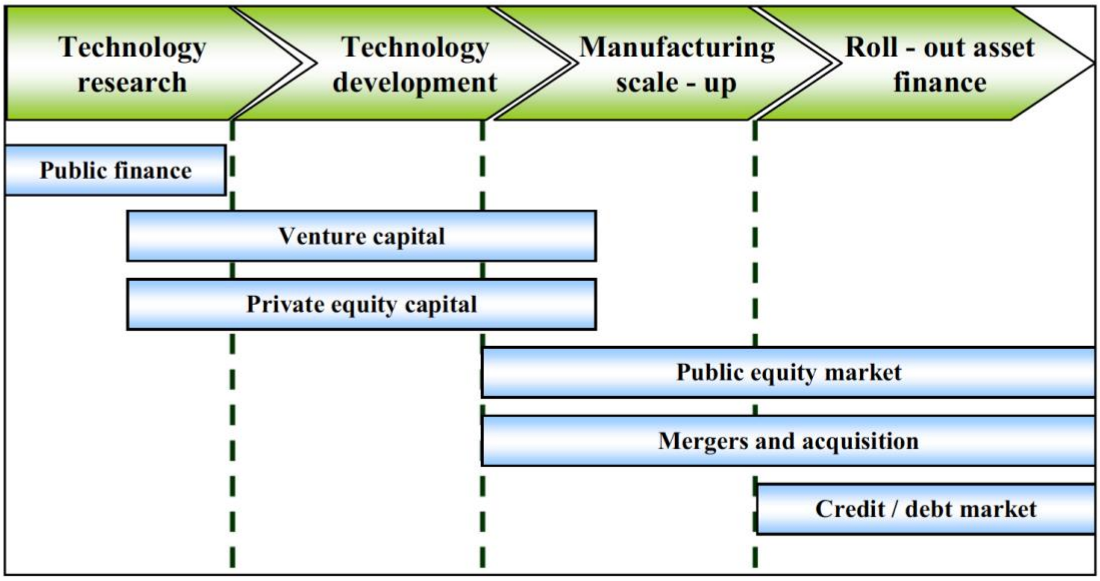
[21] Economist Dr. Nicolas Girod

[22] Asset finance can be used to finance projects of all sizes, from small-scale residential solar installations to large-scale utility-scale wind farms. This scalability makes asset finance an attractive source of funding for a wide range of renewable energy projects.

the loan. Indeed, this source of financing allows project developers to access the funding they need to purchase or lease renewable energy assets, while also providing lenders with a secure source of collateral.

Overall, as will be discussed further, the most crucial tool in RE funding, as well as the one presenting the most pressing problems and the need for innovation, is precisely asset financing.

However, Bloomberg New Energy Finance emphasizes that financing channels in advanced economies highly depend on the stage of the sector's development. As a result, the literature review revealed that there are many different funding options available today for the renewable energy sector which are strictly dependent on the four stages of development of the renewable energy sector: (1) technology research; (2) technology development; (3) equipment manufacturing; and (4) roll-out[23].



RE Financing sources in different business stages– Source: Financing instruments and channels for the increasing production and consumption of renewable energy– 2013

Public finance is highly correlated with the stage of <u>technological research</u> in renewable energy. Private investors are often reluctant to fund an unproven invention with a hazy commercial future in the early stages of technology research. In order to fund the study and development of renewable energy technologies until they are commercialized, public finance is essential; "*Public funding will comprise a small percentage of the capital ultimately deployed, but its strategic use will be essential to accessing and leveraging the private capital necessary to fund the green transition. Early-stage financing is just one example of how relatively small amounts of strategically-placed public funding can be an important catalyst for attracting much larger amounts of private sector investment.*

[23] The stage of deployment of renewable energy generation projects.

McKinsey & Company estimates that development capital and the use of risk-mitigation mechanisms have the ability to mobilize $1.8 to $2.8 trillion over 15 years."[24]

It is a kind of business model where the government or a public institution finances individuals, businesses, or organizations using a variety of financial instruments in order to aid them in achieving a certain policy purpose. So, in the context of renewable energy, public finance supports the development, acceptance, and implementation of renewable energy technology. There are several public finance institutions that are involved in supporting renewable energy development, including national governments, international organizations, and regional development banks[25].

The primary source of public funding for the development of renewable energy is frequently national governments. Governments may give incentives and subsidies to promote the use of renewable energy technology, as well as direct support to research organizations, universities, or private businesses. For instance, public funding for research and development into renewable energy is provided by the US Department of Energy, the UK Department for Business, Energy and Industrial Strategy, and the Federal Ministry for Economic Affairs and Energy of Germany.

International organizations, such as the World Bank, the IFC[26], the GEF[27], the CEM[28] and the UNDP[29], also have a noteworthy responsibility in delivering public finance for renewable energy development. To encourage the development of renewable energy, these organizations frequently collaborate with governments and business partners to create joint ventures that represent public-private partnerships.

Regional development banks, such as the EIB[30] and the ADB[31], the African Development Bank, the European Bank for Reconstruction and Development, the Inter-American Development Bank, the Islamic Development Bank, the East Africa Development Bank and the Development Bank of South Africa provide financing for renewable energy projects in specific regions.

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[24] Source: *Financing the Green Transition: Addressing the Barriers for Capital Deployment* - 2020

[25] RDBs offer financial and technical assistance for various sectors with the goal of promoting the economic and social advancement of their member nations. Infrastructure continues to be one of the sectors where RDB prioritizes supporting renewable energy projects. These banks often work in collaboration with local governments and private sector partners to support renewable energy development.

[26] International Finance Corporation.

[27] Global Environment Facility.

[28] Clean Energy Ministerial.

[29] United Nations Development Programme.

[30] European Investment Bank.

[31] Asian Development Bank.

As previously mentioned, there are several instruments of public financing in renewable energy, including grants, loans and tax incentives. These different financing tools have different objectives and target different stages of renewable energy development.

Grants and capital subsidies are non-repayable funds provided by public finance institutions to support research, development and demonstration of new renewable energy technologies with the final aim of promoting the future mobilization of private finance. These funds can be provided at different stages of technology development, from basic research to commercialization. An example could be the US Department of Energy's Advanced Research Projects Agency-Energy, which provides grants to support high-risk, high-reward research that could lead to transformative energy technologies.

Loans are funds that are made available by public financial institutions and are subject to interest repayment. Loans can also be used to pay for the development, upkeep, and operation of renewable energy projects as well as the acquisition and installation of renewable energy equipment. Governments may offer loans directly, especially at this stage, through financial intermediaries like regional development banks rather than through private banks. Within this case, the US Department of Agriculture lends loans to rural renewable energy projects, whereas the Indian Renewable Energy Development Agency's goal is to fund renewable energy projects in India.

However, the most frequently employed governmental tool, alongside capital investment, is tax incentives. Tax incentives are used because they help to promote the use of renewable energy in a variety of ways, including: increasing a company's after-tax earnings; lowering the cost of energy consumption, which encourages consumers to choose RES over fossil fuels; and encouraging the growth of a local manufacturing capacity. According to Jalilvand[32], there are 10 main types of tax incentives, depending on where and how the enticement needs to be addresses, which can hugely facilitate investments in RE: investment tax incentives; production tax incentives; property tax reductions; value-added tax reductions; sales tax reductions; import duty reductions; accelerated depreciation; R& D and equipment manufacturing tax incentives; tax holidays; and taxes on conventional fuels.

The volume of public financing declines when renewable energy technology enters the development stage, and **Venture Capital and Private Equity** start filling the void. In the early stages of technological development, the promoter is not yet prepared for financing from the private credit/debt markets due to the high level of risk and disregard of the requirements maintained by the financial institutions for accepting loans. Instead, the funds indicated above provide equity investments which they profit from. Existing shareholders in this case accept to be diluted in their ownership only

[32] Source: *Renewable energy for the Middle East and North Africa policies for a successful transition* – 2012.

because equity, unlike debt, does not create financial distress and its repayment is unequivocally dependent on the R&D success. As a result, these investors acquire ownership stakes in the rapidly expanding RE start-up and begin taking on significant management and governance responsibilities, including being appointed to the board.

Although venture capital is a subset of private equity, there are some differences among these two types of financing and, even more broadly, between these two funds and so-called infrastructure funds:

Type of fund	The main features
Venture capital funds	Money raised from a wide range of sources with high-risk appetite to include insurance companies, pension funds, mutual funds, high net worth individuals; Target new technology, new markets; Interested in early-stage companies; High risk of failure in every venture; Investment horizon around 4–7 years; Return requirement is of 50–500% internal rate of return.
Private equity funds	Money raised from a wide range of sources with medium-risk appetite to include institutional investors and high net worth individuals; Target opportunities with possibility for enhanced returns; Interested in companies and projects with more mature technology, including those preparing to raise capital on public stock exchanges, demonstrator companies, or under-performing public companies; Investment horizon is 3–5 years; Return requirement is of 25% internal rate of return.
Infrastructure funds	Funds drawn from a range of institutional investors and pension funds; Target "infrastructure", i.e. an essential asset, long duration, steady low risk cash flow; Interested in roads, railways, power generating facilities; Investment horizon is 7–10 years; Low risk and return, 15% internal rate of return.

Criteria	Private equity (PE) capital	Venture capital (VC)
Company types	PE companies buy companies across all industries	VC investors are focused on technology, bio-tech, and clean-tech
Percent acquired	PE companies almost always buy 100% of a company in a leveraged buyouts	VC investors only acquire a minority stake – less than 50%
Size	PE companies make large investments – at least 100 million USD up into the tens of billions for large companies	VC investors investments are much smaller – often below 10 million USD for early-stage companies
Structure	PE companies use a combination of equity and debt	VC investors use only equity
Stage	PE firms buy mature, public companies	VC investors invest mostly in early-stage – sometimes pre-revenue – companies

PE, VC and IF differences– Source: Financing instruments and channels for the increasing production and consumption of renewable energy– 2013

Manufacturing scale-up, in the field of renewable energy, refers to bringing a technology or product for sustainable energy from the lab to the market on a bigger scale. To scale up, a manufacturing process must be thoroughly designed and optimized in order to boost productivity and volume while cutting costs. At this stage, RE firms raise equity publicly by selling their shares mainly through specific **ETFs**[33]**, Mutual Funds**[34] **and Pension Funds**[35]. These funds invest in a plethora of renewable energy businesses and initiatives, giving investors the chance to support environmental sustainability while also participating in the industry's expansion.

Operations involving **mergers and acquisitions (M&A)** are crucial during the scaling-up phase of production. M&A can be used to increase a company's product portfolio, reduce expenses, and increase market penetration. It can also be used to acquire technologies, intellectual property, market share, and other assets.

Cases of M&A in the energy sector include Sempra Energy's acquisition of Energy Future Holdings[36] in 2018 and Tesla's acquisitions of SolarCity[37] in 2016.

Typically, the industrial scale-up phase comes right before the roll-out asset finance one, which is considered to be the most dangerous stage in renewable energy financing because it encompasses the commercial deployment and widespread adoption of the technology rather than a mere improvement in the manufacturing process and in the production capacity. Indeed, while during then manufacturing scale-up phase investments are addressed to machinery upgrading and infrastructure enhancement, the goal of this stage is to fund the creation of supply chains and actuals channels of distribution which can involve multiple risks and unsuccess factors which will be deeply analyzed in the following paragraph. There are two main subcategories within asset finance in renewable energy financing, both falling under the umbrella of Asset-Based Lending[38]:

I. Project Finance: Project finance is a structured financing technique that is commonly used to finance large-scale renewable energy projects, such as wind farms and solar power plants. A capital-intensive project can be financed through a unique SPV[39] using Project Finance, which combines loan, equity, and credit enhancement for the purposes of construction, operation,

[33] iShares Global Clean Energy ETF (ICLN), Invesco Solar ETF (TAN), First Trust NASDAQ Clean Edge Green Energy Index Fund (QCLN), VanEck Vectors Low Carbon Energy ETF (SMOG).

[34] TIAA-CREF Social Choice Equity Fund (TICRX), Calvert Equity Fund (CSIEX), Parnassus Core Equity Fund (PRBLX), Brown Advisory Sustainable Growth Fund (BIAWX).

[35] California Public Employees' Retirement System (CalPERS), New York State Common Retirement Fund, AP7 Såfa (Swedish Public Pension Fund), AustralianSuper.

[36] Sempra,2018.

[37] The Wall Street Journal, 2016.

[38] The funding is based on the value of the assets being used as collateral rather than the creditworthiness of the borrower.

[39] A Special Purpose Vehicle is a subsidiary created by a parent company to isolate financial risk. Its legal status as a separate company makes its obligations secure even if the parent company goes bankrupt. For this reason, a special purpose vehicle is sometimes called a bankruptcy-remote entity.

and maintenance. Under this strategy, the Offtake agreement consists of the PPA[40] while the project's assets and cash flows are used to secure the financing, with the lenders typically taking the senior secured position in the capital structure. Compared to standard corporate financing, project finance can have a number of benefits, such as better risk management, easier access to loan capital, and the opportunity to align cash flow from the project with debt service obligations.

II. Securitization: entails pooling assets like loans, leases, or cash flows, and then issuing bonds or other securities that are backed by those resources. The investors are then paid interest and principal from the cash flows produced by the underlying assets. Securitization can be used in the financing of renewable energy projects to make long-term contracts like PPAs or renewable energy certificates more valuable. Securitization can be more advantageous than traditional debt financing in a number of ways, including cheaper borrowing costs and increased investor access. One of the easiest-to-use low-carbon financial tools currently available for aligning investor sustainability preferences with pertinent projects is the Green Bond. Green bonds are fixed-income instruments designed to finance projects that benefit the environment or the climate. Although they are structurally comparable to traditional bonds and are often held as senior secured or unsecured debt, derivatives like mortgage-backed securities (MBS) and asset-backed securities have increasingly been used to package green debt obligations in recent years (ABS). Many projects, including large-scale wind and solar energy production, energy efficiency improvements in multi-family buildings, the transition to mass transit, and the purchase of electric vehicle fleets, are funded by green bonds.

Project finance has always been a common financing method for renewable energy projects and is still really widespread worldwide. One notable instance is the 1.5 GW Texas solar farm that Intersect Power announced in 2020. The project was funded by a combination of debt and equity, with a group of lenders, including CIT Group, National Cooperative Bank, and Rabobank, providing the financial funding.[41] Securititization is becoming increasingly common as more governments and public institutions aim to support the transition to a low-carbon economy. For example, the EIB, through the Green Bond program, has recently issued a number of green bonds to fund RE projects like wind farms, solar power plants, and hydroelectric power plants. Another such is the Australian government-owned fund called the Clean Energy Finance Corporation (CEFC), which makes

[40] Power Purchase Agreements.

[41] CIT,2018.

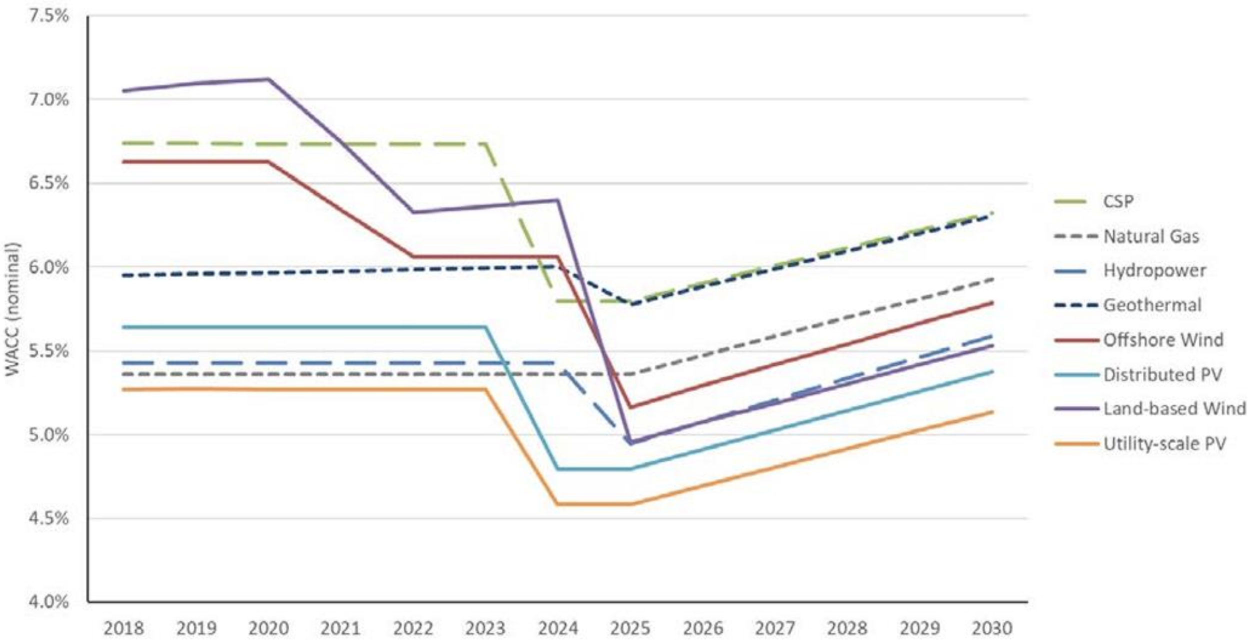
investments in a range of renewable energy sources like wind, solar, and biofuels. Via the acquisition of bonds issued by renewable energy providers, the CEFC principally makes investments in renewable energy. For instance, the CEFC stated that it would invest $100 million in a green bond issued by the French renewable energy company Neoen to fund the construction of a sizable solar project in Australia[42].

Yet, when it comes to deployment, securitization and project finance each face significant challenges. Several renewable energy initiatives face multiple financial limitations and can therefore be unsuccessful for a variety of reasons. At this point, it is crucial to evaluate the larger issue of renewable energy financing and identify innovative solutions to these problems in order to prompt the effective participation of SMEs in the Energy Transition challenge given the difficulties experienced by both traditional project finance and securitization. As the following paragraph will further outline, combining these two financing tools is a promising, though not yet sufficient, starting point to develop new financing mechanisms that could get around their drawbacks and boost the efficiency of the renewable energy financing industry even for SMEs.

1.3 Limits and opportunities of traditional RE financing mechanisms

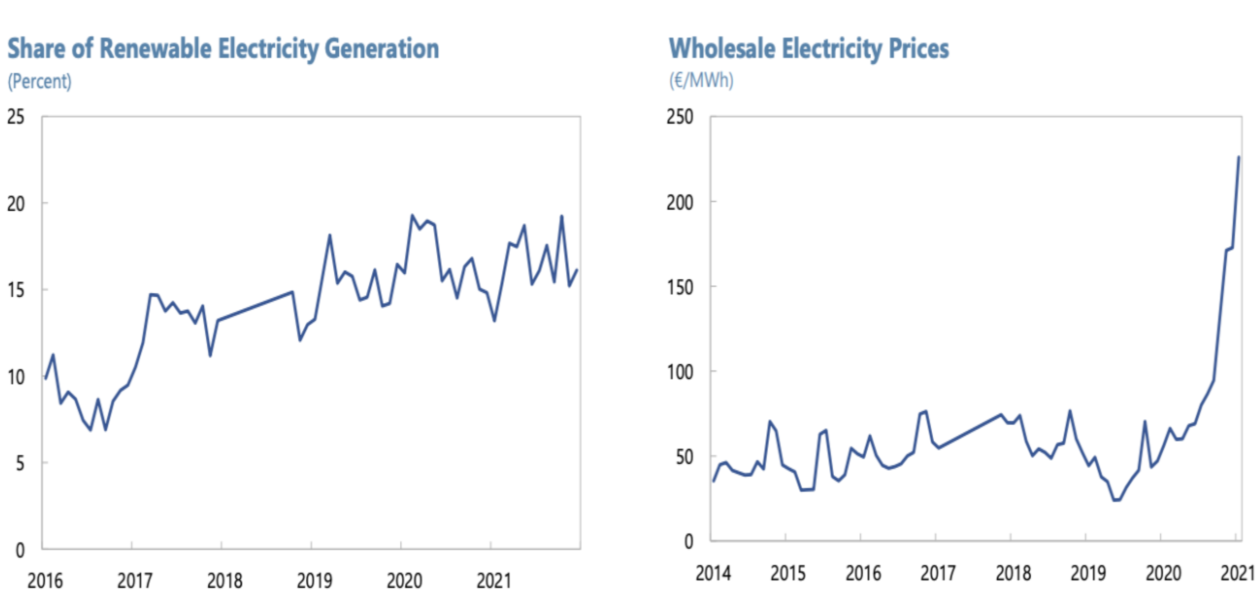
It is notable that democratized participation schemes in RES are favored by two aspects that make traditional financing schemes and major investors less relevant than one might anticipate. At least until the Easter crude oil shortage following the Russia - Ukraine conflict, due to their substantial financial commitments and the poor risk-return ratios of RE projects, established energy firms and other associated technologies and networks were "locked in" to infrastructures based on fossil fuels. In addition, since they lack the financial resources to take on large projects, RE projects whose ownership is promoted by SMEs and micro enterprises are more likely to accept the relatively high capital costs per kW of installed power compared to large central plants.

[42] NEOEN,2022.



Cost of Capital by technology – Source: The effects of differentiating costs of capital by country and technology on the European Energy Transition – 2021

However, in order to promote the financing of integrated RE generators focusing on commercially viable energy sources through conventional project financing and securitization, SMEs must overcome considerable obstacles. As for the exogenous factors inherent in the renewable industry, the volatility of the energy market is another significant challenge for SMEs in financing renewable energy projects even if the technology is mature and ready for the commercial phase. Energy prices can be unpredictable and fluctuate rapidly, making it challenging for investors to determine the risk and potential return on investment. Even before the conflict in Ukraine, which drove the average wholesale price of power to €500 per MWh in March 2022, the cost of electricity in Europe rose by more than 400 percent from an average of €35 per megawatt-hour (MWh) in 2020 to about €250 per MWh in December 2021. The most expensive technology required to meet demand within a specific time frame determines the final price of electricity according to the cost of production, which in turn depends on the energy sources used to generate electricity. This is how wholesale electricity prices are determined in Europe. So, despite a sharp decline in the levelized cost per unit of energy from new utility-scale renewable power plants in recent years, the cost of production at natural gas power plants has largely been responsible for the current surge in wholesale electricity prices in Europe.



Electricity Prices Fluctuations – Source: Chasing the Sun and Catching the Wind: Energy Transition and Electricity prices In Europe – 2022

Legislative frameworks that formerly lowered financial risk and simplified bank loan repayment for RES installations have also gotten less favorable in the EU and other countries; the switch from guaranteed FITs[43] to auction models[44] is particularly likely to discourage individual commitment because it favors large-scale projects that can diversify risks through diverse project portfolios. For a small or medium-sized business in particular, all of these reasons make it challenging to become a promoter of a financing initiative that relies heavily on third parties' funds. The Funding Gap is a seemingly insurmountable barrier to entry, and standard project financing and securitization, handled independently, do not now seem to be the right solution. What will emerge at the end of this chapter is that in fact these two financing mechanisms, if efficiently combined together, could prove to be a suitable tool for crossing this barrier and creating the basis for a financial ecosystem of renewable that is democratized, that is, in which all agents, from the public of small investors to governments, can be active participants in the Energy Transition. This solution, if assisted by a blockchain system of refinement, would allow small and medium-sized enterprises to internalize renewable energy generators and combine them with their own production cycle, selling excess production to the free market grid.

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[43] A feed-in tariff is an energy policy intended to promote the growth and usage of renewable energy sources. A feed-in tariff program pays producers of energy from renewable resources, such as solar, wind, or water, depending on the cost of production.

[44] *Renewable Energy Auctions: A Guide to Design* - Source: IRENA, 2015

It is important to note that, given the ultimate goal of the thesis to formulate a financing solution inherent to the scale-up and commercialization phase of a mature RE technology generator, the focus will be addressed to the mere financial issues rather than to regulatory or technical aspects highly challenging in previous stages of technology development.

1.3.1 The "Financing Gap challenge" and its consequence on promoters' access to credit

To fully understand the concept of "Financing Gap" it is important to determine the two prevalent business models funding RE investments:

- **Profit-Oriented**. market-driven investment strategies that draw capital, through the previously mentioned financing tools, for large-scale projects mainly promoted by large firms but exclude investor participation in decision-making.
- **Genuine**. More equal ownership models which are frequently promoted by modest to medium-sized enterprises that struggle with the issue of being "sub-scale" ventures. Indeed, the disaggregation and heterogeneity of many green infrastructure assets, such as small-scale renewable power plants, results in high transaction costs during the prospective project development[45] and a lack of asset liquidity. The magnitude or risk profile of these assets makes them illiquid, thus creating the danger that funds earmarked for sustainable projects would be diverted to ones that have little real climate impact because of a lack of standards and accountability in some asset classes.

If even the development phase were to be passed by genuine business models, the project would face an even greater hurdle once it entered the execution phase. Generally speaking, while there is a willingness to deal with high up-front capital investment through Asset Finance for profit-oriented business models, due to the nature of the genuine business models, neither traditional project financing nor Green Bonds have proven to be sufficient tools for overcoming this barrier and enter into the execution phase of the project. On the one hand, project finance is heavily dependent on debt capital, generally 80% or more of the overall capital provided, and the bankability of projects supported by SMEs is frequently lower than that of larger corporations, making it more difficult to draw in investors; "*The challenge of renewable energy development is in raising large amounts of capital to finance the upfront costs of constructing the facilities. This requires a long-term*

[45] Before entering the execution stage, project prospect development is necessary. It includes not collateralized activities of project design, feasibility studies, resource assessment, environmental impact studies and advisory services.

commitment from investors and a willingness to take on significant risk."[46] “Bankable” denotes that the project's risks have been adequately reduced, removed, or controlled in other ways and that the project’s revenues, or at least a portion of them, are sufficiently certain and secure. Therefore, limiting project risks, assuring revenues, and putting in place suitable lender safeguards to guarantee that lenders can be at ease providing debt financing on a non-recourse or limited recourse basis become the core components of bankability. While on the revenue side both large and small-scale projects share, in different proportions, the same risks linked to market volatility[47], the degree of the operational, product, supply, O&M and credit risks is surely higher for smaller scale projects.

On the other hand, the issues associated with securitization, in the form of Green Bonds, are different. Even while Green Bonds are an efficient and innovative instrument for funding green infrastructures, they miss out on several important opportunities for sustainable asset lifetime management; "*Green bonds are a great way to finance renewable energy projects, but they are typically used for projects that have already achieved financial close. This is because investors want to see a track record of success before investing in a project*." [48] Since that lenders often prefer to see several years of operational data for a wind or solar farm before placing debt in the project, Green Bonds are essentially not utilized to fund early-stage project construction.

It is clear at this point that the Funding Gap challenge for projects supported by SMEs may be solved by addressing each of its distinct components. Firstly, there is the need to build a hybrid business model able to overcome the pre-execution phase by combining fragmentation and active stakeholders’ participation with enhanced scalability. The issue is how to get to economies of scale by simultaneously maintaining the advantages of different *prosumers*[49], in the form of SMEs, engagement. To achieve "equality of arms," support for business models that promote *consumer ownership*[50] in RES must first level the playing field. Consumer ownership models must be able to coexist with their competing commercial equivalents in order for local and regional investments in RE to flourish in a legislative context that favors big investments, — in other words, the global trend towards direct marketing and auction models. Secondly, for these types of projects,

[46] Dan Kammen, Professor of Energy at the University of California, Berkeley - Source: *The New York Times*.

[47] Market risk is transferred to the seller in a PPA that gives the buyer the right to renegotiate the price if the market changes.

[48] Richard Saines, Partner at Baker McKenzie - Source: *GreenBiz*

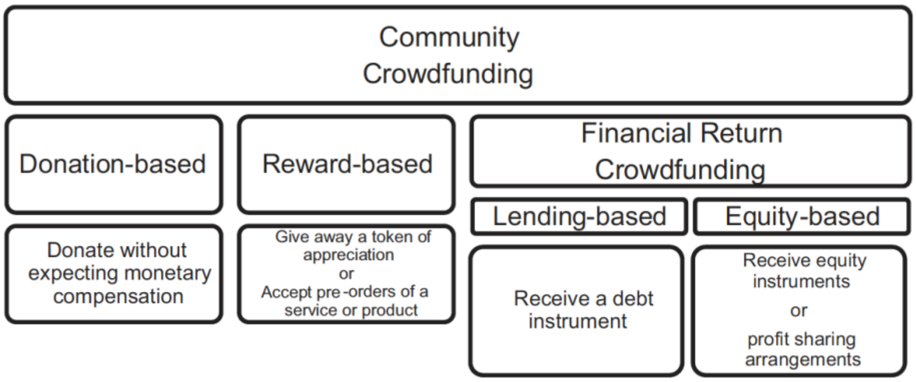
[49] “A consumer who (co-)produces the goods or services he consumes”. Source: *Energy Transition: Financing Consumer Co-Ownership in Renewables* - 2019.

[50] All participation schemes that grant local or regional consumers ownership rights in RE projects.

there is the need to bypass the higher bankability standards which make them ineligible for financial institutions.
In the next paragraph, the aim will be to dig into the underlying concepts of crowdfunding models for renewable energy generators promoted by SMEs, with an emphasis on Social Based Lending from local communities' investors. It will be examined SBL crowdfunding's features, advantages, and potential to change the market for renewable energy while overcoming the challenges related to the Funding Gap and promoting regional involvement and sustainability.

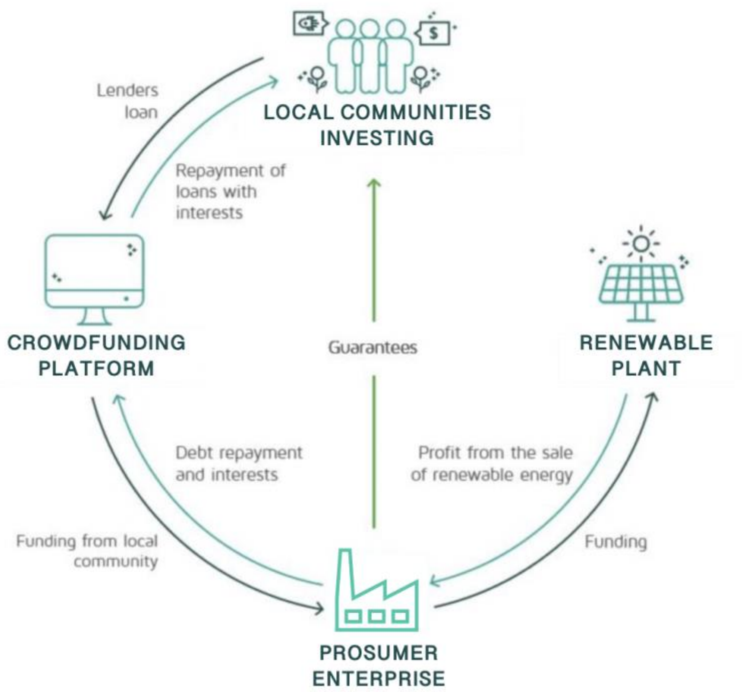
1.3.2 Social Based Lending Crowdfunding: a viable starting point for implementing effective Decentralized Energy Systems.

Crowdfunding has grown in popularity as a way to raise money for a variety of initiatives, and it has made major headway in the renewable energy industry. Social Based Lending (SBL), a specific type of crowdfunding that has attracted interest, entails local community investors banding together to financially support renewable energy projects in their area. In addition to fostering a sense of ownership and responsibility for their local environment, SBL crowdfunding methods allow communities to actively participate in the building of renewable energy infrastructure.
A Crowdfunding Social Based Lending (SBL) model links regional renewable energy projects with local community investors. SBL crowdfunding functions on a loan-based basis, in contrast to other crowdfunding structures, where investors earn incentives or shares in exchange for their contributions:



Crowdfunding structures – Source: *Crowdfunding for renewable and sustainable energy projects: An exploratory case study approach* – 2016

Renewable energy producers get loans from local community investors, which are then returned with interest from the profits made by the projects. Online platforms that serve as an intermediary between renewable energy projects and regional community investors frequently enable SBL crowdfunding methods. Investors may explore a variety of renewable energy projects on these platforms, evaluate their prospective effects, and then decide which projects to fund. The platform oversees the loan repayment procedure once a project receives funding and distributes the proceeds to investors in accordance with the arrangement, as illustrated below:



Social Based Lending mechanism – Source: *Own Elaboration*.

For renewable energy generators, SBL crowdfunding offers a number of advantages that make it a desirable financing choice for both project developers and local communities:

- Access to Capital. Via SBL crowdfunding, local community investors who are interested in promoting renewable energy initiatives can contribute much-needed funds to renewable energy projects. This could be able to close the financial gap that many renewable energy projects have, especially in the beginning phases of their growth.
- Local Engagement. By integrating local community investors in the creation of renewable energy projects nearby, SBL crowdfunding promotes local participation. Since they aid in the shift to greener energy sources and meet local energy demands, this may foster a sense of ownership and empowerment among community members.
- Sustainability. SBL crowdfunding encourages sustainability by empowering localities to fund renewable energy initiatives that support their values and advance their long-term sustainability objectives. It can aid in reducing greenhouse gas emissions, promoting environmental preservation, and diversifying local energy sources.

- Financial Benefits. By fostering employment growth and boosting local economies, SBL crowdfunding may assist local communities economically. Renewable energy projects frequently need for specialized personnel and regional materials, which can increase local employment and economic growth.
- Risk Mitigation. By distributing the risks involved in renewable energy projects among several investors, SBL crowdsourcing might lessen the financial burden on the project developers themselves. In the long run, this can increase the resilience and sustainability of renewable energy projects by acting as a buffer against future project failures or setbacks.
- Institutional Intermediaries Bypass. SBL crowdfunding increases the likelihood of successfully raising capital for renewable energy projects by cutting out the need for conventional financial intermediaries and opening up alternative financing sources and a broader investor base. Secondly, compared to conventional financing approaches, SBL crowdsourcing may result in cheaper transaction costs. The fees and interest rates that banks and other financial intermediaries frequently charge for their services can significantly increase the cost of funding renewable energy projects overall. The financing process is more effective and efficient when using SBL crowdfunding platforms, which may have reduced fees and allow for direct communication between investors and project developers. Lastly, SBL crowdfunding can also provide more adaptability and customization in financing arrangements by eschewing conventional financial intermediaries. The terms and conditions of traditional finance methods may not be appropriate for all renewable energy projects, particularly those started by small-scale enterprises or local communities. SBL crowdfunding enables more adaptable financing structures that may be adjusted to the unique requirements and conditions of the project, improving its capacity to maintain itself financially. These structures include loan periods, interest rates, and payback schedules.

Until 2018, among Europe and US, € 162 millions have been raised through the most relevant crowdfunding platforms adopting the SBL model. The table below also includes data on the amount raised, the number of completed projects, the promised return on investment to lenders and investors, and the total number of investors that contributed to the projects:

Platform and Country *	Launch date	Model	Average Return	Projects successfully funded	Amount raised (€)	# of backers
Abundance Generation (UK)	2012	Lending	7.74%	24	€45,233,525	NA
Mosaic (US)	2010	Lending	4.5% - 5.5%	NA	€17,882,690	NA
SunFunder (US)	2011	Lending	NA[c]	91 Loans[b]	€34,871,246	56
CollectiveSun (US)	2013	Lending	5.47%	7	€621,133	NA
LeihDeinerUmweltGeld (DE)	2013	Lending	6.9%	24	€5,552,950	NA
Econeers (DE)	2013	Lending	4.73%	12	€6,159,000	4102
Bettervest (DE)	2013	Lending	5-6%	51	€6,396,000	7447
GreenVesting (DE)	2009	Lending	5.21%	7	€941,200	NA
GreenXmoney (DE)	2014	Lending	4.19%	24	€939,000	NA
We share Solar (NL)	NA	Lending	4.29%	38	€4,244,500	5423
DuurzaamInvesteren (NL)	2014	Lending	5.59%	30	€18,837,000	3152
1miljoenwatt (NL)	2013	Lending	3.5%	5	€1,127,328	1162
Lendosphere (FR)	2012	Lending	5.09%	56	€14,120,850	13229
Lumo (FR)	2012	Lending	NA	25	€3,014,425	2701
Enerfip (FR)	2015	Lending	7.13%	12	€2,118,900	1251
Total Lending-Based Model (A)					**€162,059,747**	

Crowdfunding platforms details– Source: *Crowdfunding to Finance Eco-Innovation: Case Studies from Leading Renewable Energy Platforms*– 2018

As it can be noticed, SBL Crowdfunding can be characterized as an original merger of project financing and securitization. To evaluate the creditworthiness of the renewable energy project, project finance concepts are in fact used. This entails assessing the project's technical, economic, and regulatory factors to determine its viability and capacity to generate income. The money secured through crowdfunding is repaid using the financial flows from the project, which are anticipated to come through the power purchases. Additionally, similarly to securitization, SBL crowdfunding involves combining individual loans from several investors to finance the renewable energy project. These loans are subsequently organized into marketable securities in the form of tokens that represent the investors' interests in the project.

With the help of this ground-breaking framework, renewable energy projects may be funded in a more complex and scalable manner, and the funding business model can be adjusted to combine elements of both the genuine and the profit-oriented structures. When projects are supported by SMEs, the transition from a highly-centralized to a more decentralized energy system that relies on more dispersed generation, energy storage, and a more engaged customer base through demand results in a more successful financing approach. Indeed, decentralized energy is extremely SME-friendly in theory as having access to locally produced energy would reduce their reliance on fluctuations in the energy market, such as price hikes. Secondly, it may result in additional income from selling extra electricity to the grid.

However, it would be erroneous to believe that such an architected system is free from difficulties and problems that could undermine its effective implementation. After having highlighted these, the next chapter will formulate a framework that, starting from this foundation, would evolve such a structure through the adoption of blockchain systems.

CHAPTER II - Decentralized Autonomous Organizations for RE Generators: Combining Digitalization with Secure Financing

Decentralized Autonomous Organizations (DAOs) are an entirely novel form of organizational structure that is run without the need for a central authority, is controlled by smart contracts, and is made possible by blockchain technology. These structures emerged from the necessity for decentralization and accessibility, as well as from the need for more active engagement from and control over the community of private investors; "*DAOs are a fascinating development in the evolution of organizational structures, offering an innovative way to coordinate and incentivize collective action in a decentralized and transparent manner*".[51]

The feasibility of using DAOs to fund renewable energy generators, particularly for small and medium-sized businesses, is proposed in the present work as a possible solution to the previously discussed barriers associated with the Energy Transition; "*DAOs can enable more efficient and effective financing for renewable energy projects, providing a new way to allocate capital and mobilize investment in the clean energy sector*." [52]

The suggested strategy intends to broaden financial accessibility, lower transaction costs, and improve transparency while offering a more equitable distribution of benefits among stakeholders. SMEs may actively participate in the process of change to a more sustainable energy future through the usage of DAOs, which can realistically democratize the financing of renewable energy by revolutionizing Social Based Lending configurations currently known; "*DAOs can help unlock the potential of small and medium enterprises in the renewable energy sector, empowering them to play a more significant role in the Energy Transition*".[53]

It is crucial to first comprehend the technicalities behind DAOs functioning and benefits with respect to conventional SBL Crowdfunding structures before exploring their potential uses for financing RE generators. Therefore, the core of this chapter will be to examine the applications of DAOs in the renewable energy sector while also looking at the legal and governance difficulties and restrictions faced in this setting.

[51] Christine Lagarde, President of the European Central Bank.

[52] Mohamed El-Erian, Chief Economic Advisor at Allianz.

[53] Helena Helmersson, CEO of H&M Group.

2.1 DAOs features and benefits in comparison to established SBL Crowdfunding platforms.

The Decentralized Autonomous Organization (DAO) is a new phenomenon that has recently gained a lot of attention thanks to the growth and popularization of blockchain technology. There is no central authority or administrative hierarchy in a perfect DAO. The organization's management and operational procedures are all encoded on tamper-resistant blockchains and rely entirely on group decision-making and participation. Natural ecosystems that exhibit self-organization towards Swarm Intelligence[54], CMOs[55] on the Web, and DAI[56] can all be seen as the early stages of DAO and the basis for its creation.

Decentralized Governance, firstly proposed by the 2009 Nobel economics laureate Elinor Ostrom[57], is also a central theme when dealing with DAOs. Self-Governance relies on the hypothesis that structures created through spontaneous community organizing have overlapping and dispersed jurisdictions, which can effectively stifle opportunism and free-riding behavior and promote the long-term advancement of the public good. Crowdfunding itself is indeed based on such an assumption. However, the development of blockchain technology aids in the actual implementation of DAO. Blockchain integrates decentralized data storage, timestamps, consensus algorithms, asymmetric encryption, and has the properties of immutability, auditability, and decentralization. As a result, it can safely and effectively carry out value and information transfers.

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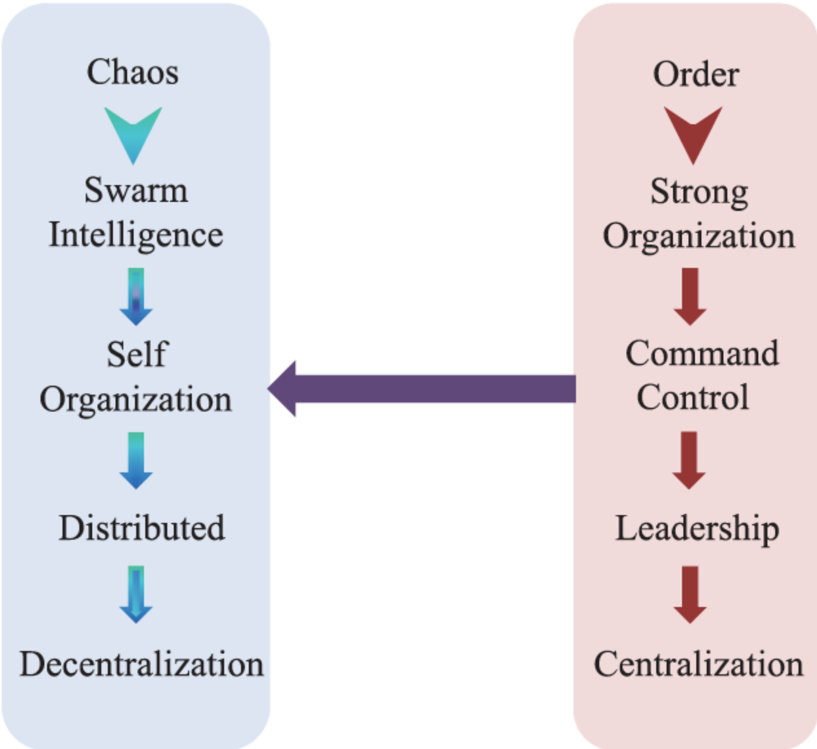
[54] Source: "*Particle swarm optimization: Basic concepts, variants and applications in power systems*" - 2008.

[55] Cyber Movement Organizations. They represent social movement organizations or groups that were created or strengthened online, i.e., netizens who came together fast to discuss, engage in, and collectively carry out specific social behaviors for a given issue or event. "Crowdsourcing", "Internet Water Army", and "Human Flesh Search" are examples of common online CMOs that feature dynamic, real-time, self-organized, and virtual-real interactions.

[56] Distributed Artificial Intelligence. DAI focuses mostly on how intelligent systems that are logically or physically distributed work together to solve complicated problems in parallel. DAI systems frequently feature a large number of distributed autonomous nodes/agents, which not only possess the ability to select, prioritize, and behave in a goal-directed manner, but also possess sociability via communication, collaboration, and negotiation. A DAI system is more open and flexible than centralized systems since it lacks both centralized control and global data storage. High redundancy gives it significant fault tolerance capabilities.

[57] Source: "*Beyond markets and states: Polycentric governance of complex economic systems*" - 2010.



From Centralization to Decentralization– Source: *Decentralized Autonomous Organizations: Concept, Model and Applications*– 2019

The world's first DAO[58] was introduced in 2016 and quickly raised Ether worth 150 million dollars, making it the biggest crowdfunding initiative in the world at the time.

Since then, a number of DAOs, including *DigixDAO*[59] and *Aragon*[60], have been provided.

In the paragraph that follows, a thorough overview of DAO will be conducted making use of the artefact "*IEE Transactions on Computational Social Systems*" provided by Shuai Wang, Wenwen Ding, Juanjuan Li, Yong Yuan, Liwei Ouyang, and Fei-Yue Wang with the goal of condensing the concept and the characteristics of DAOs in light of the current trend of technology and industry innovation and the lack of a unified technical and analysis framework.

[58] Source: Bitcoin Magazine - 2016

[59] The DIGIX platform, which seeks to be the first trading platform for digital gold, is where DigixDAO is derived from.

[60] Platform that offers users the infrastructures they need to develop and run many types of DAOs, including businesses, NGOs, and open source initiatives. Aragon gives users the ability to freely build international, bureaucracy-free groups and work across boundaries and without intermediaries.

2.1.1 DAOs technical framework and reference model

As previously stated, DAO is a blockchain-based organization that may function independently from a central authority or management structure. To realize an organization's self-operation, self-governance, and self-evolution, distributed consensus protocols and token economy incentives are used in DAOs to record all management and operational rules in the form of "smart contracts" on blockchain, which will thereafter be analyzed. In other words, we also refer to its properties as:

- **Decentralized and Distributed.** In a conventional organization, authority is centralized, and a top-down hierarchy is used. DAO, however, lacks a central authority and a hierarchical structure; instead, its objective is accomplished by distributed network nodes cooperating and interacting with one another from the bottom up. As a result, the connections between nodes or between nodes and organizations are no longer based on administrative affiliation but rather on the values of equality, voluntarism, reciprocity, and mutual benefit as well as the endowment of each individual with unique resources and comparative advantages.

- **Autonomous and Automated.** Code is law, power is distributed rather than centralized, organization is no longer pyramidal but rather distributed, and administration is no longer based on a bureaucratic structure but rather on community autonomy in the ideal DAO. Additionally, since a DAO typically operates in accordance with the regulations and collaboration patterns established by all stakeholders, consensus and trust within a DAO are easier to achieve, which reduces the costs associated with trust, communication, and transactions.

- **Organized and Ordered.** Leveraging smart contracts, the DAO's operational guidelines, participants' rights and obligations, and the terms governing rewards and penalties are all open and transparent. Individuals who pay, contribute, and assume responsibility would be matched with corresponding powers and benefits to promote the division of labor and the unification of power, responsibilities, and interests, so as to make the operation of the organization more coordinated and orderly. Rights and interests of relevant participants are accurately differentiated and dimensioned through a series of efficient governance rules.

The proposed reference model for a decentralized autonomous organization (DAO) has a five-layer architecture, starting at the bottom with fundamental technology and advancing up to governance operation, incentive mechanism, organization shape, and manifestation.

Basic Technology Layer– Source: *Decentralized Autonomous Organizations: Concept, Model and Applications*– 2019

I. **Basic Technology Layer**. The Internet Protocol, Blockchain, Big Data, Artificial Intelligence, and other infrastructures that underpin DAO and its derived applications are all contained within this layer. *The Internet Protocol* is adopted to promote participation from nodes dispersed throughout the globe, DAO is typically constructed on the P2P[61] network. The use of *Blockchain Technology* is essential for DAO to fulfill its objectives of decentralization and open autonomy. Blockchain's consensus mechanism makes it possible for nodes in a decentralized system with widely dispersed decision-making authority to successfully come to an agreement. Smart contracts embed the DAO's operational rules as computer code into the blockchain, making it clear that the code is a kind of legal management. Additionally, timestamps and asymmetric encryption guarantee the security requirements and ownership authentication of DAO. Each node in a DAO could eventually turn into an autonomous agent through *Artificial Intelligence.* These agents are autonomous since they possess BDI[62] capabilities. They are anticipated to eventually take the position of humans in a variety of tasks, including perception, reasoning, and decision-making. Furthermore, smart contracts now have What-If -type deduction, computation, and intelligent decision-making in unknowable scenarios in addition to automatic enforcement in accordance with predefined If-Then-type statements. *Big Data Technology* has the ability to gather in real time the state information, intrachain transaction information, and system operation information of DAO nodes and can be used to understand the evolution and development

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[61] Peer-to-Peer is a network in which interconnected nodes share resources among each other without a centralized administrative system.

[62] The Basic Data Infrastructure is a set of agreements that allows participating parties to jointly develop a specific IT network. This IT network makes it possible for data to be shared and/or retrieved from the source after authorization. The BDI is a realization of concepts that are being developed as part of the European FEDeRATED1 project.

trend of DAO. The blockchain and IoT[63] can be coupled to create *Blockchain of Things*, which digitally transforms and incorporates smart assets and physical assets into DAO. As a solid IoT service platform, DAO can automate equipment trading, monitor the whole life cycle of smart devices, and use smart contracts to facilitate interoperability between smart devices.

Governance Operation Layer– Source: *Decentralized Autonomous Organizations: Concept, Model and Applications*– 2019

II. **Governance Operation Layer.** This layer can provide organization self-governance and ongoing iterative upgrades through on-chain and off-chain collaboration. It encodes consensus through smart contracts. Consensus mechanisms, smart contracts, digitization, intelligent matching, and on- and off-chain cooperation are specifically included in this layer. Organizations typically rely on *Consensus-based Agreements* to function. By imposing legal restrictions, a contract is intended to protect the rights and interests of people, businesses, and even the orderly functioning of society. However, there are numerous issues with how contracts are actually put into practice, such as the challenge of determining whether a contract is valid, the challenge of realizing the cancellation of a change, the challenge of determining who is responsible for a contract's breach, etc. DAO is based on *Smart Contracts* that are implemented on the blockchain and protected by it. In general, smart contracts are automatically executable and enforceable contracts between contractors that take the form of business logic. Smart contracts essentially program the intricate connections between network nodes, completing all transactions from negotiation through fulfillment utilizing interfaces and protocols. Nodes representing various interests can negotiate and clarify their rights and obligations, decide on and validate the contract terms, and then program the contracts on blockchain for distribution, verification, and auto execution thanks to DAO. The beginning point is *Digitalization* and while it is the foundation of DAO governance, smart contracts provide the trust guarantee. The gathering and analysis of data, followed by their application

[63] The Internet of Things describes the network of physical objects — "things"— that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

for the improvement of user experience, business model innovation, and other purposes, is the essence of digitalization. Digitalization serves as a tool for intelligent management and decision-making rather than being an aim in and of itself. It does this by deeply modeling and analyzing the organization. A DAO running on a decentralized processing-storage carrier frequently uses AI technology to automatically combine, match, and connect people, organizations, knowledge, events, products, services, etc. Therefore, *Intelligent Matching* is a crucial way for DAO to lower communication costs and increase efficiency. By digitizing information and behavior data of people or organizations, for instance, a DAO can automatically match roles and positions for people based on their contributions and skills. This allows task identification, recommendation, and matching to be completed. The knowledge and human capital can be quickly mobilized in this way. DAO can also do a multi-dimensional evaluation of an individual's work's process and outcomes. The evaluation findings show a person's rank in the DAO honor system, and people at different levels will have access to distinct interests and rights. Furthermore, DAO uses an *On-Chain and Off-Chain* collaborative governance method, in contrast to traditional centralized administration where the interests of the controlling shareholders are dominant. Using smart contracts, on-chain governance primarily aims to establish, update, and maintain consensus. In a climate of mutual mistrust, the goal is to establish a credible system and guarantee the interests of all parties. In a challenging, open, and unreliable Internet context, the consensus mechanism investigates how nodes in a distributed system maintain data consistency and concur on a proposition. PoW[64], PoS[65] and PBFT[66] are examples of common consensus algorithms. Off-chain governance is a set of governance practices used to make sure that the consensus is established, acknowledged, disseminated, and renewed. DAO is more commonly characterized as a small portion of on-chain governance plus the majority of off-chain governance due to the limits of existing technology. On-chain governance will, however, become more of a concern as the technology advances. Additionally, both hard and soft forks are useful tools for resolving conflicts in DAO governance. Forks have a minimal influence on the market when compared to how public firms handle disagreements, which also highlights the benefits of DAO governance based on a consensus method.

[64] Proof-of-Work is a technique used by cryptocurrencies to verify the accuracy of new transactions that are added to a blockchain thanks to a competitive valuation method

[65] Proof-of-Stake uses randomly selected validators to confirm transactions and add new blocks to the blockchain.

[66] Practical Byzantine Fault Tolerance is a distributed consistency algorithm based on state machine replication. It requires each node to sign when sending messages, and other nodes cannot modify other nodes' messages.

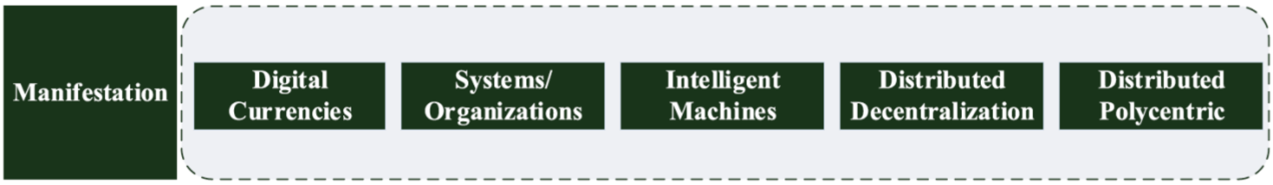
Incentive Mechanism Layer– Source: *Decentralized Autonomous Organizations: Concept, Model and Applications*– 2019

III. **Incentive Mechanism Layer.** The key driving force behind DAO is the *Token Incentive*. A type of negotiable digital asset known as a token serves as a record of rights and interests. Real-world stocks, bonds, and options can be digitized and taken on the form of tokens. According to general consensus, a token at the very least combines the qualities of equity and debt (value-added, long-term revenue), property (indicating the right to use, products, or services), and currency (circulating within a specific range). Tokens serve as the primary financial incentives for other participants while the property rights of the DAO system are shared by the sponsors, developers, and other stakeholders. The term "Token Economy"[67], which refers especially to the use of the financial properties of crypto digital assets to map the goods and services to token and then accomplish low-cost or even zero-cost transactions, describes the new economic model produced by token. Currently, payment tokens, functional tokens, and asset tokens are the most prevalent types of tokens. According to the characteristics of the project, each DAO can create its own token and control the *Distribution method*, *Lock-in duration*, *Circulation,* and other aspects of the token model. The mechanism design is essential to token model development. Promoting participant incentive compatibility and achieving win-win outcomes are the objectives. On the one hand, a good token model integrates financial capital, human capital, and other capitals together, changes the dynamic between individuals and organizations, lowers operating expenses, and simultaneously satisfies the demand for funding at the outset of the project. However, because the token serves as the project's anchor, high-quality projects will cause the token's market value to grow over time, which could negatively affect the participants' ability to receive financial incentives.

[67] Source: *Social Energy: Emerging Token Economy for Energy Production and Consumption* - 2019

Organization Form Layer– Source: *Decentralized Autonomous Organizations: Concept, Model and Applications*– 2019

IV. **Organization Form Layer.** The DAO's organizational structure consists of a *Large-Scale Community Autonomy* combined with a *Multi-Center Stereoscopic Network* structure and a *Small Number of Basic Teams*. DAO varies from the orderly to mixed, from the quest of stability and solidification to search of dynamic balance, from relatively simple to diverse, when compared to traditional organizational forms. These characteristics can be summed up as Flat[68], Open[69], Parallel[70] and Human-Machine Integrated[71].



Manifestation Layer– Source: *Decentralized Autonomous Organizations: Concept, Model and Applications*– 2019

V. **Manifestation Layer.** DAO can take many different forms. Depending on the services offered, it might be *Interconnected IoT Devices* like self-driving cars, Public Development *Organizations/Systems* like Ethereum, or even *Digital Currencies* like Bitcoin. Additionally, the DAO can present a *Distributed Decentralization* feature, like a public blockchain, or a

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[68] The organizational hierarchy is skewed. Individuals' flexibility can be fully utilized, and transparent and effective management can be accomplished.

[69] Boundaries between organizations' internal and external environments have also been dismantled. DAO can change at any time dependent on particular tasks, projects, and requirements, and when its mission is accomplished, it disbands or dies.

[70] In a future DAO, each real-world person or group will have a corresponding virtual counterpart. The virtual-real interaction, closed-loop feedback, and on-chain and off-chain cooperation could be used to optimize decision-making and parallel tune organizational governance.

[71] As technology develops, the DAO will eventually become fully integrated. Humans will grant permission to the intelligent agents in a DAO to do various commercial operations. Similar to humans, these agents will engage in competition, coordination, and cooperation.

Distributed Polycentric one, like a consortium blockchain[72]. Currently, DAO frequently uses the framework of Nonprofit Foundation, Commissioned Companies or Diverse Manifestations. As the primary mechanism for the issuance of tokens, nonprofit foundations typically carry out Initial Coin Offering (ICO), distribution, management, and supervision. The commissioning firms are in charge of providing marketing, legal, and technological development services. Then, DAO is frequently promoted as an open-source community to encourage cooperation between on-chain and off-chain systems.

It is possible to deduce the benefits that these structures have over the conventional types of Social Based Lending Crowdfunding that are currently available once the reference model for DAOs is recognized. However, in order to contextualize this innovation within the RE industry and comprehend the concrete evolution in the financing process that could result, it is important to discuss them in detail.

2.1.2 P2P Crowdfunding Tokenization: from Web 2.0 to DAOs

As previously explained, Peer-to-peer lending is a technique for debt financing that enables people and companies to lend or borrow directly from each other through an online platform without the intervention of a bank or other conventional financial institution. P2P lending has been a significant alternative to bank lending during the past decade as a different type of technology-enabled financial service. Due to a lack of credit history or actual collateral, standard bank loans that are currently available to groups like start-ups, small and medium sized businesses, and entrepreneurs are sometimes expensive or challenging to get. Therefore, P2P lending platforms make it easier to access new financing sources by serving as a middleman between investors and those companies. They also make it simpler for investors to find and support projects and investment opportunities that interest them. Additionally, because there are no financial intermediaries involved, borrowers frequently receive loans at interest rates that are lower than those provided by banks. Lenders who distribute the loan amount across several borrowers earn consistent, alluring rewards while spreading risk among numerous borrowers. However, there is "no free lunch" with peer-to-peer lending. Lenders and borrowers must take on a lot of risk in exchange for higher yields, including specific new challenges peculiar to Web 2.0[73] P2P lending.

[72] Nodes from multiple organizations or enterprises govern the network with far more privacy. They collaborate to share and change information through this platform to maintain workflow, scalability, and accountability.

[73] The second stage of development of the Internet, characterized by the change from static web pages to dynamic or user-generated contents.

It's interesting to note that these platforms' issues emerge both from the fact that they are designed to replace of traditional financial intermediaries and hence from their business model:

- **Information asymmetries**: One of the greatest obstacles in conventional peer-to-peer lending platforms is the information asymmetries between project creators and lenders, which can lead to adverse selection and moral hazard on the part of project creators. The former occurs when lenders are unable to distinguish between good and bad creators who may default on their loans, whereas the latter is the result of ineffective binding guarantees provided by the creator, who may end up using the funds for purposes other than those specified on the platform. Peer-to-peer lending platforms typically lack the same level of access to credit information as traditional institutions, resulting in these issues. Indeed, in traditional relationship banking, the bank's lending decision is partially based on the analysis of codified, explicit information, such as income statements, tax returns, and balance sheets, and partly on implicit information generated by a client interview or by having a long-standing relationship with the client. This second type of information relates to interpersonal trust and focuses on an evaluation of the customer's unique economic and social circumstances. Clearly, a platform business lacks both the individual consumer contact and the time required to generate this type of personal data. P2P lending platforms utilize the instruments of big data analytics to analyze large data sets of economic data about borrowers combined with personal information provided directly by the user or generated about the user by internet sources. Data such as the borrower's social media activities, age, education, and location – the borrower's digital social footprint – replace the interpersonal trust component of traditional relationship banking when estimating the borrower's probability of default. Typically, a software program performs the credit evaluation, establishes the pricing, and decides whether to accept or reject the borrower's P2P lending request independently and without interference from the platform's management. *RateSetter*, a peer-to-peer lending platform in the United Kingdom, had to write off £80 million ($112 million) in loans in 2020 due to an increase in defaults caused by the pandemic. The company was criticized for failing to adequately disclose the risks associated with investing in these loans[74].

- **High fees due to "white label banks".** Only licensed institutions are allowed to originate loans in the United States and Germany. Consequently, both loan origination and payment service are performed by a commercial bank, which subsequently resells the debt to the

[74] Source: *The Guardian* - 2020.

platform. The bank assigns receivables to the platform in accordance with the law. In practice, this means that a bank acts as an additional intermediary between the debtor and the platform. The involvement of a credit institution is required to comply with national banking regulations and makes it much more expensive for platforms, as banks impose a fee of 0.5% to 1.5% of the loan amount, which is assessed to both lenders and borrowers. They are referred to as white-label banks because their names do not display, hence users of the platform are unaware of the bank's involvement in the transaction.

- **Non-disciplined secondary market for traded loans.** Secondary markets are crucial for enhancing liquidity. The problem relies on the fact that secondary markets in which loans are transacted on peer-to-peer lending platforms are frequently unregulated and susceptible to manipulation and volatility. This can result in financiers incurring investment losses. In 2016, the Chinese peer-to-peer financing platform *Ezubao* was discovered to be a Ponzi scheme, causing investors to lose over $7.6 billion. The platform was accused of establishing fraudulent loan agreements to entice investors and manipulating the secondary market to prevent investors from withdrawing funds[75].

- **Need for institutional lenders for reaching volume and overcoming break-even levels.** Due to the fact that P2P platforms profit from fees charged to counterparties rather than the spread between active and passive interest rates, high investment volumes are essential. The main P2P-lending platforms in Europe and the United States have been loss-making for at least the first three to five years of operation. These losses indicate that the majority of platforms struggle to attract enough users and lack the transaction volume required to cover fixed advertising and marketing costs. This explains the effort to attract more institutional investors as clients, as their investment volume is significantly greater than that of retail investors. Peer-to-peer platforms may embrace the increase in volume, but the trend suggests the demise of a key concept in peer-to-peer finance: the direct connection between backer and borrower. In the past year, Funding Circle became the pioneer of retail investors boycott thus reflecting the aforementioned P2P lending's struggles combine to the enhanced regulatory oversight and the negative impact of the Covid-19 pandemic[76].

- **Money laundering**. Insofar as the triumph of EU unity is undeniable, it is arguable that the Union is a victim of its unprecedented and unmatched homogeneity. The earlier description

[75] Source, *New York Times* - 2016
[76] Source: Financial Times - 2022

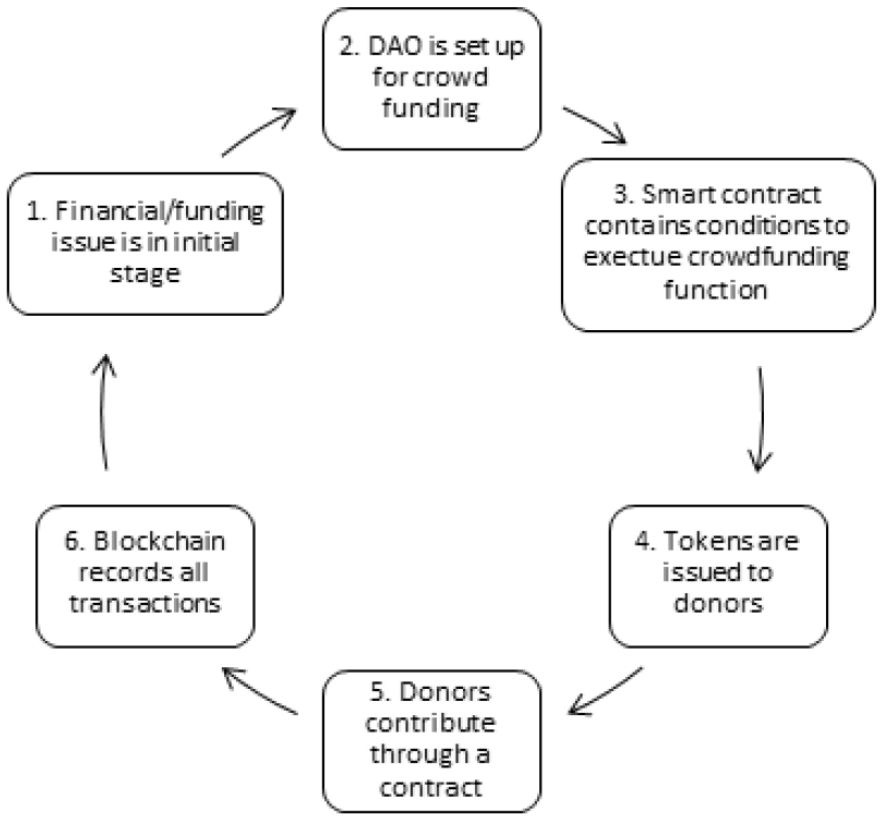
of the EU revealed how easily the countries, particularly in the Eurozone, are able to trade with one another, particularly without the need for currency exchange. As a result, investors do not have to be concerned about, for instance, inflation in one country that would strengthen the domestic currency of the sponsor, resulting in a decrease in equity value. Despite this favorable environment, the Union is extremely concerned about the movement of illegal funds within its borders. Under the guise of investors, crowdfunding platforms can be secure havens for money laundering. This is primarily fueled by the information asymmetries that pose an additional challenge for crowdfunding. As a result, the European Central Bank and other relevant entities that oversee the legitimacy of activities across EU member states have made crowdsourcing a priority. This surveillance alone is sufficient to impair crowdsourcing by discouraging investors who are confident that authorities are aware of money laundering and other misdeeds on various platforms.

- **Cap funding amounts set by regulators.** The regulatory limits set by various government bodies on the maximum amount that can be raised through crowdfunding is one of the greatest obstacles faced by conventional peer-to-peer lending platforms. The precise quantitative limit of peer-to-peer lending platforms differs by country and regulatory authority. In Europe, the European Securities and Markets Authority (ESMA) currently sets the limit for peer-to-peer lending platforms at €5 million per initiative or business over a 12-month period. Whereas in US, the SEC sets the limit on individual investments in peer-to-peer loans. The current limit is 10% of an investor's net worth or annual income, whichever is greater, with an annual cap of $100,000. This limit pertains to investors with and without accreditation. In contrast, the maximum quantity that can be raised through crowdfunding in the United Kingdom is £8 million. These regulatory limits are in place to prevent companies from raising an excessive amount of capital via crowdfunding, which can increase the risk of fraud and other abuses, although preventing the launch of projects with high upfront costs, such as RE generators.

- **Limited market reach due to cross-border regulation discrepancies.** Discrepancies in regulations between nations are an additional significant obstacle for traditional peer-to-peer lending platforms. Each country has its own set of regulations governing crowdfunding, and these regulations can vary substantially between nations. In the United States, crowdfunding is regulated by the SEC, whereas in the United Kingdom, it is regulated by the Financial Conduct Authority (FCA). These regulatory differences can make it challenging for peer-to-peer lending platforms to expand their operations internationally and reach a larger market.

The instance of Funding Circle, one of the largest peer-to-peer lending platforms in the UK, illustrates these issues. In 2013, the platform announced its intention to expand into the U.S. market[77]. However, the company confronted a number of regulatory obstacles, such as the need to obtain licenses from state regulators in all 50 states, each of which had its own set of regulations. As a consequence, Funding Circle was forced to postpone its expansion plans by a number of months and invest substantial resources in regulatory compliance[78].

These obstacles can make it difficult for conventional P2P lending platforms to connect borrowers and lenders in a fully efficient way. However, DAOs provide potential solutions to these problems. First of all, the blockchain's security, efficiency, and cost-effectiveness make it ideally suited for the portfolio registration of crowdfunding-funded companies. Indeed, the *tokenization*[79] process of lending-based crowdfunding, hence DAOs implementation cycle starting from smart contracts preparation and subsequent ICO, can be easily described:



DAOs Implementation Cycle – Source: *Blockchain technology-based crowdfunding using smart contracts*– 2022

[77] Source: Reuters, 2013

[79] Process of exchanging sensitive data for non-sensitive data called "tokens" that can be used in a database or internal system without bringing it into scope.

The blockchain technology is so secure that the information enumerated in the blocks about entrepreneurs can be relied upon without the need of including accurate stock and shares update, allowing investors to determine how or when to invest in a particular project based on descriptions such as project nature, progress, funder response, and completion timeline, etc. The efficacy of the blockchain is exemplified by its unrivaled capacity to connect investors and fundraisers, as well as General and Limited Partners in the Private Equity industry[80], without the rigors of documentation and additional accreditation from, for instance, certification organizations; "*Besides enhanced security, peer to peer transactions reduce the rigors of regulatory compliance with financial management authorities. Such authorities are meant to validate issues concerning the authenticity of projects and tax compliance among other regulatory measures. The blockchain has such information already, and its facilitation of peer to peer transactions thus allows investors to interact with the contractors without lawyers and bulky verification documents.*" [81]

Additionally to the adaption feasibility of traditional SBL crowdfunding to DAOs, what truly drives change in this transition are the blockchain characteristics themselves that allow for decentralization of the decision-making process, transparency among creators and lenders, security and immutability by virtue of the smart contracts contained. Being blockchain networks not under the authority of a single entity, thereby preventing a single point of failure and the seizure of the network by a select few users, a balance between project creators and the public of lenders is permitted. In a distributed network known as Blockchain, users collaborate to reach consensus on the network's state. Transparency is fostered because Data recorded in a blockchain is accessible to the general public and visible to all network participants. Its time-stamped nature, its authentication feature[82], its connection to the previous block, and its hermetic configuration, which precludes the modification of a block's data in retrospect, ensure the blockchain's security. The latter prohibits the posting of false investment-related information in order to perpetuate fraud. The notion of immutability relies on the fact that, as described previously, DAOs operate through smart contracts, which are essentially blocks of code that execute when a certain set of conditions is met. These smart contracts determine the laws of the DAO. Those who have a stake in a DAO have voting rights and can vote on or propose new governance ideas, which can impact the organization's operations. This model prohibits

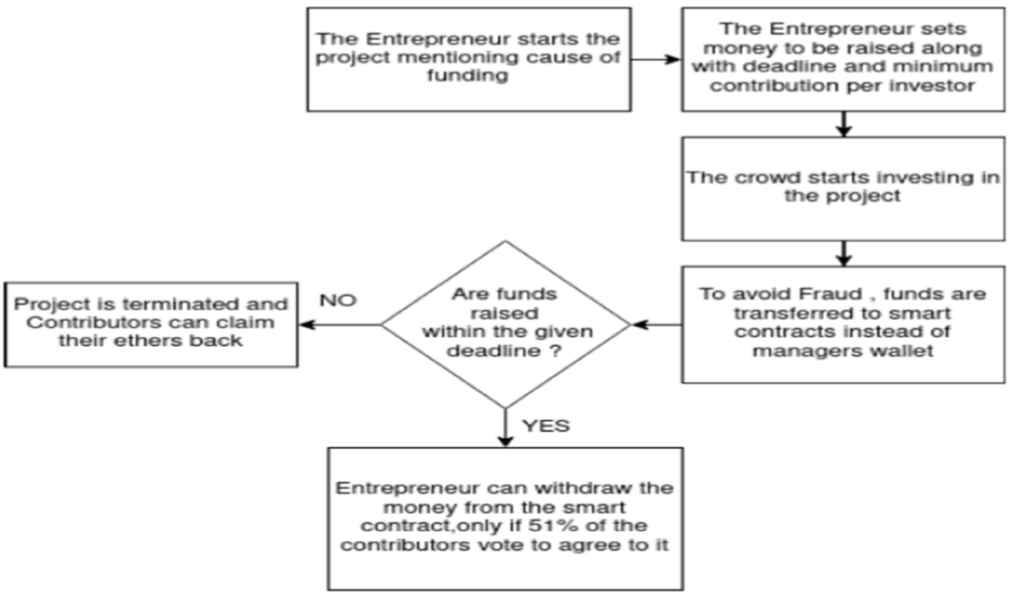
[80] Source: *Bitcoin, Blockchain, Ethereum, the DAO – What's in it for the Private Equity industry?* - 2016

[81] Source: *Application of Blockchain Technology in Crowdfunding* - 2017

[82] Accounts on blockchains are pseudo-anonymous but identifiable. Everyone is able to view which public address sent how much money to another public address. Therefore, despite the fact that participants in the blockchain network do not reveal any private information, each participant's identity can be verified, and all transactions are traceable and visible across the network.

spamming of DAOs with proposals: A proposal will only be accepted if the large majority of interested parties support it. The smart contracts specify the manner in which the majority is selected, which varies from DAO to DAO.

All these characteristics combined together limit to the maximum extent the information asymmetries inner in traditional P2P crowdfunding platforms' business model and foster the liquidity of debt securities, now referred as tokens, by virtue of the enhanced trust and the availability of regulated marketplaces[83] for them. It is even true to state that blockchain technology allows for more reach as there is no cap in the raiseable amount nor limitations in terms of geographic dislocation of lenders; "*One perk of blockchain technology is that it is censorship-proof*[84]*. This makes all applications built on blockchains censorship-proof as well. This removes restrictions that traditional crowdfunding sites might otherwise impose on individuals or businesses. GoFundMe does not process payments from China, Nigeria, Russia, Lebanon, Iran and a host of other countries. Nigeria is Africa's largest economy while China is the world's second-largest economy, yet residents of both economies can't access the largest crowdfunding platform in the world. With blockchain technology, investors or donors from these countries can easily contribute to a DAO."* [85]Furthermore, DAOS are highly flexible and have so far faced minimal regulations from authorities. DAO joining members, according to their own financial contributions, share the risks among themselves and, should the project fail to materialize, the funds get immediately reimbursed following the scheme highlighted below:



DAOs guarantees– Source: *A review: a Blockchain based Crowdfunding Decentralized Application*– 2022

[83] Source: *A complete list of security token exchanges - 2019*

[84] censorship resistance refers to the freedom to transact, the freedom from confiscation, and transaction immutability.

[85] Source: *Cointelegraph* - 2022

It is also important to note that, if the requirement specified in the underlining smart contracts are met, both retail and institutional investors can participate in the ICO alike traditional crowdfunding systems. The difference is that, due to the absence of white label banks, fees are almost inexistent and therefore the investor's type is practically indifferent.

2.2 DAOs concrete application in the RE industry

As explained in the first chapter, to promote SMEs active participation and thus to facilitate the Energy Transition, energy systems are becoming increasingly active, decentralized, complex and multi-agent, with a growing number of actors and potential actions. Communication and data exchanges between the various components of a power network are becoming increasingly complex, making central management and operation increasingly difficult. In order to accommodate these decarbonization, decentralization and digitalization trends, local distributed control and management techniques are required. Research endeavors and newly created enterprises[86] suggest that blockchain technology may provide solutions to some of the challenges faced by the energy industry. In substance, by fostering reliable transaction recording, eliminating intermediaries, removing to the highest extent regulatory reporting and compliance and building a functioning global supply network, blockchain-based market structures could help decentralized energy systems achieve efficiency. Indeed, according to a commercial report by Deloitte[87], blockchain-enabled transactional digital platforms could provide energy companies with operational cost reductions, increased efficiency, rapid and automated processes, transparency, and the potential for reduced capital requirements. The potential for cost reductions is not limited to utilities, but also applies to energy consumers and prosumers, who face rising energy prices and the elimination of RES incentives, respectively. Blockchain-promised solutions, such as P2P trading in local or consumer-centric marketplaces, could potentially result in energy consumer cost reductions.

Although blockchain could be applied to a variety of use cases related to the business processes[88] of energy companies including billing, sales and marketing, trading, data transfer, grid management, resources sharing and competition, it is in the financing process through SPVs of Independent Power Projects that resides the core of such an innovation. In this regard, the document "*IEE Transactions*

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[86] Examples include: Stockholm Green Fintech, Climate Chain Coalition, Project Genesis, Green Asset Wallet, WePower, Green Digital Finance Alliance.

[87] Source: *Blockchain: Enigma. Paradox. Opportunity* - 2016

[88] Source: *Blockchain Technology in the Energy Sector: A Systematic review of challenges and opportunities* – Paragraph 3.1 - 2019

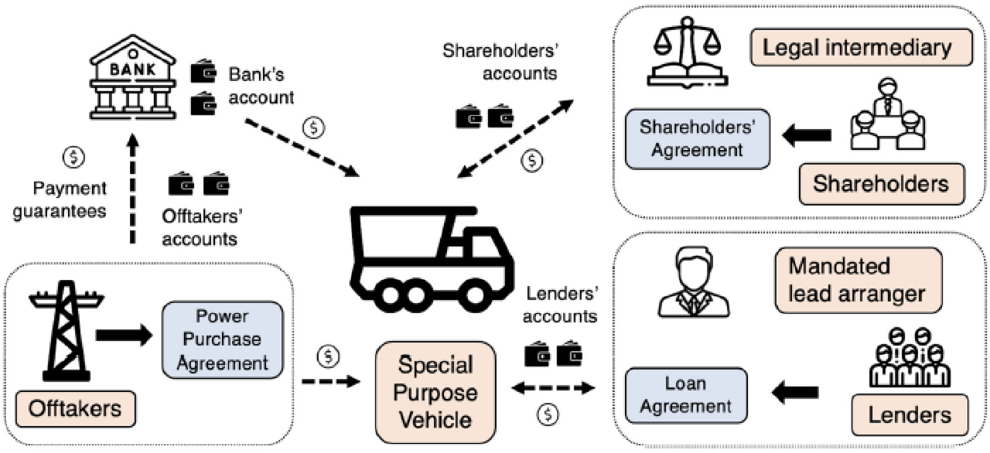
on Industry Applications" provided by Olakunle Alao and Paul Cuffe will be referenced in order to propose a novel Decentralized Autonomous Organization application: a blockchain-based Special Purpose Vehicle supported by various autonomous mechanisms.

2.2.1 How to structure a blockchain-based SPV

Independent power projects are funded, constructed, owned, and operated by the private sector and constituted via a Special Purpose Vehicle (SPV), a legal entity whose primary purpose is to implement a power project. SPVs have become one of the most rapidly expanding sources of investment in the electricity sector and have recently made financing massive power projects easier for the public sector. However, due to the aforementioned limitations of traditional finance sources, which include high credit, liquidity, margining, third-party, legal, and process risks, funds for these investments are expensive and difficult to acquire. The optimal scenario for renewable generator SPVs is for project owners to have access to funding from multiple location-independent investors with varying risk appetites and available capital. Investors, on the other hand, demand the fractionalization of such capital-intensive assets, which enables them to invest any quantity of money in a project and to sell their investments to interested parties on an open market. Additionally, they wish to be guaranteed a portion of the project's future revenues. The purchasers of electricity from the SPV must have a payment structure that reduces their direct and indirect electricity costs. These parties intend to accomplish their goals in a frictionless, seamless, and reliable manner. The inherent characteristics of blockchains, such as decentralization, tokenization, and immutability, as well as self-executing and persistent smart contracts, could facilitate a new SPV arrangement that enables these parties to realize their goals. Consequently, the objective is to design the mechanisms that would support such an arrangement. Anyways, before going in depth, it is important to show the risks associated with SPVs after having presented its structure and life cycle.

A SPV is a commercial enterprise created by one or more organizations for a particular purpose, such as the implementation of a renewable electricity project. SPVs have the legal status of an independent entity, with autonomous assets and liabilities from their parent companies. The SPV's shareholders, financiers, and off-takers are the three most important parties from an investment standpoint. The shareholders are the legal owners of the generator's physical assets. In exchange for an ownership stake in the SPV, they provide initial equity capital for the initiative. They are formed at the beginning of the project through a traditional shareholders' agreement, which is typically underwritten by mutually contracted legal intermediaries.

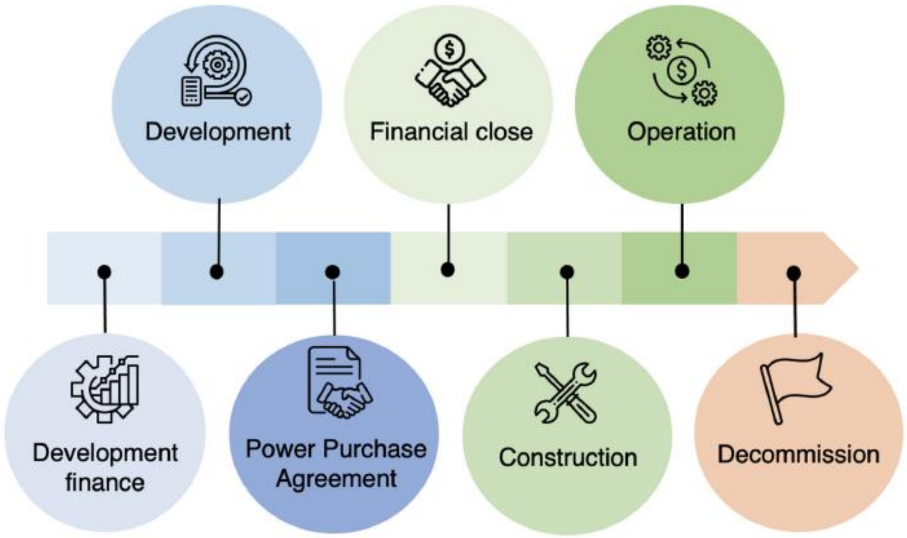
The present graph summarizes the structure of a typical SPV:



Structure of traditional SPV– Source: *Structuring SPVs for financing RE generators on a blockchain marketplace*– 2022

The structure of this conventional shareholder arrangement exposes the SPV to legal[89], process[90], and third-party[91] risks.

The SPV lifecycle is represented in the figure below:



SPV lifecycle– Source: *Structuring SPVs for financing RE generators on a blockchain marketplace*– 2022

[89] Due to the potential costs of lengthy and arduous arbitration procedures resulting from contractual and ownership disputes between shareholders.

[90] the prospect that shareholders will incur financial losses as a result of the inefficient bureaucratic traditional contracting regime. Losses may also be incurred due to the error-prone and sluggish laborious procedures of the legal intermediary, resulting in operational unreliability.

[91] The contracted legal intermediary may be dishonest or partial, discreetly favoring some shareholders over others.

After shareholders have been established and initial funds have been provided, the enterprise enters the earliest phase of the SPV life cycle: development finance. This phase entails the development of the power project, including technical and financial feasibility assessments and in-depth studies of environmental and social impact. In order to secure their revenue streams, projects that are successful in the development stage sign bilateral power purchase agreements with the designated electricity purchasers, also known as off-takers. This bilateral agreement is susceptible to counterparty credit[92] risk and again to third-party, legal, and process risks. The conventional method for mitigating SPV credit risk involves appointing an intermediary, typically a commercial bank, to retain cash collateral for the off-taker. Off-takers may also purchase from a commercial bank a letter of credit that serves as payment default insurance coverage. Thus, if an off-taker defaults on its payment obligations to the SPV, the delegated bank will cover the deficit. Traditional credit risk hedging strategies are costly and expose the SPV to third-party risks, such as the possibility of a fraudulent or bankrupt intermediary administering collaterals. Due to the potential costs of mediating processes or resulting from disputed payments or payment defaults between the SPV and off-takers, they are exposed to legal risks. Due to the error-prone and sluggish bureaucratic intermediary administering the payment guarantees, they also face process risks.

After signing the power purchase agreement, SPVs endeavor to achieve financial close by securing all construction funds. The SPV obtains funds from financiers, who are typically development finance institutions or commercial banks, in order to secure debt financing or a loan for the project's financial close. The limited financial resources available from these few traditional sources make this process difficult and costly. Due to the limited number of investors involved in financing such capital-intensive projects, investments carry inherent liquidity[93] risk. Liquidity, in its simplest form, denotes that investors can contribute any amount of capital to a project and readily sell their investments to interested parties on an open market. Moreover, during the finance mobilization phase, a mandated lead arranger typically functions as the facilitator and coordinator of financing from multiple financial institutions, exposing investors to third-party risk. The inherent administrative inefficiencies of conventional financial institutions delay the process of finance mobilization for SPVs, resulting in a high level of process risk. Again, legal risks may emerge as a result of the costs that may be incurred during arbitration proceedings resulting from contractual disputes between lenders.

After financial conclusion and construction, the SPV intends to operate the power project sustainably to generate returns for its investors. Returns result from the receipt of revenues from customers.

[92] It is the possibility that the SPV's revenues will suffer as a result of payment defaults by off-takers.
[93] It persists when investors are unable to quickly liquidate their positions at any time.

However, in conventional SPVs, electricity payments are typically infrequent, resulting in accumulated settlement payments and exposing off-takers to high margining[94] risks. Non-regular settlement times necessitate that off-takers hold larger cash collaterals or purchase letter of credit at exorbitant costs to match the amount of insured cash flow, thereby increasing the risk of high margin payments. Margining risks reduce electricity demand and result in higher electricity prices for end-users.

Ultimately, the power project is decommissioned following the duration of the power purchase agreement, which typically corresponds to the project's operational existence.

Notably, the aforementioned obstacles and constraints make it difficult for conventional SPVs to acquire the necessary funds for project implementation. Even if they succeed, it is at a high price and after a lengthy and exhausting process.

Having stated the specific difficulties met in the structuring and closing processes of a traditional SPV combined to the more general "Financing Gap" challenge inherent in the RE industry, the aim is now to combined DAOs and SPVs in such a way that securitization and project finance logics can find the right balance and offer a disruptive financial innovation suitable to evolve existing Web 2.0 SBL crowdfunding structures and hence to be effectively implemented within the current global decentralization trend of energy systems.

The concerns to be addressed are the following two:

I. How can a DAO be designed to replicate the technical, legal, and commercial capabilities of conventional SPVs while mitigating the new risks[95] it introduces?

II. How can a DAO surmount the limitations and hedge the underlying risk exposures of existing SPV structures?

The blockchain SPV maintains the core functionalities of conventional SPVs via three autonomous mechanisms: mobilization, collateralization, and settlement.

Consequently, design risks are reduced. These autonomous mechanisms facilitate finance mobilization from a location-independent community for the SPV, revenue collection from the electricity purchaser, and eventual project revenue distribution to investors.

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[94] It is a financial risk that future cash flows are smaller than expected due to the payment of margins, i.e. a collateral as deposit from a counterparty to cover some (or all) of its credit risk.

[95] Volatility, design, security, account.

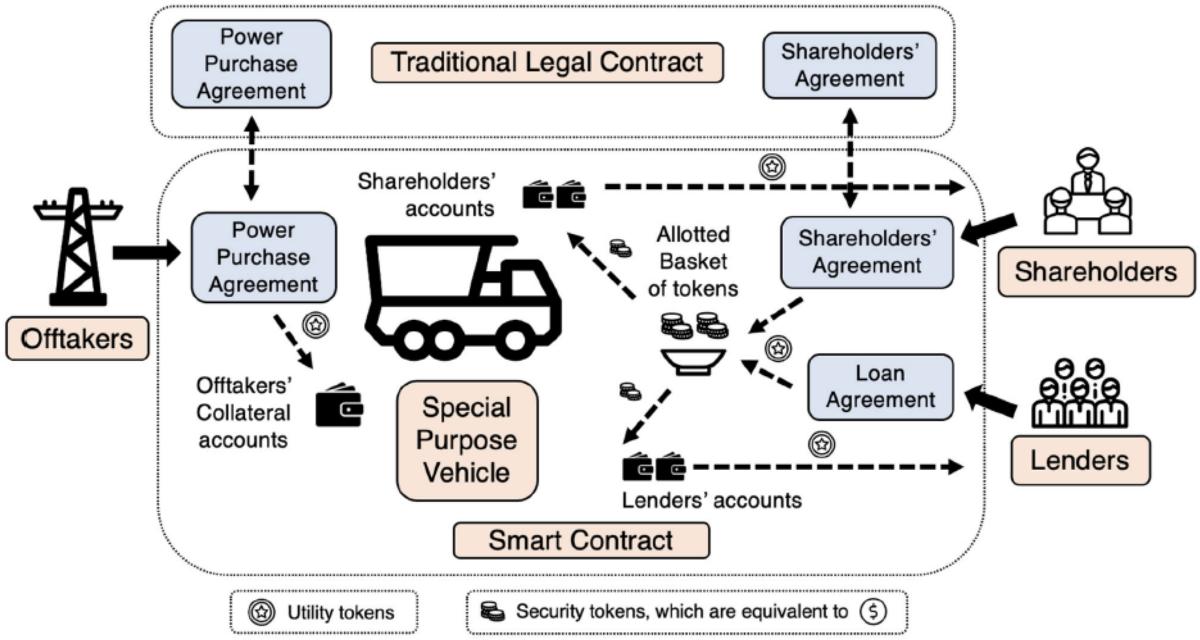
Notably, relatively stable currencies such as the US dollar are used as the medium of exchange in conventional project financing. However, the native currencies of blockchains are extremely volatile, exposing the SPV to the risk of incurring financial losses, as is the case with cutting-edge DAOs for renewable electricity. Thus, by integrating a stable coin into the smart contract, volatility risk can be mitigated. This interaction with another blockchain application, however, introduces security hazards. Consequently, a mature stable coin cryptocurrency functioning on decentralized governance and finance principles such as the DAI[96] may be selected as the utility token for the proposed DAO.

The trio of autonomous mechanisms is additionally employed to hedge the underlying credit, liquidity, margining, third-party, and process risk exposures of conventional SPVs. The autonomous mobilization mechanism governed by the smart contract, such as the one promoted by *WePower*[97], enables a global community of location-independent investors to fund renewable generators with any amount, in exchange for the DAO's native fungible security token, and to be guaranteed a share of the project's future revenues by redeeming the token. This enormous funding pool means renewable generators have access to capital more quickly and at a greater rate. The mobilization mechanism mitigates liquidity risk because investors can readily trade their project investments. The autonomous collateralization mechanism mitigates the credit risk inherent in conventional SPVs, incentivizing off-takers to satisfy their payment obligations to the renewable generator. Due to the autonomous settlement mechanism that facilitates prompt settlement payment to investors, off-takers are protected from margining risks. All of these actions, as well as those of other agreements within the SPV, such as the shareholder's agreement, are enforced by the smart contract without human oversight. Legal risks associated with conventional SPVs are mitigated by the autonomous smart contract that enables enduring and uncontestable agreements. As a result of the process automation introduced by the same self-executing, persistent, and immutable smart contracts that operate based solely on the predefined conditions embedded within them, process risks are minimized.

This newly configurated structure is shown in the figure below:

[96] It is a stable coin cryptocurrency that is fungible and closely pegged to the US dollar through decentralized incentive structures. Users can therefore possess DAI without the normal risk of price volatility associated with other cryptocurrencies. A community of Maker DAO governance fungible token holders supervises the Maker Protocol, the interconnected smart contracts that fuel DAI. With such decentralized governance, changing the strategic focus of the community requires only a majority vote from the governors, allowing the developers to upgrade the source code of the system.

[97] Platform connecting energy suppliers, corporate buyers and energy producers for easy, direct green energy transactions.



Structure of traditional SPV– Source: *Structuring SPVs for financing RE generators on a blockchain marketplace*– 2022

The blockchain SPV's three main parties are shareholders, decentralized lenders, and off-takers. The smart contract governs and motivates these parties' actions and inactions, minimizing third-party, legal, and process risks. Therefore, they have no need to interact directly with one another. Rather, they operate in accordance with the predefined agreements encoded in the business logic of the smart contract. Shareholders are the legal owners of the generator's physical assets. In exchange for supplying initial funding for the project, shareholders receive an ownership stake in the SPV. Partnerships among shareholders, for instance within an industrial area made of manufacturing SMEs, are formed off-chain at the onset of the undertaking via a conventional shareholders' agreement[98].

The traditional agreement's representation of each shareholder's stake is then immutably recorded in the smart contract. Following traditional Project Finance logics, the majority of project funding for the construction of the power project must come from external sources[99]. Through the autonomous mobilization mechanism of the smart contract debt financing is secured for the SPV from decentralized financiers located anywhere in the world.

The shareholders acquire these funds through an ICO scheme governed by a conventional loan agreement. In such a program, the product of the number of tokens and price per token equals the

[98] A shareholders' agreement is an agreement between the shareholders of a company which generally sets out the shareholders' rights, privileges and obligations along with the foundation of how the corporation will be set up, managed and run.

[99] The amount of debt that can be raised is defined in the debt term sheet of the project and is usually expressed by a maximum of leverage ratio of 75% and a minimum DSCR of no less than 1.4x.

total investment cost of the project. After that, they distribute a portion of the tokens amongst themselves, which represents the off-chain equity they contributed at the SPV's inception. Finally, they sell the remaining tokens through the blockchain SPV platform's mobilization mechanism. The number of tokens sold is intended to correspond to the amount of debt financing required to implement the initiative. The ownership of these security tokens grants decentralized lenders access to future revenue sources in the form of utility tokens, in a manner wholly governed by the smart contract. Decentralized lenders will receive total annual payments based on the project's DSCR until all debt has been repaid in full. Before the total debt is completely repaid, the remaining annual revenue after debt service is distributed to the shareholders. However, once the entire debt has been completely serviced, the shareholders will receive all of the project's revenues until it is decommissioned.

Algorithm 1: Mobilization Mechanism.

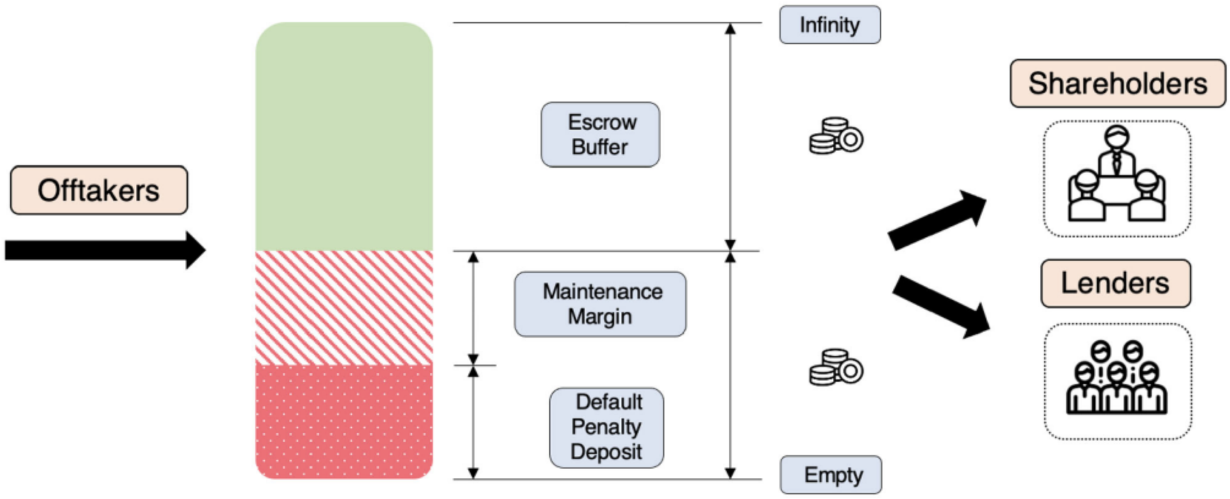
\\\\ E_i and A_i is the contribution and address, respectively, of i^{th} shareholder.
Input: F, E, E_i, A_i
(A) Shareholders contribution:
\\\\ Derive required debt D
let $D = F - E$
\\\\ Assign security tokens to shareholder based on its contribution
$\mathbb{M}(i)$: $\beta_i \longrightarrow A_i$
Output: $\mathbb{M}(i)$
\\\\ D_j and A_j are the utility tokens contribution and address, respectively, of j^{th} decentralized lender.
Input: D_j, A_j
(B) Decentralized lenders contribution:
\\\\ Check if the mobilized debt D^* is less than the required debt and if the contributed debt by the decentralized lender is not greater than the difference between the required and mobilized debt.
if $(D^* < D)$, $(D_j \leq D - D^*)$ **then**
  \\\\ Assign security tokens to decentralized lender based on its contribution
  $\mathbb{M}(j)$: $\beta_j \longrightarrow A_j$
  \\\\ Top-up D^* with the decentralized lender contribution
  let $D^* = D^* + D_j$
else
  \\\\ Revert transaction to the initial state
end if
Output: $\mathbb{M}(j)$, D^*

Mobilization Mechanism– Source: *Structuring SPVs for financing RE generators on a blockchain marketplace*– 2022

Prior to the ICO program, investors must secure the revenue stream that will serve as the premise for loan repayment to decentralized lenders. The revenue stream is derived from the off-takers, or purchasers of the renewable generator's excess electricity produced[100]. A conventional power purchase agreement between the shareholders and the off-takers ensures the revenue stream of the project. The parameters of this agreement are initially negotiated off-chain, after which they are immutably encoded in a smart contract.

Through the smart contract, shareholders and decentralized lenders receive revenue streams from the off-takers once the project begins operations. For achieving this purpose, a blockchain-enabled smart meter acts as a hardware oracle, recording electricity consumption data from off-takers and passing it to the smart contract for settlement purposes.

This decentralized and untrustworthy arrangement introduces a new obstacle: what if the off-takers do not have the funds or the motivation to pay for the electricity they have consumed? In order to mitigate the credit risk posed by the off-takers, an autonomous collateralization mechanism is proposed[101]. The smart contract collateral mechanism manages off-takers' collaterals autonomously to encourage them to accomplish their payment obligations to the SPV.



Off-takers deposits – Source: *Structuring SPVs for financing RE generators on a blockchain marketplace*– 2022

As previously outlined, the holding of such collaterals can lead to margining risk. The off-takers' collateral account serves as maintenance margin and default penalty deposit. Every trading period,

[100] For this structure to be feasible for manufacturing SMEs, the assumption is that part of the energy produced by the RE generator should satisfy the need of self-consumption (specific Kw/h must be stipulated in the smart contract accordingly) before being sold to the grid.

[101] The traditional mechanism for minimizing credit risk is by purchasing a letter of credit from or depositing cash collateral in a financial institution. However, these mechanisms are expensive and expose the SPV to third-party, legal, and process risks, already described in previous sections.

the maintenance margin of an off-taker reflects its credit exposure to the SPV. To ensure that off-takers have sufficient funds in their collateral account to make settlement payments inutility tokens due to the SPV, the minimum reserved maintenance margin must be greater than the off-takers expected future payment. The default penalty is used to penalize defaulting off-takers whose maintenance margin falls below the minimum requirement. A failure to maintain the maintenance margin results in a deduction from the default penalty deposit. Once the default penalty deposit is depleted, the off-taker's blockchain-enabled meter is notified, and electricity supply is subsequently cut off. In practice, the proposed collateralization mechanism results in zero off-taker credit risk for SPVs, because the smart contract incentivizes SPVs to meet their payment obligations.

Algorithm 2: : Collateralization Mechanism.

\\\\ A_k is the address of the offtaker
Input: A_k
\\ \\ For all offtakers A_k do the following:
for $k \longleftarrow 1$ to A_k **do**
  \\\\ Check if offtaker's maintenance margin falls below the minimum requirement
  if $(M_k < M_{\min})$ **then**
    \\\\ Deduct default penalty H from the default penalty deposit H_k^* of the offtaker
    let $H_k^* = H_k^* - H$
  end if
  \\\\ Check if the default penalty deposit of the offtaker is lower than the default penalty payment
  if $(H_k^* < H)$ **then**
    \\\\ Empty collateral account R_k of offtaker
    let $R_k = 0$ (i.e., $M_k = 0$, $H_k^* = 0$)
    \\\\ Record offtaker as expelled X_k from the smart contract
    $\mathbb{M}(k)$: $A_k \longrightarrow X_k$
  else
    \\\\ Revert transaction to the initial state
  end if
end for
Output: $\mathbb{M}(k)$, R_k

Collateralization Mechanism – Source: *Structuring SPVs for financing RE generators on a blockchain marketplace*– 2022

The autonomous settlement mechanism, which enforces prompt smart contract settlement as electricity is consumed and metered in real time, mitigates the margining risk. This mechanism reduces the credit exposure of the off-taker to the SPV in each instance, and consequently the margining risk.

Algorithm 3: : Settlement Mechanism.

\\ \\ For all investors $A_{i,j}$, do the following:
for $i, j \longleftarrow 1$ to $A_{i,j}$ **do**
  \\\\ Check if the settlement function has not been invoked within a prespecified period I', where I and I^* are the current and last invoke time, respectively.
  if $(I \geq I^* + I')$ **then**
    \\\\ Top-up shareholder account R_i with due revenue
    let $R_i = R_i + \beta_i \times \delta_t$
    \\\\ Top-up decentralized lender account R_j with due revenue
    let $R_j = R_j + \beta_j \times \delta_t$
  else
    \\\\ Revert transaction to the initial state
  end if
end for
Output: R_i, R_j

Settlement Mechanism – Source: *Structuring SPVs for financing RE generators on a blockchain marketplace*– 2022

In order to guarantee investors' protection, it is important to understand and to deal with the ICO process for assessing whether token offerings meet both U.S and E.U peculiar requirements in terms of Securities' Regulation. Hence, the attention will be posed on the *Slock.it. v SEC* case, which arises food for thought on the lawfulness of the comparison among tokens and securities.

2.3 Tokens as securities: ensuring a legal guarantee for investors' protection

The emergence of DAOs will likely accelerate as blockchain and smart-contract-based technologies advance. Establishing a consistent roadmap requires a legal organizational framework that facilitates political, legislative, and social debate on the governance of DAOs and codifies the current standard of governance for all legally registered DAOs. Once there is a set of standards, default rules by which a DAO must abide in order to organize under a state statutory scheme, there will be a benchmark for investor protection, duty allocation, disclosure, and liquidity expectations. In addition, mandating compliance with applicable securities regulations regarding the solicitation, sale, and transfer of DAO-Tokens can facilitate more gradual, controlled DAO launches that prioritize investor or token-holder protection. Despite the possibility that this will not result in an infallible system for governing primary blockchain markets, investor protection is a necessary consideration that must be given adequate weight.

Tokens on a blockchain have a fluid nature. The rights and duties associated with a specific token are highly customizable, whereas the underlying smart contract is complex and rigorously executed. The propensity for fraud and opportunism is a side effect of large-scale token issuances and the unrestricted trade of tokens in secondary markets. As already discussed, A DAO-based entity employs cryptographic tokens[102] to convey ownership interests in the organization's underlying projects. In addition, the tokens confer voting rights proportional to the total number of tokens issued and a right to a portion of the organization's proceeds on their holders. Therefore, a valid question would be: Would someone invest in a company where all management is replaced by investors' remote control? This was the same query posed to the public by "The DAO[103]," a hypothetical investment fund designed by a group of coders named *Slock.it* to operate a decentralized autonomous organization almost exclusively through digital code. The intention was to create a democratic enterprise, but the plan ran into trouble when a hacker exploited the company's code and captured approximately $50 million in investor funds.

The significance of “The DAO's plan” and the magnitude of its subsequent failure attracted the attention of the Securities and Exchange Commission (the "SEC"), resulting in a decision that has since complicated the future of blockchain ventures: for guaranteeing investors’ protection, tokens or virtual currencies sold in an Initial Coin Offering ("ICO") could be considered securities under federal securities law.

The purpose of the following paragraphs will be to move from this presumption and provide a detailed analysis of what an ICO is, as well as to determine whether the proposed blockchain-based SPV satisfies both the US requirements of the *Howey Test*[104] and the European notion of “*Transferable Securities*”.

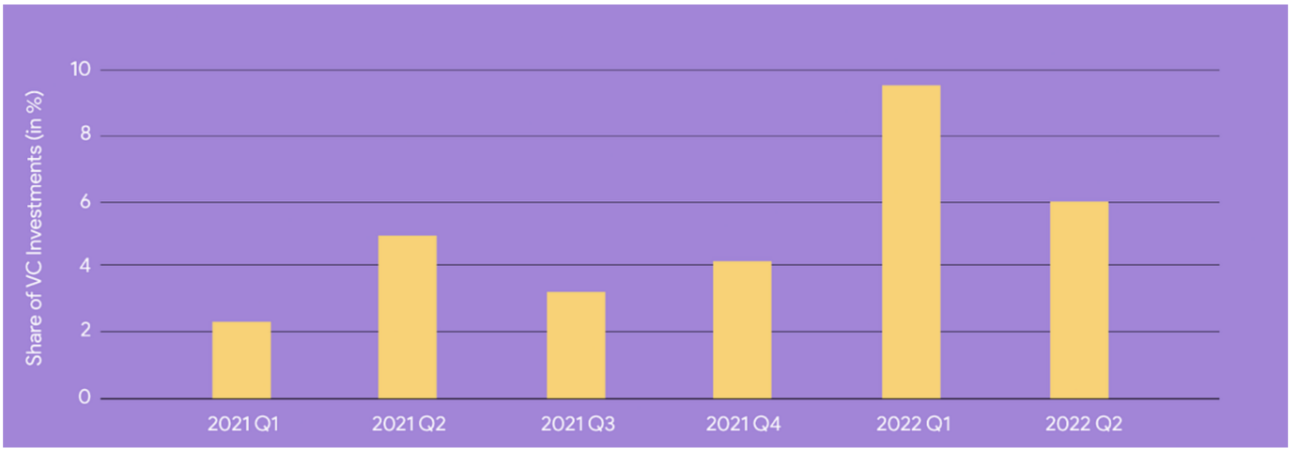
2.3.1 ICOs regulation: gauging consistency to the *Howey Test* based on the *Slock.it. v SEC* case

From the Industrial Revolution to the Internet Age, new technologies and financial markets have emerged simultaneously. Now, blockchain-based decentralized enterprises have introduced the ICO market. During an ICO, a company raises funds by issuing digital tokens for physical currency. Since 2003, ICOs have been monitored, but between April 2016 and November 2017, the total amount of funds raised through ICOs increased from $56 million to over $3.5 billion. In addition, venture capital participation in funding DAO projects has increased since 2021, frequently coinciding with macroeconomic and cryptocurrency market cycles. In the first quarter of 2022, venture capital investments reportedly reached a local apex of over $160 million.

[102] *Unique digital asset which is constrained by rule sets that exist on the relevant blockchain network.*

[103] *Source: Understanding the DAO attack - 2023*

[104] It determines what qualifies as an “investment contract” and would therefore be subject to US securities laws.



VC volume of investments in DAOs – Source: *Cointelegraph Research VC Database* – 2022

However, as the market expands, so does the dread of fraud and its impact on the economy, which in turn attracts the attention of regulators. In response to the explosive growth of the ICO market, the SEC has successfully incorporated the ICO business model into the Securities Exchange Act.

A "security" is defined by the "Exchange Act" as "*any note, stock, treasury stock, security future... [or] investment contract*."[105] In turn, the SEC has clarified and defined these examples via promulgated interpretations and judicial review of the Securities Act's scope. When determining whether to regulate a new investment instrument, both the SEC and the courts consider the purpose of the Exchange Act, which is to prevent significant abuses in the largely unregulated securities market. In order to render a verdict in the *Slock.it v. SEC* case, the "Howey Test" for investment contracts was applied to determine whether Coins issued during ICOs are securities.

"*An investment contract for purposes of the Securities Act means a contract, transaction or scheme whereby a person invests his money in a common enterprise and is led to expect profits solely from the efforts of the promoter or a third party*."[106] The economic realities of the agreement should take precedence over the literal form of the contract. Over time, the Howey Test has been reduced to four factors that must be met in order to classify an investment contract as a security: (1) there must be an investment of money; (2) in a common enterprise; (3) with a reasonable expectation of profits; and (4) derived primarily through the efforts of others' management. By making use of the Columbia Business Law Review "*ICOs, DAOs, and the SEC: a Partnership Solution*" published by Ori Oren, the scope is now to assess whether the *Slock.it* DAO fits within the Securities Act definition of investment contract:

[105] Securities Exchange Act of 1934, § 3(a) (10), 15 U.S.C. § 77b(a) (1).

[106] SEC v. W.J. Howey Co., 328 U.S. 293, 298-99 (1946).

I. The initial portion of the Howey Test may require determining whether the contract was engaged into for investment or consumption purposes. Similar contract forms can be categorized as either investments or consumption, with the distinction based in part on the economic motivation underlying the transaction. In addition, the first factor of the Howey Test questions if an investment was made with "money." According to this criterion of the Howey Test, the SEC determined that "money" had been "invested" in "The DAO." The "investment" aspect of participation in the ICO is evident; purchasers expected to receive a return on their contribution. The novel question was whether or not cryptocurrencies such as Bitcoin and Ether constitute "money." The SEC resolved this issue by citing two precedents, *Uselton v. Commercial Lovelace Motor Freight, Inc*. and *SEC v. Shavers*, to argue that virtual currencies are money: at some point in the transaction, fiat currencies must have been exchanged to acquire Ether, which has a fiat currency value and is used to invest in The DAO token. Therefore, purchasers of DAO tokens invested money in "The DAO" token designed by *Slock.it*.

II. While the SEC recognizes "common enterprise" as part of the definition of an investment contract security, it does not address whether the DAO ICO qualifies as a common enterprise, instead focusing on the "managerial effort of others" factor. Each DAO investor's success is dependent on the success of the other investors. However, vertical commonality is more debatable in this case, and some justices rely heavily on it.[107]

"*A common enterprise within the meaning of Howey can be established by a showing of 'horizontal commonality': the tying of each individual investor's fortunes to the fortunes of the other investors by the pooling of assets, usually combined with the pro-rata distribution of profits.*"[108] The DAO concept corresponds to this definition of a shared enterprise. The success of an investment in The DAO is facilitated by the pool of Ether contributed by each investor. Profits are distributed proportionally to the number of tokens held by each token holder. In some courts, this will satisfy the common enterprise requirement of Howey.

Other courts will recognize vertical similarity as evidence of a common enterprise. In vertical commonality schemes, "an investor's fortunes are tied to the promoter's success rather than to the fortunes of his or her fellow investors." The Eleventh and Fifth Circuits recognize broad vertical commonality, which requires proof that the investor's returns are tied to the efficacy

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[107] Source: *Why the Common Enterprise Test Lacks a Common Definition A Look into the Supreme Court's Decision of SEC v. Edwa* - 2005

[108] Revak v. SEC Realty Corp., 18 F.3d 81, 87 (2d Cir. 1994).

of the promoter. The court in Villeneuve determined vertical commonality because investors could not have succeeded without the advertising services provided by the scheme's promoters. In cases where there is no horizontal commonality, the Ninth Circuit will look to a strict version of vertical commonality, which requires that investors' fortunes be "intertwined with and dependent upon the efforts of those seeking the investment of third parties." In such an evaluation, the court examines deeper than the promoter's contributions to the scheme, instead focusing on whether the promoter's efforts generate investment returns. The DAO ICO may satisfy broad vertical commonalities. The Villeneuve court found vertical commonality in a scheme in which the promoters "*provide[d] advertisements, training, products, and [selected] the areas where products are sold," adding that "[t]he failure to provide any of these services would determine the success or failure of the scheme.*"[109] The court judged the Villeneuve scheme to be a common enterprise despite the tenuous relationship between the promoters' contribution and the sales efforts of investors, who were similar to franchisees in the Villeneuve scheme. The DAO Curators provide comparable threshold services, such as approving voting pitches. Token holders are unable to vote on a smart contract proposal without Curator approval. Neglecting curation would unquestionably result in the scheme's failure, so broad vertical commonality is met here. However, strict vertical similarity is difficult to apply in this circumstance. In a case where an investor's funds were not aggregated, i.e. there was no horizontal commonality, the Ninth Circuit found a common enterprise because the success of the investor's investment depended on the success of the promoter's business operations. This is arguably not the case in The DAO. First, the architects of The DAO provided the bare minimum of code required for token purchasers to pool their funds. Thereafter, there is no longer any relationship between the investors and the founders, so the success of the investors is dependent on the new execution code they authorize and the investments they choose, regardless of the founders. Because they were tasked with ensuring that pitches were appropriate for implementation, the Curators were closer to success than the investors. The success of investors required Curators' services but was not dependent on them. An investment could have been approved by Curators and then rejected by voters, or it could have been approved by voters and been unsuccessful, regardless of the operation of the Curators. In addition, token-holding voters could supplant Curators, further separating Curator performance from investor success. The Curators are part of the same horizontal, decentralized structure of the DAO, which is the final argument against both modalities of vertical commonality. Decentralization is the core concept underlying the business model. In

[109] Villaneuve, 698 F.2d at 1124.

addition, the Curators are intermediaries chosen by token holders, but they lack the ability to exert control over token holders. The primary purpose of the Curators is to defend minority token holders from an attack by a majority token holder (such as voting to take all of the funds, which almost occurred before the Curators intervened). One DAO Curator views his position as "human-training wheels" and foresees a future in which Curators are no longer required. Another Curator saw an even smaller role in protecting against majority attacks, which consisted of merely certifying "whether payment addresses are truly associated with proposals" and whether code complies with security standards. Curators are not to make decisions based on the profitability of a proposed contract.

Curator control is therefore procedural and not substantive. Lack of narrow vertical commonality would not defeat the common enterprise factor in the majority of courts because horizontal commonality exists.

III. The third factor's application to The DAO is relatively straightforward, so the SEC Report only devoted a brief paragraph to its analysis. The potential for financial returns attracted DAO investors to the novel investment model. "Profits" refers to "[*p]rofits in the sense of income or return, such as dividends, other periodic payments, or the increase in the value of an investment*."[110] A DAO Token's value could rise, and the token could be traded on another virtual exchange for Bitcoin or even U.S. dollars. At some point in the transactional chain, the liquidity of the return on a DAO investment becomes actual. Hence, there is no doubt that purchasers of DAO tokens invested capital with a reasonable expectation of profit.

IV. The fourth factor is the most controversial in the SEC's application of the Howey Test to “The DAO”. The SEC argued that "*The efforts of Slock.it, its co-founders, and The DAO's curators were essential to the enterprise*"[111], hence satisfying the managerial-efforts-of-others criterion. *Slock.it* is the group of programmers who initiated “The DAO”; they wrote the code, issued and promoted the ICO, selected the initial Curators and proposed the first pitch, and then stepped back to address technical questions regarding how to participate in “The DAO”. The SEC determined that these activities were "crucial" to the "success or failure" of the business. The controversy surrounding the SEC's decision arises mainly from two factors: (1) the founders' future intention to step aside as soon as the code was in place, after having held

[110] SEC v. Edwards, 540 U.S. 389, 394 (2004).

[111] Id. (citing SEC v. Glenn W. Turner Enters., Inc., 474 F.2d 476, 482 (9th Cir. 1973)).

a mere ministerial[112] role, by replacing the Curators with code generated by token holders whenever possible; (2) the investors' ability to participate in the profit scheme by contributing sales activities or voting on governance, thereby ensuring that the success of the investment did not depend "solely" on efforts of *Slock.it*.

Despite the legitimate doubts inherent in the SEC's decision against "*The DAO*" which led to defining the tokens issued during the ICO as securities in all respects, this precedent can still legitimize the blockchain-based SPV proposal discussed above. indeed, there is no doubt that this proposal satisfies all the four requirements of the Howey Test and leaves no room for controversy regarding the fourth point: the success of the operation would in fact depend solely on the curator of the SPV appointed in the Shareholders' agreement. More specifically, both the dispersed community of lenders and the more geolocated one of shareholders (in case there would be more than one SME acting as a project promoter) would benefit from the curator's effort during the project execution phase and from the code creators during the initial designing stage of the "DAO-like" SPV. All this would allow the investing public to benefit from the investor protection regime provided by the US Financial Markets Regulation while enjoying the aforementioned advantages associated with blockchain investment compared to traditional decentralized financing platforms.
However, before delving into the final chapter, it is necessary to extend DAOs legitimacy even to the EU Regulation of Initial Coin Offerings, therefore reconciling EU and US Securities Laws. For this purpose, the paper "*Regulation of Initial Coin Offerings: Reconciling US and EU Securities Laws"* released by Phillip Maume and Mathias Fromberger will be quoted.

2.3.2 The notion of "Transferable Securities" in the EU Financial Markets Regulation

The financial markets in the European Union are governed at the EU level. Since the 1990s, the EU has enacted a vast array of Directives and Regulations outlining the rules for initial public disclosure, regulation of intermediaries, and market conduct. In response to the Global Financial Crisis (2007-2009), the EU has revised and expanded its framework for financial markets. The expression 'transferable securities' is central to EU financial markets regulation. For instance, the EU prospectus regulation applies to public offerings of securities[113]. Directive 2014/65/EU on Markets in Financial Instruments[114] centers around 'financial instruments', which, per Section C of Annex I, includes

[112] It refers to all those support activities which cannot be defined as entrepreneurial, i.e. technical support and security clearance and compliance.

[113] Article 1(1) of Regulation (EU) 2017/1129.

[114] MiFiD2.

“transferable securities”. EU Regulation 596/2014 on Market Abuse pertains to 'financial instruments' as defined by MiFiD2[115]. Thus, the query is whether tokens are 'transferable securities' as defined by EU financial regulation's uniform definition. Evidently, the definition is founded on the transfer of units on the secondary market and not on the underlying investment characteristics. This is a significant departure from the United States' approach, which emphasizes the "investment contract". Notably, market supervision and law enforcement are still the responsibility of the national financial markets’ administrators of EU member states. The ESMA[116] is charged with promoting supervisory convergence and the uniform application of market rules, among other responsibilities. However, regulatory enforcement remains the responsibility of national agencies. The consequence is that EU financial markets regulators do not speak with one voice.

In contrast to U.S. securities regulation, its EU counterpart is based on a strict interpretation of the law. This means that statutory requirements are specified in great detail in the regulation, thus leaving little room for discretion. This approach provides a high level of legal certainty for the markets, considering that a *'substance over form*' approach, as adopted by the U.S. Supreme Court, would be in conflict with the desired harmonization in the EU, as courts in various EU member states could adopt different approaches, resulting in regulatory patchwork. Regarding the classification of tokens, it would be preferable if the Howey test as applied by the US SEC and the EU definition of 'transferable securities' came to similar conclusions. Nonetheless, the EU's black-letter approach does not address requirements such as "reasonable expectation of profit" and "profit derived from the managerial efforts of others." Instead, the EU definition emphasizes securities transfers. Due to the restrictive language of the applicable EU regulations, there is little space for the use of U.S. developed principles and tests. Consequently, EU regulators and courts cannot merely adopt the Howey test. Aligning the classification of ICOs would be a significant move toward establishing a global standard. Harmonization between EU and US financial markets regulation must begin with the wording of the applicable EU rules, bringing them more in alignment with the US approach and utilizing established statutory interpretation techniques to avoid unintended outcomes.

According to the statutory definition provided in Article 4(1) (44) of MiFiD2, "*transferable securities" are those classes of securities that are negotiable on the capital market, excluding instruments of payment”*. Article 4(1) (44) of MiFiD2 specifies shares, bonds, and respective derivatives as transferable securities. Notably, no definition of 'securities' as such is provided. To our knowledge, the CJEU[117] has not issued a single decision regarding the definition of securities in

[115] Article 2(1) and Article 3(1) MAR.

[116] European Securities and Markets Authority.

[117] Court of Justice of the European Union.

general. Although this creates uncertainty among market participants and necessitates a cautious approach to the definition, it also offers an opportunity for easily integrating tokens within the definition of securities once several requirements are met:

I. **Transferability**. A security must be transferable in order to be negotiable. This means that there cannot be any obstacles that render the transfer impracticable, nor can the transfer be contingent on the satisfaction of formal requirements such as notarial certification[118]. Transferability of the units does not necessitate a physical embodiment, such as a certificate. Therefore, the intangible character of tokens does not affect their transferability. The token issuer can restrict the transferability of tokens. Non-transferability would result, however, if the unit could not be transmitted at all. A simple contractual restriction, such as a contractual transfer prohibition or an issuer-required transfer approval, does not alter the fact that tokens are generally transferable. Some token issuers provision their tokens with transfer-impossible lock-up mechanisms. In these instances, the subscriber retains and can only retain proprietorship of the token. As a result, these tokens are not transferable securities in accordance with Article 4 of MiFiD2, thus making the EU financial markets regulation inapplicable. This is in stark contrast to the Howey test in US securities regulation, which has no bearing on transferability. In some ICOs, however, these transferability restrictions are only temporary. Occasionally, the transfer restriction is lifted after a predetermined time, allowing tokens to be transferred. Consequently, from a structural standpoint, the token would not be a transferable security during the initial offering on the primary market but would become one later on the secondary market. Under these conditions, the transferability requirement should be deemed to have been met from the onset of the initial offering. It is illogical to designate a token as a transferable security at one point in its lifecycle after having been declassified it as a non-transferable security in the beginning Clearly, EU legislators desired a uniform definition of 'transferable securities' across the EU's financial markets regulatory landscape. Therefore, regulatory pillars such as the Market Abuse Regulation and the Prospectus Regulation also utilize the definition provided in Article 4 of MiFID2. Additionally, there is the issue of cherry picking[119]. It would violate the fundamental

[118] WOLFGANG GROß, KAPITALMARKTRECHT § 2 WpPG para. 3 (6th ed. 2016); Andreas Fuchs in WPHG § 2 para. 15 (Andreas Fuchs ed., 2d ed. 2016); against the need for simple transferability Heinz-Dieter Assmann in WERTPAPIERHANDELSGESETZ § 2 para. 8, 10 (Heinz-Dieter Assmann & Uwe H. Schneider eds., 6th ed. 2012).

[119] It is the process of choosing investments and trades by following other investors and institutions that are considered reliable and successful over the long term.

principles of investor protection if issuers could circumvent an unpopular aspect of financial markets regulation, such as the prospectus requirement, while reaping the benefits of a more enticing fungible token. Investing in tokens was also possible with insider knowledge. If the lockdown is lifted following the initial public offering (thereby transforming the token into a 'transferable security'), the prohibition on insider trading would be rendered ineffective. Allowing such a technical bypass is unacceptable and creates an enormous loophole in the regulation of EU financial markets. If issuers wish to remain outside of its application scope, they must guarantee that none of its regulatory provisions apply. Permanently removing the token's ability to be traded is the only solution. Thus, tokens are 'transferable' under Art. 4(1) MiFiD2 from the start (i.e., at the time of the ICO) if transferability is enabled or a lockdown is lifted after the ICO.

II. Capital Markets. Similar to 'securities', the term 'capital markets' is undefined under EU law. However, the European Commission employs a broad interpretation that encompasses all contexts in which buying and selling interests in securities intersect. This flexible approach permits the application of financial markets laws to new market structures that were not anticipated when the regulation was drafted. However, this interpretation of 'capital markets' is still insufficient because it includes 'securities' in its definition, which raises the issue of what 'securities' are in this context. In the traditional stock market environment, it is evident that the units that are typically traded on an exchange (e.g., equities, bonds, etc.) are securities, so it is not surprising that commentators also tend to avoid addressing the issue directly. Tokens are not yet traded on traditional exchanges, which poses the question of where the line between capital markets and other markets should be drawn. Capital markets are generally regarded as a subset of the financial markets. Article 4(1) of MiFiD2 specifies the categories of markets that fall under the definition of capital markets[120]. The ongoing relationship between the issuer and the investor, based on the traded instrument, is typically the primary distinction between capital markets and other portions of the financial markets, such as money markets or commodity markets, or markets other than financial markets. Bonds create an ongoing flow of funds from the issuer to the investor, whereas stocks provide investors with membership rights in the respective company. In both instances, the investment is motivated by the expectation of a profit. Profits should be broadly construed to include dividends and recurring payments. Consequently, a token awarding a flow of funds from the issuer to the investor, either at a fixed rate or based on the company's profits, is potentially negotiable on

[120] These are regulated markets, multilateral trading facilities and organized trading facilities.

the capital markets. A token cannot qualify as a 'transferable security' if it does not confer membership rights, comparable rights, or monetary inflows. Therefore, if the potential return on investment can only be derived from an increase in token value on the secondary market or if, in case of a utility token, it only grants a consumption benefit, the respective token is not an investment token and cannot be considered a 'transferable security' a priori even if it is tradable[121]. This strategy is consistent with the goals of EU financial markets regulation, notably protecting investors (and thus investment decisions) rather than consumers (and consumption decisions). It also bears some resemblance to the Howey test; nonetheless, the approaches differ in certain respects. The Howey test is conclusive as to the existence of an 'investment contract' and, consequently, the application of US investment laws. Using the typical characteristics of securities as a constituent element of 'capital markets' under Art. 4(1) MiFiD2 eliminates the applicability of EU financial markets laws to tokens that obviously have nothing to do with capital markets. It could happen that, under this approach, some tokens commonly referred to as utility tokens would fall under EU financial markets regulation. The transfer of voting rights is sometimes cited as an example of utility tokens, despite the fact that it is a traditional membership privilege. In contrast, the MiFiD2 definitions adhere to a strict, black-and-white approach to regulating financial markets. In fintech regulation, it is common for generally accepted and legal definitions to diverge. However, the fact that the requirements for transferable securities are not by the aforementioned types of tokens met does not imply that these investments are unregulated. These tokens may be subject to additional regulatory regimes (such as payment system regulation, anti-money laundering regulation, and crypto exchange rules). It is also conceivable that the growing significance of cryptocurrency tokens will result in the introduction of new forms of regulation, such as new licensing requirements for trading venues. However, this is a matter of currency/payment regulation rather than securities regulation, and, as such, it will not be discussed in this thesis.

[121] Some commentators appear to believe it is sufficient for a token to be classified as an 'investment token' if it is tradable on a secondary market: even tokens that primarily aim to serve as a utility token will typically have an investment component because they can be traded, and thus sold for a profit, on token exchanges after the ICO. This is not convincing because it overextends the definition of 'investment' – the mere possibility of purchasing and selling something, even on a structured market, does not make it an investment.

III. **Negotiability**. To be regarded 'transferable securities', according to Article 4(1) (44) of MiFiD2, tokens must be tradable. In contrast to 'transferability,' which refers to the mere prospect of being exchanged, a unit is negotiable if its format permits its sale or purchase in a structured-market environment (such as the capital markets). This is also called the 'convenience' of the transfer. Strictly speaking, the notion of negotiability already encompasses the idea that an instrument is transferable. Typically, tokens are regarded 'negotiable'. The use of the word 'negotiable' rather than 'negotiated' indicates that the tokens are not required to be traded on an exchange. If the securities in question are of a type that can be transacted on the trading facilities, then this clause applies. Tokens are not currently transacted on traditional stock exchanges, but rather on various crypto exchanges. Any investment instrument that is listed on a cryptocurrency exchange is a tradable security. The same holds true for non-traded tokens with similar characteristics to those that are already traded, as it suffices that such units could be traded in the future. In other words, any token would be considered negotiable unless it is explicitly stated from the inception that it will never be traded on a cryptocurrency exchange or a facility of a similar nature. It is difficult to conceive why a token could not be exchanged on such a platform. Even if the respective units are incapable of being traded in multilateral systems, this is not conclusive evidence that they are not negotiable, according to the European Commission's position. Some commentators argue that the respective units must enable for a higher level of transaction reliability and security. Specifically, market participants must ensure that third parties cannot assert rights after the transmission of securities. This is a result of the anonymization of capital market trading. In traditional securities markets, this refers to the opportunity to acquire the assets in good faith[122]. The required protection can also be provided by means of equal efficacy. However, even if such a (unwritten) requirement for dependability were necessary, it would not be a problem because tokens are inherently trustworthy given the blockchain basis: once the recording has occurred, it is nearly impossible to modify the respective data. The outcome is a level of dependability and security that, undoubtedly, exceeds the level of protection provided by the norms of acquisition in good faith.

[122] Source: Good Faith Acquisitions of Movables - TOWARDS A EUROPEAN CIVIL CODE – 2010.

IV. **Standardization**. For units to be negotiable, they must be standardized[123]. This follows from the concept of anonymous capital markets transactions, which necessitate the respective units to be identifiable and enumerated. Transactions must be feasible without the need for additional negotiations between the parties. Standardization does not necessitate that all devices on the market possess identical characteristics. In practice, other securities, such as stocks, appear in various forms (common stocks, preferred shares, bearer shares, registered shares, etc.). Similarly, there are numerous types of tokens with distinct properties. This does not imply, however, that tokens are not "standardized" under Article 4(1) (44) of MiFiD2. It is not required that all tokens from various issuers be standardized, which means that certain 'typical' tokens circulate on the markets. Rather, the purpose of the standardization requirement is to exclude securities that have been customized for specific consumers, as doing so would create market volatility. The standardization requirement is met if all tokens in a particular ICO are of the same type, or if the ICO contains distinct classes of tokens that are easily distinguishable and therefore negotiable. Typically, this is the case with ICOs. Additionally, the fact that tokens are sometimes purchased in increments is irrelevant. The reason for this is that the subscription interface frequently requests the subscriber's investment amount, which is then converted into token fractions. The same principle applies to the acquisition of exchange-traded funds (ETFs). However, 'standardization' does not necessitate the complete exchange of the units in question. Even if token increments are transferred, they remain identifiable and therefore standard.

Again, after having assesed its consistency to the *Howey Test* as required by the U.S. Securities Regulation regime, the blockchain-based SPV appears to adhere to the notion of *Transferable Securities* in place in the EU. Indeed, being the issued investment token transferable, negotiable, standardized and potentially operating on a secondary market which could be compliant to the definition of "capital markets", the potential public of investors would be granted with the set of rights listed in the *2014/65/UE*[124] when dealing with RE investments through DAO-like SPVs within the EU territory. Obviously, the same conclusion could not be drafted for other types of DAOS and it is therefore not intended to set as a generally applicable rule. In fact, for investments through DAOs to be subject to the investor protection regimes of the United States and the European Union, the

[123] It entails the creation of protocols to guide the development of a product or service based on the consensus of all industry stakeholders. The standards ensure that goods and services produced in a particular industry are of consistent quality and comparable to other comparable goods and services produced in the same industry.

[124] Source - *MiFID II e MiFIR: la nuova Direttiva 2014/65/UE ed il nuovo Regolamento (UE) n. 600/2014* - 2014

underlying smart contracts must conform to the aforementioned specifications. In other words, the objective would be to align the *wet code*, or nationally accepted set of principles, with the *dry code* inherent to the smart contract. Despite the current impossibility of standardizing an already incomplete regulation regarding investments through DAOs, it is interesting to observe that the proposed SPV has the basis to be ruled by the US and EU regimes for investors' protection. This finding would render this innovative form of financing RE generators more credible and reliable, thus allowing to combine an efficient and "SMEs-friendly" form of fixed-income investment (under the perspective of the decentralized lenders) with a concrete and applicable set of rules for safeguarding the individuals involved.

CHAPTER III – "*CENTRALE DEL LATTE DEL MOLISE*" Case Study: Investment Simulation in a Proprietary RE Generator via DAO

As the worldwide drive towards decarbonization gains momentum, it becomes imperative for small and medium energy-intensive businesses to investigate sustainable alternatives and contribute actively to the Energy Transition. Emerging technologies, such as DAOs, in conjunction with currently available incorporation structures, however, offer new financing options for renewable energy projects. In fact, after having described the structuring process in the second chapter, the purpose of this research is to evaluate the concrete viability of blockchain-based SPVs as a potential solution for integrating manufacturing SMEs into the Energy Transition. Specifically, this study focuses on an Italian SME operating in the dairy industry, encompassing the processing of milk and its derivatives, the production of dairy products, heat treatment activities, and the bottling of raw milk. By virtue of its established reputation, "*Centrale del Latte del Molise*" is likely to offer a promising opportunity to investigate the viability of a blockchain-based SPV for simulating the financing of an already existing proprietary RE generator[125]. The mission of *Centrale del Latte del Molise* is centered on sustainability and environmental stewardship. As part of its commitment to the sustainability goals of the United Nations, the company aims to reduce its environmental impact. It envisions operating a facility with zero CO2 emissions, utilizing cutting-edge technologies and procedures to achieve this lofty objective. By investing in the development and implementation of an advanced system, *Centrale del Latte del Molise* aims to pioneer the integration of existing technologies. This strategy is consistent with the company's commitment to creating a positive environmental impact and achieving carbon neutrality.

Overall, Centrale del Latte del Molise is a major player in the dairy industry due to its rich history, steady growth, and commitment to sustainability. The company's dedication to its Molise roots, commitment to quality, and aspirational goals for a sustainable future position it favorably in an ever-changing market.

The findings of this study have the potential to inform policymakers, industry stakeholders, and SMEs operating in energy-intensive sectors regarding the viability and applicability of blockchain-based SPVs in advancing sustainable development and Energy Transition objectives.

[125] In 2018, the company financed, through equity, bank debt and non-repayable government incentives, a plant to make serum released in the milk process an effective input for the production cycle.

3.1 Research Question & Company Overview: assessing the suitability of "Centrale del Latte Del Molise" as a Project Promoter

The present case study answers the following research question: "Are blockchain-based SPVs a feasible and workable investment solution for allowing energy-intensive SMEs to become promoters of RE projects?". It should always be borne in mind that, being the present study a simulation, it showcases an investment in a RE plant which the company already financed in 2018. As known, the innovation relies on the way of funding such a plant whose characteristics, which will be described throughout the current chapter, have been presented to the undersigned by insiders.

Therefore, from now on, the investment project will be defined as "*Serum Recovery Cycle Initiative*" and displayed as if it has never contemplated before for the only purpose of answering the research question.

However, it is necessary to firstly present the target company and to assess its suitability to the thesis topic before delving into the workability section.

Centrale del Latte del Molise is a dairy company with an extensive history. In 1963, Nicola Sassano founded the company, which is now led by his son Francesco. The company has transitioned from an artisanal enterprise to a small-scale industry over the years. It made substantial progress on the Italian market by forming partnerships with major distributors. With a strong emphasis on its Molise roots, *Centrale del Latte del Molise* places a great deal of importance on family and the surrounding area. This dedication is reflected in its flagship products, which use only milk sourced locally. The company is extremely proud of its Molise heritage and aims to highlight it through its products.

The company's revenue has grown consistently and has reached approximately 42 million euros in 2022. The success of the company can be attributed to its wide range of activities. It employs approximately 90 people who are involved in various facets of the business.

The company's operations include logistics tasks such as storage, warehouse management, material handling, and inventory management. It also includes the manufacture of dairy products and maintaining of machinery. In addition, *Centrale del Latte del Molise* is responsible for outbound logistics, including the storage of finished goods, management of materials, and order processing. The marketing and sales departments play a crucial role in the promotion and distribution of the company's products. Complementing these primary activities are secondary functions that contribute to the company's overall success. These include procurement, in which *Centrale del Latte del Molise* obtains raw materials from reputable vendors. Research and development are essential for driving innovation and improving product quality. The company also prioritizes efficient human resource management, including recruitment and employee training.

Centrale del Latte del Molise primarily operates within Italy and reaches its customers through extensive retail distribution channels. However, the company's reach extends well beyond national borders, with exports to numerous regions around the globe. It ships its products to the United States, Europe (France, Spain, Switzerland, Austria, Germany, Netherlands, Portugal, Poland, Latvia, and Sweden), Africa, and Asia (China and South Korea). The company has established itself on both domestic and international markets with great success.

Other southern Italian businesses compete with *Centrale del Latte del Molise* in the fiercely competitive dairy industry. Its main competitors include *Sabelli SPA, Delizia SPA, and Capurso Azienda Casearia SPA*. These businesses, such as *Centrale del Latte del Molise*, aim to gain market share and satisfy consumer demands for high-quality dairy products.

As highlighted by the company's own Mission Statement, commitment toward sustainability is a key point in determining the company's suitability as a candidate for the proposed investment solution. In general, four criteria can be adopted to determine, both autonomously and thanks to insiders' descriptions, whether or not the present company can be considered as a suitable project promoter both in terms of potential token buyers' attractiveness and from a purely operational point of view:

I. **Company Reputation.** Local and foreign investors always pose an eye on the credibility of the company they want to invest in. Although in this peculiar case the financial resources would be addressed to the SPV, which is a separate legal entity, socially aware stakeholders would not ignore the mother company commitment to sustainable and green economy initiatives. Within the case of *Centrale Del Latte Del Molise*, in order to meet the challenges of the market and improve the use of resources, the company, through a combination of new advanced technologies to improve production in both efficiency and quality, manages to achieve reductions in the consumption of methane gas, electricity and water, leading it to be an integrated factory 4.0[126]. The company, aims at developing a serum recovery cycle, designed to valorize precisely the main sub-product of production. The interview held with the energy engineer Dr. Marco Pula helps to better understand the overall recycling process: " "*Through milk serum, the company is able to set up an almost entirely circular production cycle: the watery part of the milk serum, after being purified of solid waste, is reused in the production process of milk derivatives while the waste itself, conveyed to a special container*

[126] In 2018, the company financed, through equity, bank debt and non-repayable government incentives, a plant to make serum released in the milk process an effective input for the production cycle.

full of bacteria, is anaerobically digested to produce bio gas useful for generating additional electricity."

II. Favorable Regulation. The Law Decree n. 58/1998, also known as TUF[127], is an important piece of Italian legislation that consolidates numerous financial laws and regulations. Consequently, the securities regulation pertaining financial instruments as defined by MiFiD II and derived directly from EU Regulation 596/2014 is transmitted to the TUF, which functions as the cornerstone of Italy's financial regulatory framework. TUF contains several provisions concerning financial activities, such as Scope and Purpose[128], Financial Intermediaries[129], Investor Protection[130], Securities and Market[131], Supervision and Enforcement[132], and Administrative Sanctions[133]. If it has been previously established that the tokens issued by the DAO-like SPV can be defined as "Transferable Securities," then the integration and conveyance of this specific case within the TUF should occur automatically.

III. Off-Takers Availability. Once a renewable energy facility has been built and is generating revenue in Italy, it is usually straightforward to find electricity purchasers. Italy has a well-developed electricity market and rules that stimulate the use of renewable energy, generating

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[127] Testo Unico sulla Finanza.

[128] TUF regulates various facets of financial activities, such as the administration and operation of financial markets, investor protection, and the behavior of financial intermediaries. Its primary purpose is to assure market integrity, market transparency, and the proper operation of the financial system.

[129] TUF establishes regulations for financial intermediaries such as banks, investment firms, and asset management firms. It establishes licensing requirements, prudential regulations, business conduct rules, and disclosure requirements for these entities.

[130] TUF prioritizes investor protection. It establishes standards for the provision of investment services, including the obligation to act in clients' best interests, disclose pertinent information, and ensure that financial products are suitable for investors. Additionally, TUF establishes regulations for the distribution and marketing of financial instruments to retail investors.

[131] TUF regulates the requirements for the issuance, trading, and disclosure of securities. It regulates public offerings, prospectus requirements, market abuse (insider trading and market manipulation), as well as the operation of regulated markets and multilateral trading facilities.

[132] TUF designates CONSOB (*Commissione Nazionale per le Società e la Borsa*) and the Bank of Italy as the regulatory authorities responsible for supervising and enforcing financial regulations in Italy. These authorities have the authority to supervise financial intermediaries, impose penalties for noncompliance, and assure adherence to TUF's provisions.

[133] The TUF stipulates a variety of administrative sanctions for violations of financial regulations. These sanctions may consist of fines, suspensions, license revocations, and other penalties. The severity of the punishment is proportional to the nature and gravity of the violation.

advantageous conditions for the sale of generated electricity. The Energy Market Operator (GME)[134] is the primary mechanism for selling renewable energy in Italy. The GME manages the energy exchange platform where producers can sell their electricity. Renewable energy producers can sell their electricity at market prices by participating in market segments like the Day-Ahead Market and the Intraday Market. Furthermore, renewable energy producers can enter into PPAs with a variety of Italian entities participating in renewable energy procurement, including energy firms, industrial and commercial sectors, public sector and government bodies[135]. As explained in Chapter II, the latter solution is the one which is viable for the present case.

IV. **Equity Contribution Affordability.** Concerning the "*Serum Recovery Cycle Initiative*", the debt component within the SPV will cover 60% of the overall capital structure, hence allowing the mother company to fund the 40% equity portion while the payback of third parties' services[136] would be accomplished through specific company reserves addressed for this scope. In the case of *Centrale del Latte Del Molise*, the company started from 2019 a capital accumulation plan worth a total of 18 million € also with the aim of integrating new technologies to adapt production to Integrated Factory 4.0 standards.[137]

Considering these criteria, *Centrale del Latte del Molise* emerges as a suitable project promoter for the "*Serum Recovery Cycle Initiative*". Its solid reputation, commitment to sustainability, supportive regulations, access to off-takers, and financial resources indicate that it is prepared to accept the challenge of promoting a renewable energy initiative. Centrale del Latte del Molise can further enhance its role in the Energy Transition and contribute to a sustainable future by leveraging blockchain-based SPVs.

3.2 Methodology

A thorough blend of financial and project-specific inputs were sourced in the methodological approach used to present and gather results from the case study, including insights from corporate

[134] GME website.

[135] By purchasing renewable energy for their operations, industries like Fiat Chrysler Automobiles and retail chains like Esselunga have demonstrated their commitment to reducing their carbon footprints. (Source: EsmMagazine – 2022).

[136] Examples of third-parties services for the DAO-like SPV could be the blockchain code generators.

[137] Source: Francesco Sassano – owner.

insiders, particularly the organization's CEO. This systematic approach revolved around simulating an already existing investment scenario through the utilization of a blockchain-based SPV. Hence, the methodology of this study is structured into two distinct phases, each serving a crucial role in answering the central research question: "*Are blockchain-based SPVs a feasible and workable investment solution for enabling energy-intensive SMEs to become promoters of RE projects?* "

The initial phase, named as the Preparation Phase, includes several crucial features critical to the successful operation of the blockchain-based SPV. This phase encompasses the design and implementation of the project's specific smart contracts, which serve as the fundamental foundation for the SPV's activities. The specific areas addressed within this phase include the SPV's incorporation and capital structure, interaction dynamics with off-takers, token issuance and distribution strategies, the transparent determination of interest rates, conditions for anticipated SPV termination, and a comprehensive summarizing table outlining the specifications and key agreements of the project - "*Serum Recovery Cycle Case Initiative*" - promoted by the focal company, "*Centrale Del Latte Del Molise*". These aspects work together to build the framework for the subsequent execution phase.

Furthermore, the following phase, referred to as the Execution Phase, is critical to comprehending the financial complexity of the blockchain-based SPV. This stage requires developing three distinct financial schedules: The Decentralized Lenders Debt Repayment Schedule, the Profit and Loss Statement (P&L), and the Cash Flows Estimation. These schedules allow for an in-depth evaluation of the project's financial performance, offering insights into profitability and financial sustainability. The Debt Repayment Schedule outlines the timetable and amounts for repaying decentralized lenders, the P&L statement provides a thorough overview of the SPV's financial performance, and the cash flow estimation assists stakeholders in determining available cash flows and assessing the project's financial viability.

By adopting this comprehensive methodology, which integrates both the Preparation and Execution Phases, the study aims to provide a holistic assessment of the feasibility and viability of utilizing blockchain-based SPVs as an investment solution for energy-intensive SMEs seeking to promote renewable energy projects. The ensuing sections delve further into the specifics of these phases, offering a detailed analysis of the design, functioning, and financial aspects of the SPV's operation.

3.2.1 Preparation Phase: designing the SPV underlying Smart Contracts

In the preparation phase of the DAO - like SPV issued by "*Centrale Del Latte Del Molise*" to fund the "*Serum Recovery Cycle*" project, the design and implementation of smart contracts together with the underlying mobilization, settlement and collateralization mechanisms described in paragraph

2.2.1 play a crucial role in ensuring the SPV's straightforward and efficient operation. This section will delve into the specifics of the smart contracts that underpin the SPV, focusing on key aspects such as the SPV's incorporation and capital structure, interaction with off-takers, token issuance and distribution, interest rate determination and SPV termination conditions. The contents of the smart contracts will be prioritized over their literal coding. Although, by simply comprehending the operation of these smart contracts, it is possible to gain insight into the fundamental elements governing the procedure and governance of the blockchain-based SPV during its preparation phase.

I. **Incorporation & Capital Structure.** The SPV is the project's selected incorporation structure, for which ADGM[138] released a flawless guide of how to pursue an application form[139]. Naturally, The SPV overall process will have to be adapted by blockchain designers[140] to the present case. As generally known, the SPV is recognized as a distinct legal entity created for a specific purpose, in this instance the "*Serum Recovery Cycle Initiative*" project. The SPV provides a distinct legal and financial framework that isolates the risks and liabilities of the project from those of its shareholders or sponsors, in the particular case of "*Centrale Del Latte Del Molise*". It has to be noted that he Ministry of the Environment and Energy Security (MASE) published *Decree No. 23 on January 13, 2023*[141], which approves the Application Rules, including annexes and appendices, for accessing incentives for biomethane fed into the natural gas grid. These provisions were introduced by the Ministerial Decree (MiTE) of September 15, 2022, which defines the incentive rules for biomethane production. The Measure is a component of the actions envisioned in the PNRR: "Development of biomethane, according to criteria for the promotion of the circular economy" (*Mission 2, Component 2, Investment 1.4*)[142] to support biomethane production via the

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[138] ADGM.com

[139] Source: *SPV Incorporation Guide* - ADGM

[140] A blockchain designer develops decentralized applications (dApps) and smart contracts based on blockchain technology, as well as understanding the architecture and protocols of the technology.

[141] A sum of €1,730,400,000 for the following purposes: to support the construction of new biomethane production facilities; to convert and improve the efficiency of existing agricultural biogas plants towards the production of biomethane for transport, industry and heating. The biomethane must comply with the criteria set forth in the Renewable Energy Directive (EU) 2018/2001 (RED II Directive) in order for the measure to comply with the "do no significant harm" principle and the relevant requirements of Annex VI, footnote 8, of Regulation (EU) 2021/241; Document signed with digital signature, pursuant to Legislative Decree No. 82 of March 7, 2005 and D.P.C.M. February 22, 2013, as amended. - the remaining part of the above sums amounting to 193,000,000 euros for the implementation of circular economy interventions.

[142] PNRR - M2C2 – Investment Line 1.4.

construction of new plants or the conversion of existing complexes. Regarding this measure and based on the PNRR's available resources, two modes of facilitation will be used to provide incentive grants: Capital contribution[143] and Incentive Tariff[144]. In light of this initiative, and assuming the "*Serum Recovery Cycle Initiative*" will be considered eligible for it also counting on its blockchain framework[145], the remaining portion to be financed through private resources would be the 60% of the overall Capex. The total project capital expenditure to be financed amounts to 15 million €, with 6 million € financed via *Investment Line 1.4*, 7.8 million € funded through the company's capital reserves, thus figuring in Centrale Del Latte Del Molise own balance sheet, while leaving to the DAO-like SPV the remaining 1.2 million € respecting a D/E ratio of 1.5[146].

SPV BALANCE SHEET	
SOURCE OF FUNDS	USE OF FUNDS
DEBT 720.000,00 €	**COGENERATOR** 400.000,00 €
EQUITY 480.000,00 €	**DIGESTOR** 400.000,00 €
	BUILDING 400.000,00 €
1.200.000,00 €	**1.200.000,00 €**

SPV Balance Sheet – Source: *Own Elaboration* – 2023

II. **Interaction with Off-Takers.** A 10-year build–own–operate and take-or-pay power purchase agreement concerning the excess energy produced by the plant at a fixed tariff of *236€ / MWh*[147] is then assumed to be negotiated and signed off-chain between the independent power

[143] A fee equivalent to 40% of the expenses incurred exclusively for the design and implementation of the intervention with reference to the receipted payments falling within the eligible expenses pursuant to Article 8, paragraph 2, of the Ministerial Decree of September 15, 2022, within the maximum eligible costs defined in Annex 1 of the Decree, will be recognized.

[144] It is anticipated that a fee will be paid for biomethane produced net1 and fed into the grid. The Decree specifies two categories of incentive tariff mechanisms: all-inclusive tariff (TO) and premium tariff (TP).

[145] AI, Blockchain, IOT Fund.

[146] Being the debt financing provided by the decentralized lenders collateralized to the SPV and linked to the PPAs, its amount should be proportioned to the cash flows generated by the plant in order to pay them back.

[147] Source: "*Bio - Gas Done Right*" - 2020.

project and several off takers, including manufacturing industries, large co-ops, homes, etc., despite the assumption that the machinery will last forever[148]. The parties are incentivized to engage into a fixed tariff contract because it is mutually advantageous for them to hedge their exposure to the spot price volatility of the deregulated electricity market, since high prices are advantageous for the generator but detrimental for the consumer and vice versa. We assume that the smart contract agreement between the shareholders and the off-takers includes a weekly payment frequency, a maintenance margin equaling 150% of the subsequent week's payment, and a default penalty payment settled at *100 € / MWh* €.

III. **Token Issuance and Distribution.** After signing the power purchase agreement, Centrale Del Latte Del Molise, in its capacity as a shareholder, raises the funds necessary for the project to reach financial close by launching a security token offering program on the blockchain SPV and allocating 1,200,000 security tokens at a price of €1 each.[149] The shareholder holds 480 thousand tokens (€ 480,000) in accordance with its off-chain equity stake in the SPV. The remaining 720 thousand tokens (€ 720,000) are then sold to the public via the blockchain SPV platform[150]. By interacting with the blockchain smart contract, they can redeem directly a portion of the project's future revenues in utility tokens using these security tokens. The smart contract autonomously collects and allocates the revenue payments of the off-takers to each investor. The investors' share of the revenue is proportional to the number of security tokens they hold in the smart contract. Consequently, investors can periodically request a withdrawal from their smart contract accounts. Evidently, revenue distribution to investors is governed by the smart contract's loan agreement, which prioritizes payment to decentralized lenders based on the DSCR[151], which in this case is 1.23x. One intriguing possibility would be the prospect of trading on a secondary market[152] the security tokens representing debt investment

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[148] Being the "Serum Recovery Cycle" a project whose aim is to revolutionize the production process of "Centrale Del Latte Del Molise", its life is assumed to have an infinite basis such as the company itself. At the end of the 10th Year it is supposed that: the PPA agreements will be renegotiated and maybe renewed with the former counterparties and there will be no outstanding initial debt left; The company's self-consumption rate will be from 100%. Hence, the company will start being the sole beneficiary of the electricity produced.

[149] At this price, the total value of the tokens is €20 million, matching the total investment cost of the project.

[150] For simplicity, it is assumed just one class of lenders.

[151] EBIT/ Debt Repayment.

[152] For example, platforms like OpenFinance, tZERO, or Polymath facilitate the trading of security tokens on secondary markets. These platforms leverage blockchain technology to provide secure and efficient trading infrastructure, enabling

in the "*Serum Recovery Cycle*" SPV. By facilitating the trading of security tokens on secondary markets, the blockchain-based SPV provides lenders with liquidity and tradability. It allows them to exit their positions or transfer their interests in a compliant and transparent manner.

IV. Interest Rate Determination. To attract decentralized lenders and secure the required capital for the project, it is essential to establish a fair and transparent system for determining interest rates. For this purpose, it will be made use of the table below, showing the proper formula for determining interest rates in the context of RE SPVs:

CoD = European RfR + CDS + PS	1. European RfR: Risk-free Rate at EU-level 2. CDS: 10-year Credit Default Spread of the Examined Country 3. PS: Renewable Energy Project Spread

Interest Rate Determination for SPVs – Source: *Risk-based analysis and policy implications for renewable energy investments in Greece*– 2017

In the present case, debt would be fully repaid after 10 years and data referred to 10 years European RFR and CDS will be extracted respectively from *World Government Bonds*[153] website and *Damodaran*'s table[154]. Concerning the RE project spread, *Edbodmer*[155] website has allowed to define a range of 2% - 4%. Considering the small scale of the project:

$$CoD = 2.43\% + 3.79\% + 3\% = \mathbf{9.22}\%$$

V. Conditions for anticipated SPV Termination. Emphasis must be placed on the extraordinary causes of SPV termination and the anticipated liquidation of project assets for lenders repayment in order to safeguard all parties and ensure clarity. Conditions may include significant off-takers insolvency or bankruptcy, material breach, lack of regulatory or legal requirements, and events of force majeure. If the SPV confronts insolvency or bankruptcy, provisions for initiating the termination process must be in place. This may entail the sale of

investors to buy, sell, and trade securities tokens representing ownership in various projects, including renewable energy initiatives.

[153] Source: *worldgovernmentbonds.com* - 2023

[154] Source: *Country Default Spread and Risk Premiums* - 2023

[155] Source: *Interest Rate and Credit Spread Analysis from FRED* - 2023

project assets in order to repay decentralized lenders. Termination may also be triggered in the event of a material breach of the SPV's contractual obligations, such as a significant violation of the project agreement or default on critical terms. This would necessitate the orderly liquidation of assets to satisfy the repayment requirements of the lenders. Additionally, termination may be required if the SPV fails to comply with applicable regulatory or legal requirements. This may involve environmental regulations, licensing, permits, or other legal requirements. The liquidation procedure would then be initiated in order to satisfy the creditors' repayment obligations. Finally, events beyond the SPV's control, such as natural disasters, terrorist attacks, or political disturbance, may result in termination. In such situations, the liquidation of assets would be required to ensure that creditors are repaid to the greatest extent possible under the circumstances.

The preparation phase of the blockchain-based SPV not only establishes a robust framework for the "*Serum Recovery Cycle*" project by resolving these critical aspects in the design and implementation of smart contracts, but it also guarantees transparency and efficiency. These smart contracts provide a firm, transparent and immutable foundation for governing interactions with off-takers, facilitating token issuance and distribution, determining interest rates, and defining the conditions for SPV termination.

The table below summarizes the project specifications, the power purchase agreements and the loan schedule in detail:

SPECIFICATION AND KEY AGREEMENTS OF "*SERUM RECOVERY CYCLE*" CASE STUDY

Project Specifications	**SPV Input**
Power Technology	Bio - Mass
Total Capital Expenditure	€ 1.200.000
Annual Operating Expenditures (% Revenues)	5%
Plant Lifetime Value (in Years)	25
Tax Rate	24%
Power Purchase Agreement	
Tariff	236 €/MWh
Duration	10 years
Supply Agreement	take-or-pay
Delivery Mechanism	build-own-operate
Loan Agreement	
Gearing Ratio	60:40
Alloted Tokens	1,2 Million
Token Price	€ 1
Loan Tenure	10 years
Interest Rate	9,22%
Debt Service Coverage Ratio	1.23x

Specification and key agreements of "Serum Recovery Cycle" Case Study – Source: *Own Elaboration* – 2023

The following paragraph will plunge into a quantitative analysis, providing valuable insights into the financial aspects of the project, from cash flows estimation to payoff assessment.

3.2.2 Execution Phase: Cash-Flows estimation and Pay-Offs assessment

As the blockchain-based SPV for the "*Serum Recovery Cycle*" project approaches its execution phase, it is critical to formulate the three financial schedules involved. Each of these provides vital insight into the financial performance of the project, ensuring responsible financial management and aiding decision-making processes:

- **Debt Repayment Schedule to Decentralized Lenders**. The debt repayment plan is a critical financial feature of the blockchain-based SPV that sets the timetable and amounts for repaying primarily the decentralized lenders. This schedule displays the agreed-upon interest rates and loan length, providing a clear grasp of the debt payment obligations. By sticking to this timetable, the SPV ensures regular and consistent repayments, thereby preserving a strong relationship with its lenders.

- **Profit and Loss Statement (P&L):** The Profit and Loss Statement offers an extensive overview of the SPV's financial performance, including revenues, expenses, and net income. It covers operating expenses, taxes, and other costs connected with running the renewable energy project, as well as revenue sources such as power purchase agreements with off-takers. The P&L is an important roster for evaluating the project's profitability and financial health, allowing stakeholders to make informed decisions and assess the project's viability. The SPV can find areas for cost minimization, revenue development, and overall financial performance improvement by reviewing the P&L statement.

- **Cash Flow Estimation**: Cash flow estimation is a critical component of the SPV's financial planning, comprising both Free Cash Flow to Firm (FCFO) and Free Cash Flow to Equity (FTE). FCFO indicates the cash flows accessible to all stakeholders, including lenders and shareholders, after operating expenses, capital expenditures, and taxes are deducted. FTE, on the other hand, reflects the cash flows available to the SPV's equity owners after servicing debt obligations. Accurate cash flow estimation is critical for analyzing the project's financial sustainability, determining the ability to pay debt obligations, and distributing returns to shareholders in the form of self-consumption of the energy produced.

Hence, The SPV can carefully navigate its financial responsibilities, optimize profitability, and maintain a sound financial footing throughout the project's lifecycle by relying on the inputs provided which would be guaranteed by the in-built smart contracts. Results are as follows:

Blockchain Loan Schedule	0	1	2	3	4	5	6	7	8	9	10
VA	**720.000,00 €**	138.384,00 €	131.745,60 €	125.107,20 €	118.468,80 €	111.830,40 €	105.192,00 €	98.553,60 €	91.915,20 €	85.276,80 €	78.638,40 €
i	**9,22%**										
Dr	720.000,00 €	648.000,00 €	576.000,00 €	504.000,00 €	432.000,00 €	360.000,00 €	288.000,00 €	216.000,00 €	144.000,00 €	72.000,00 €	0,00 €
CI		66.384,00 €	59.745,60 €	53.107,20 €	46.468,80 €	39.830,40 €	33.192,00 €	26.553,60 €	19.915,20 €	13.276,80 €	6.638,40 €
CC		72.000,00 €	72.000,00 €	72.000,00 €	72.000,00 €	72.000,00 €	72.000,00 €	72.000,00 €	72.000,00 €	72.000,00 €	72.000,00 €
Debt Tokens number	**720.000,00**										
Price x Token	**1,00 €**										
Yearly Token Pay-off		**0,19 €**	**0,18 €**	**0,17 €**	**0,16 €**	**0,16 €**	**0,15 €**	**0,14 €**	**0,13 €**	**0,12 €**	**0,11 €**

P&L	0	1	2	3	4	5	6	7	8	9	10
Revenues		203.904,00 €	203.904,00 €	203.904,00 €	203.904,00 €	203.904,00 €	203.904,00 €	203.904,00 €	203.904,00 €	203.904,00 €	203.904,00 €
OPEX		10.195,20 €	10.195,20 €	10.195,20 €	10.195,20 €	10.195,20 €	10.195,20 €	10.195,20 €	10.195,20 €	10.195,20 €	10.195,20 €
EBITDA		**193.708,80 €**	**193.708,80 €**	**193.708,80 €**	**193.708,80 €**	**193.708,80 €**	**193.708,80 €**	**193.708,80 €**	**193.708,80 €**	**193.708,80 €**	**193.708,80 €**
Depreciation		48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €
EBIT		**145.708,80 €**	**145.708,80 €**	**145.708,80 €**	**145.708,80 €**	**145.708,80 €**	**145.708,80 €**	**145.708,80 €**	**145.708,80 €**	**145.708,80 €**	**145.708,80 €**
NOPAT		**110.738,69 €**	**110.738,69 €**	**110.738,69 €**	**110.738,69 €**	**110.738,69 €**	**110.738,69 €**	**110.738,69 €**	**110.738,69 €**	**110.738,69 €**	**110.738,69 €**
EAT		**60.286,85 €**	**65.332,03 €**	**70.377,22 €**	**75.422,40 €**	**80.467,58 €**	**85.512,77 €**	**90.557,95 €**	**95.603,14 €**	**100.648,32 €**	**105.693,50 €**

DCF MODEL	0	1	2	3	4	5	6	7	8	9	10
NOPAT		110.738,69 €	110.738,69 €	110.738,69 €	110.738,69 €	110.738,69 €	110.738,69 €	110.738,69 €	110.738,69 €	110.738,69 €	110.738,69 €
Depreciation		48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €	48.000,00 €
CAPEX	1.200.000,00 €										
FCF	**-1.200.000,00 €**	**158.738,69 €**	**158.738,69 €**	**158.738,69 €**	**158.738,69 €**	**158.738,69 €**	**158.738,69 €**	**158.738,69 €**	**158.738,69 €**	**158.738,69 €**	**158.738,69 €**
IRR	**5%**										
EAT		60.286,85 €	65.332,03 €	70.377,22 €	75.422,40 €	80.467,58 €	85.512,77 €	90.557,95 €	95.603,14 €	100.648,32 €	105.693,50 €
Debt Repayment	720.000,00 €	-72.000,00 €	-72.000,00 €	-72.000,00 €	-72.000,00 €	-72.000,00 €	-72.000,00 €	-72.000,00 €	-72.000,00 €	-72.000,00 €	-72.000,00 €
FCFE	**-480.000,00 €**	**36.286,85 €**	**41.332,03 €**	**46.377,22 €**	**51.422,40 €**	**56.467,58 €**	**61.512,77 €**	**66.557,95 €**	**71.603,14 €**	**76.648,32 €**	**81.693,50 €**
IRR	**3%**										
Self Consumption Rate (% Revenues)		18%	20%	23%	25%	28%	30%	33%	35%	38%	40%
Self Consumption Rate - Sundays (% Revenues)		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Self Consumption Rate - Excl. Sundays (% Revenues)		**20%**	**23%**	**26%**	**29%**	**32%**	**35%**	**38%**	**40%**	**43%**	**46%**

Cashflows estimation and pay-offs assessment schedule – Source: *Own Elaboration* – 2023

3.3 Main Findings & Discussion

The results obtained provide a sound basis for answering the research question of the present work, namely, whether blockchain-based SPVs are not only a feasible alternative for raising external debt capital but also, and more importantly, whether such a solution is workable for *Centrale Del Latte del Molise* and, more generally, for any energy-intensive SME interested in undertaking such a project. Analyzing its feasibility is simpler and more straightforward, however, it is necessary that the external exogenous factors, first and foremost the legal framework inherent to investor protection presented in the preceding paragraphs, is favorable and suitable for the inclusion of DAO-like SPVs within it. If ever the answer were to be affirmative, it can be asserted that raising capital by issuing debt-tokens in order to bridge the project's financing gap is an obviously beneficial alternative both for the sponsoring company, which would benefit from a pool of international investors and make up for all the shortcomings associated with traditional SBL crowdfunding, and for the decentralized holders of such debt instruments. The latter would benefit from relatively high interest rates, up to *9.22%* in this specific case, and less risk, due to the execution guarantees, including the eventual automatic termination, allowed by the smart contracts inherent in the blockchain, compared to traditional debt investment in sovereign and corporate bonds. More importantly, it would give retail investors access to a credit market that until now has been marked by a monopolistic presence of commercial banks and other traditional financial intermediaries.
To conclude whether such an initiative is, however, always workable for each enterprise that puts it in place, it is good to break down the matter into several subparts, listed below:

I. Trade-off among self-consumption of produced energy and disposal of external collateralized capital. This trade-off is a central issue in assessing the workability of the specific project. In fact, since the debt is collateralized to the cash flows, which in turn are linked to PPAs agreements, it is logical to expect that the consumption of the energy produced will be subordinated to the repayment of the debt installment year after year, until its expiration. In the specific case of the "*Serum Recovery Cycle Project*," taking into account the business shutting set for each Sunday of the year, during the other days of the week between project inception and closure the company will be able to consume an increasing amount of energy produced up to almost 50% of revenues forecasted for the tenth year[156]. In absolute terms, this value per se could be positive for some SMEs but limiting for others, just as in the case of

[156] It is important to note that, unless there won't be a further capital increase after the loan tenure date is reached, once the debt outstanding is fully repaid, the company will finally be able to consume its energy entirely.

Centrale Del Latte Del Molise. Indeed, considering that out of a total investment of €9 million, whose 80% is reported on the company's balance sheet, the tokenized debt consists of only 8% of the total, for such a small contribution it would arguably be preferable to opt for an alternative financing solution that does not sacrifice more than half of the energy produced for pay back purposes.

It should be added, however, that the power technology adopted, even after deducting the cost for installing the dedicated building, is itself historically and still inefficient when compared with wind and solar power plants in terms of MW generated per euro invested.[157]

II. Availability of alternative capital sources. The issue of trade-off is inextricably linked to the theme of alternative sources of capital. Indeed, it should not be forgotten that structuring an SPV via blockchain is an innovative proposition that, before becoming completely stand-alone over time, will likely remain complementary to other better-known forms of capital injections. In fact, the project in question still relied on a capital allocation from the Italian National Plan Di Recovery e Resilience, which, in the current assumption, allowed for € 6 million in non-repayable funding as well as for the sale of the energy produced through a premium tariff equivalent to € 236/MW. What's more, according to Francesco Sassano's statement: "*At the time of the project, in addition to the financing through capital reserves and the financing granted towards various European incentives, I obtained a 30-year bank loan directly recorded on the company's balance sheet.*" It is evident that for a company with a € 42 million turnover the traditional alternative of bank debt persists, despite the fact that the purpose of this thesis paper is precisely to formulate a financing model that goes beyond the involvement of bank intermediaries since, as already explored in the previous paragraphs, they are generally reluctant to lend money to small and medium-sized companies for projects of this magnitude. Nevertheless, even this aspect still prompts the determination that the blockchain solution, for the company and the project in question, is not workable.

III. Multiple Shareholders for fostering project scalability. In the context of renewable energy projects, scalability refers to a project's ability to increase its energy production capacity more than proportionally to the amount of investment or funding. As a result, depending on the specific technology, project design, and market conditions, it is feasible for renewable energy projects. Because of technological breakthroughs, economies of scale, and better efficiency, several renewable energy systems, such as solar and wind power, have exhibited scalability.

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[157] Source: *Costi di produzione di energia elettrica da fonti rinnovabili* – 2013.

As these technologies improve, the cost of energy per unit falls, making larger projects more economically viable. Scalability is also applicable to biomass-based renewable energy projects, such as the one under consideration. However, the degree of scalability might vary depending on a number of factors, technology advances[158], feedstock availability[159] and logistics[160] above all. This is the reason why formulating the presence of multiple shareholder-companies, in this case peers of *Centrale Del Latte Del Molise*, operating in the same industrial cluster, would favor additional equity capital to finance a RE plant with efficiency greater than 0.1 MW/h while ensuring relatively few difficulties in terms of logistics. Indeed, the issue of energy sharing in the context of industrial clusters acting like proper energy communities turns out to be central.[161] Consequently, the blockchain system inherent to the SPV would be further enriched by smart contracts concerning internal governance and thus the regulation of shareholder interactions, eventually codifying, automating and making this aspect transparent as well.

In the light of the above, even if the DAO-like SPV can in all respects be feasible, it cannot be considered workable for the examined company. However, it can be said that the perfect candidate is an energy-intensive company whose turnover and balance sheet strength are not so solid as to be considered eligible for an onerous bank loan and which is therefore willing to wait several years before fully exploiting the energy produced by the RE plant. Decentralized lenders would always be protected by the blockchain since cash flows will depend on the RE plant and will be independent from the company's profitability itself. Without a doubt, this financing system can be combined with the various national and supranational incentives and then gradually become self-standing, once the incentive era comes to a definitive end, over time. The issue of multiple shareholders deserves a separate evaluation: the amount of energy self- consumed must always be evaluated and forecasted for both cases, decisions and actions will have to be taken accordingly.

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[158] Advancements in biomass conversion technologies, such as improved efficiency and cost-effectiveness, can contribute to scalability by reducing the cost per unit of energy produced.

[159] Biomass projects rely on the availability of organic materials as feedstock. Scalability depends on the consistent and reliable supply of feedstock, which may vary based on geographic location, agricultural practices, and waste generation.

[160] Scalability can be influenced by the availability of infrastructure for collecting, transporting, and processing biomass feedstock. Improved logistics can enable larger projects with increased feedstock demand.

[161] Source: *Towards the Decarbonization of Industrial Districts through Renewable Energy Communities: Techno-Economic Feasibility of an Italian Case Study* - 2023

CONCLUSIONS

In conclusion, this thesis adopted an exhaustive approach to addressing the essential limitation for definitively embarking the Energy Transition by investigating alternate methods of financing renewable energy (RE) generators. The emphasis was on Decentralized Autonomous Organizations (DAOs), which provide a promising path for actively incorporating energy-intensive small and medium-sized firms (SMEs) in the greater context of sustainable energy development by allowing them to become active promoter as equity-holders of RE projects. The research journey has been separated into key segments, each of which sheds light on a distinct component of this novel finance model.

The major goal of this research was to provide clarity and structure to the landscape of renewable energy funding, with a focus on DAO schemes. The thesis demonstrated the potential benefits of including SMEs into the Energy Transition process, hence contributing to a more inclusive and sustainable energy landscape. The case study of "Centrale Del Latte Del Molise" revealed that the implementation of blockchain-based SPVs in the form of DAOs is achievable, assumed that US and EU legislative frameworks adapt in accordance with these new models and integrate investor protection mechanisms especially by treating asset-based tokens as proper securities.

Nevertheless, it is crucial to note that the given blockchain-based SPV framework may not be applicable to all enterprises. While this study has made great progress in understanding the potential of DAOs in RE funding, more research is needed to fine-tune and optimize the model for diverse business scenarios and circumstances.

At the heart of this study has been the research question, "Are blockchain-based SPVs a feasible and workable investment solution for allowing energy-intensive SMEs to become promoters of RE projects?" Although the case study's limitation, referring to the excessively specific sample selected, was acknowledged, the findings suggest that DAO-based finance methods have the ability to change the energy sector. This capability extends to overcoming the inherent restrictions of the current RE financing architecture, particularly when applied to energy-intensive SMEs.

In the end, while the literature surrounding this topic is still relatively limited, the investigation of blockchain and DAO-based funding methods for RE projects represents a significant step toward reaching Energy Transition targets and significantly innovating the industry. The energy landscape may become more sustainable, inclusive, and responsive to the requirements of varied stakeholders by embracing innovation and redefining traditional financial systems. As the energy sector evolves, the ideas given in this thesis add to the ongoing conversation about redesigning renewable energy funding for a more sustainable future.

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EXECUTIVE SUMMARY

The world is at a crucial juncture in its Energy Transition, where renewable energy has become a central pillar of global energy security, economic growth and environmental protection. Despite significant progress in the deployment of renewable energy sources, the current financing architecture remains limited and hinders the ability to fully realize the potential of renewable energy and the active participation of multiple stakeholders, especially in the form of energy-intensive SMEs as project developers. The use of blockchain-based SPVs has been identified as a promising solution to the challenges faced by traditional project finance and asset securitization in the renewable energy sector. Indeed, by creating a decentralized and digitized platform for project financing, SPVs can reduce transaction costs, increase access to capital, and improve transparency and security.

It is known that the integration of renewable energy sources into the energy mix has become increasingly relevant in the face of global energy security, economic growth and environmental protection. Precisely for this reason, it is important to note that the development and operation of proprietary renewable energy RE generators is a key factor that can positively impact firm financial performance. This is true regardless of the financing method used, as building and operating proprietary RE generators can bring a range of benefits, such as reducing energy costs, improving energy security and reliability, and enhancing corporate image and reputation. In general, developing and operating their own RE generators may be extremely advantageous for energy-intensive SMEs, particularly those in the manufacturing and agri-food industries, who typically face unique challenges in securing funding and finance for renewable energy projects. Moreover, by taking control of their energy supply and generating their own renewable energy, both SMEs and Big Corps may increase their competitiveness and long-term financial stability. According to the natural resource-based view (NRBV), businesses can gain a competitive edge by carefully utilizing resources that support ecologically friendly economic activities. The NRBV serves as the theoretical underpinning for a study of the relationship between RE consumption and firm financial performance, with the objective of evaluating the strategic benefits of CSR and proactive environmental management. By incorporating RE use into their production and operational processes, businesses have the chance to gather socially complex resources to outmaneuver rivals and gain performance-based competitive advantages. However, implementing a strategy for sustainable growth like RE usage, which aims to protect natural resources for future and long-term profit, calls for a sizable investment, a long-term outlook, and a long-term commitment to market development. Furthermore, businesses would not be able to use RE to reduce the environmental cost of their growth and development without the technology advancement and infrastructure that permit its use. Therefore, in order to implement significant technology and infrastructure changes, sustainable growth also demands extensive interaction with external parties. If such conditions and parameters are met, due to better exploitation of natural resources and related capabilities established in accordance with firms' different strategic priorities of environmental sustainability, companies recognized for excellent RE use will eventually outperform their respective industry competitors. Specifically, the standard historical (ROI), a forward-looking (Tobin's Q), and the EBITDA are the financial indicators that are examined and compared among firms recognized as top RE users in the EPA's Fortune 500 Top Green Power Partners list and their industry competitors. For the purpose of measuring the financial performance of the firm, the operating margin, Tobin's Q, and firm ROI were computed using the Standard & Poor's Compustat Database, which provides easily accessible financial data for many significant U.S. companies. 60 businesses from 40 different four-digit NAICS code industries were identified. The results of the analysis showed that for each of the seven years that were looked at, the top RE partner businesses in the sample had parameter scores that were significantly higher than the industry medians.

However, at this point, it's crucial to comprehend how businesses, particularly medium-sized and small ones, can finance such massive initiatives that can revolutionize the production cycle with a green approach while also making them active participants in the energy market and the overall Energy Transition process. To do so, it is important to gauge the different financing channel currently available for RE funding. In this context, Bloomberg New Energy Finance emphasizes that financing channels in advanced economies highly depend on the stage of the sector's development. As a result, the literature review revealed that there are many different funding options available today for the renewable energy sector which are strictly dependent on the four stages of development of the renewable energy sector: (1) technology research; (2) technology development; (3) equipment manufacturing; and (4) roll-out. Public finance is highly correlated with the stage of technology research in renewable energy. The volume of public financing declines when renewable energy technology enters the development stage, and Venture Capital and Private Equity start filling the void. Consequentially, manufacturing scale-up, in the field of renewable energy, refers to bringing a technology or product for sustainable energy from the lab to the market on a bigger scale. To scale up, a manufacturing process must be thoroughly designed and optimized in order to boost productivity and volume while cutting costs. At this stage, RE firms raise equity publicly by selling their shares mainly through specific ETFs, Mutual Funds and Pension Funds or, as an alternative exit strategy, by entering into operations involving Mergers and Acquisitions (M&A). Typically, the industrial scale-up phase comes right before the focus stage of the thesis: roll-out asset finance. It is considered to be the most dangerous stage in renewable energy financing because it encompasses the commercial deployment and widespread adoption of an established technology rather than a mere improvement in the manufacturing process and in the production capacity. Indeed, while during then manufacturing scale-up phase investments are addressed to machinery upgrading and infrastructure enhancement, the goal of this stage is to fund the creation of supply chains and actuals channels of distribution which can involve multiple risks and unsuccess factors. Project finance and securitization are the two main subcategories within asset finance in renewable energy financing, both falling under the umbrella of Asset-Based Lending.

Yet, each of them faces significant issues and it is therefore crucial to evaluate the "*Financing Gap*" challenge when it comes to funding projects characterized by already established RE technologies and to identify innovative solutions in order to prompt the effective participation of SMEs in the Energy Transition. As for the exogenous factors inherent in the renewable industry, the volatility of the energy market is a significant challenge for SMEs in financing renewable energy projects even if the technology is mature and ready for the commercial phase. Moreover, legislative frameworks that formerly lowered financial risk and simplified bank loan repayment for RE installations have also gotten less favorable in the EU and other countries: the switch from guaranteed FITs to auction models is particularly likely to discourage individual commitment because it favors large-scale projects that can diversify risks through diverse project portfolios. For gauging the endogenous factors, it is firstly important to describe the two prevalent business models funding RE investments: 1) Profit-Oriented. market-driven investment strategies that draw capital, through the previously mentioned financing tools, for large-scale projects mainly promoted by large firms but exclude investor participation in decision-making. 2) Genuine. More equal ownership models which are frequently promoted by modest to medium-sized enterprises that struggle with the issue of being "sub-scale" ventures. Indeed, the disaggregation and heterogeneity of many green infrastructure assets, such as small-scale renewable power plants, results in high transaction costs during the prospective project development and a lack of asset liquidity. The magnitude or risk profile of these assets makes them illiquid, thus creating the danger that funds earmarked for sustainable projects would be diverted to ones that have little real climate impact because of a lack of standards and accountability in some asset classes.

If even the development phase were to be passed by genuine business models, the project would face an even greater hurdle once it entered the execution phase. Generally speaking, while there is a willingness to deal with high up-front capital investment through Asset Finance for profit-oriented business models, due to the nature of the genuine business models, neither traditional project financing nor securitization in the form of Green Bonds have proven to be sufficient tools for overcoming this barrier and enter into the execution phase of the project. On the one hand, project finance is heavily dependent on debt capital, generally 80% or more of the overall capital provided, and the bankability of projects supported by SMEs is frequently lower than that of larger corporations, making it more difficult to draw in investors. "*Bankable*" denotes that the project's risks and costs have been adequately reduced or controlled in other ways and that the project's revenues, or at least a portion of them, are sufficiently certain and secure. While on the revenue side both large and small-scale projects share, in different proportions, the same risks linked to market volatility, the degree of the operational, product, supply, O&M and credit risks is surely higher for smaller scale projects. On the other hand, the issues associated with securitization are different. Even while Green Bonds are an efficient and innovative instrument for funding green infrastructures, they miss out on several important opportunities for sustainable asset lifetime management as they are typically used for projects that have already achieved financial close; this is because investors want to see a track record of success before investing in a project. Since that lenders often prefer to see several years of operational data for a wind or solar farm before placing debt in the project, Green Bonds are essentially not utilized to fund early-stage project construction. This is the reason why, for a small or medium-sized business in particular, all of these reasons make it challenging to become a promoter of a financing initiative that has to rely heavily on third parties' capitals. Hence, the "*Financing Gap*" is a seemingly insurmountable barrier to entry, and standard project financing and securitization, handled independently, do not now seem to be the right solution. However, it may be solved by addressing each of its distinct components: firstly, there is the need to build a hybrid business model able to overcome the pre-execution phase by combining fragmentation and active stakeholders' participation with enhanced scalability; secondly, these types of projects should find a way to bypass the higher bankability standards which make them ineligible for financial institutions.

Under this scenario, Social Based Lending Crowdfunding constitutes a viable starting point for implementing effective Decentralized Energy Systems. SBL, a specific type of crowdfunding that has attracted interest, entails local community investors banding together to financially support renewable energy projects in their area. In addition to fostering a sense of ownership and responsibility for their local environment, SBL crowdfunding methods allow communities to actively participate in the building of renewable energy infrastructure. A Crowdfunding SBL model links regional renewable energy projects with local community investors, functioning on a loan-based basis: renewable energy producers get loans from local community investors, which are then returned with interest from the profits made by the projects. Online platforms that serve as an intermediary between renewable energy projects and regional community investors frequently enable SBL crowdfunding methods. Investors may explore a variety of renewable energy projects on these platforms, evaluate their prospective effects, and then decide which projects to fund. The platform oversees the loan repayment procedure once a project receives funding and distributes the proceeds to investors in accordance with the arrangement. For renewable energy generators, SBL crowdfunding offers a number of advantages in terms of access to capital, local investors engagement, risk mitigation and banking intermediaries bypass that make it a desirable financing choice for both project developers and local communities. As it can be noticed, SBL Crowdfunding can be characterized as an optimal merger of project financing and securitization. To evaluate the creditworthiness of the renewable energy project, project finance concepts are in fact used. This entails assessing the project's technical, economic, and regulatory factors to determine its viability and capacity to generate income. The money secured through crowdfunding is repaid using the financial flows from the project, which are anticipated to come through the power purchase agreements. Additionally, similarly to securitization, SBL crowdfunding involves combining individual loans from several investors to finance the renewable energy project. These loans are subsequently organized into marketable securities in the form of tokens that represent the investors' interests in the project. With the help of this ground-breaking framework fostering decentralized energy systems by combining elements of both the genuine and the profit-oriented structures, renewable energy projects may be funded by energy-intensive SMEs in a more complex and scalable manner. Moreover, having access to locally produced energy would reduce their reliance on fluctuations in the energy market.

However, it would be erroneous to believe that such an architected system is free from difficulties and problems that could undermine its effective implementation. Actually, there is "no free lunch" with peer-to-peer lending: lenders and borrowers must take on a lot of risk in exchange for higher yields, including specific new challenges peculiar to the Web 2.0 P2P lending business model, namely: adverse selection and moral hazard; high fees due to “white label banks”; non-disciplined secondary market for traded loans; need for institutional lenders for reaching volume and overcoming break-even levels; money laundering; cap funding amounts set by regulators; limited market reach due to cross-border regulation discrepancies.

These obstacles can make it difficult for conventional P2P lending platforms to connect borrowers and lenders in a fully efficient way. However, Decentralized Autonomous Organizations (DAOs) provide potential solutions to these problems as they are: Decentralized and Distributed, Autonomous and Automated, Organized and Ordered. First of all, the blockchain's security, efficiency, and cost-effectiveness make it ideally suited for the portfolio registration of crowdfunding-funded companies. Indeed, the *tokenization* process of lending-based crowdfunding, hence DAOs implementation cycle starting from smart contracts preparation and subsequent ICO, can be easily structured. The blockchain technology is so secure that the information enumerated in the blocks about entrepreneurs can be relied upon without the need of including accurate stock and shares update, allowing investors to determine how or when to invest in a particular project based on descriptions such as project nature, progress, funder response, and completion timeline, etc. The efficacy of the blockchain is exemplified by its unrivaled capacity to connect investors and fundraisers without the rigors of documentation and additional accreditation from, for instance, certification organizations. Additionally to the adaption feasibility of traditional SBL crowdfunding to DAOs, what truly drives change in this transition are the blockchain characteristics themselves that allow for decentralization of the decision-making process, transparency among creators and lenders, security and immutability by virtue of the smart contracts contained. Being blockchain networks not under the authority of a single entity, thereby preventing a single point of failure and the seizure of the network by a select few users, a balance between project creators and the public of lenders is permitted. In a distributed network known as Blockchain, users collaborate to reach consensus on the network's state. Transparency is fostered because Data recorded in a blockchain is accessible to the general public and visible to all network participants. Its time-stamped nature, its authentication feature, its connection to the previous block, and its hermetic configuration, which precludes the modification of a block's data in retrospect, ensure the blockchain's security. The latter prohibits the posting of false investment-related information in order to perpetuate fraud. The notion of immutability relies on the fact that, as described previously, DAOs operate through smart contracts, which are essentially blocks of code that execute when a certain set of conditions is met. These smart contracts determine the laws of the DAO, specify the manner and the conditions under which an arrangement is selected, executed and terminated. All these characteristics combined together limit to the maximum extent the information asymmetries inner in traditional P2P crowdfunding platforms' business model and foster the liquidity of debt securities, now referred as tokens, by virtue of the enhanced trust and the availability of regulated marketplaces for them. It is even true to state that blockchain technology allows for more reach as there is no cap in the raiseable amount nor limitations in terms of geographic dislocation of lenders because of its *censorship-proof* nature. Furthermore, DAOS are highly flexible and have so far faced minimal regulations from authorities. DAO joining members, according to their own financial contributions, share the risks among themselves and, should the project fail to materialize, the funds get immediately reimbursed. It is also important to note that, if the requirement specified in the underlining smart contracts are met, both retail and institutional investors can participate in the ICO alike traditional crowdfunding systems. The difference is that, due to the absence of white label banks, fees are almost inexistent and therefore the investor's type is practically indifferent.

As already explained, to promote SMEs active participation and thus to facilitate the Energy Transition, energy systems are becoming increasingly active, decentralized, complex and multi-agent, with a growing number of actors and potential actions. In light of this, DAOs are likely to meet these needs: research endeavors and newly created enterprises suggest that blockchain technology may provide solutions to some of the challenges faced by the energy industry. In substance, by fostering reliable transaction recording, eliminating intermediaries, removing to the highest extent regulatory reporting and compliance and building a functioning global supply network, blockchain-based market structures could help decentralized energy systems achieve efficiency. Although blockchain could be applied to a variety of use cases related to the business processes of energy companies including billing, sales and marketing, trading, data transfer, grid management, resources sharing and competition, it is in the financing process through SPVs of Independent Power Projects that resides the core of such an innovation. In this regard, it is proposed a novel Decentralized Autonomous Organization application: a blockchain-based Special Purpose Vehicle supported by various autonomous mechanisms. Knowing the legal, margining, liquidity process and third parties' risks met in the structuring and closing processes of a traditional SPV combined to the more general "*Financing Gap*" challenge inherent in the RE industry, the aim is to combined DAOs and SPVs in such a way that securitization and project finance logics can find the right balance and offer a disruptive financial innovation suitable to evolve existing Web 2.0 SBL crowdfunding structures and hence to be effectively implemented within the current global decentralization trend of energy systems. The concerns to be addressed are the following two: 1) How can a DAO be designed to replicate the technical, legal, and commercial capabilities of conventional SPVs while mitigating the volatility, design, security and account risks it introduces? 2) How can a DAO surmount the limitations and hedge the underlying risk exposures of existing SPV structures? The blockchain SPV maintains the core functionalities of conventional SPVs via three autonomous mechanisms: mobilization, collateralization, and settlement. Through the autonomous mobilization mechanism of the smart contract debt financing is secured for the SPV from decentralized financiers located anywhere in the world. The shareholders acquire these funds through an ICO scheme governed by a conventional loan agreement. In such a program, the product of the number of tokens and price per token equals the total investment cost of the project. After that, they distribute a portion of the tokens amongst themselves, which represents the off-chain equity they contributed at the SPV's inception. Finally, they sell the remaining tokens through the blockchain SPV platform's mobilization mechanism. The number of tokens sold is intended to correspond to the amount of debt financing required to implement the initiative. The ownership of these security tokens grants decentralized lenders access to future revenue sources in the form of utility tokens, in a manner wholly governed by the smart contract. Decentralized lenders will receive total annual payments based on the project's DSCR until all debt has been repaid in full. Before the total debt is completely repaid, the remaining annual revenue after debt service is distributed to the shareholders. However, once the entire debt has been completely serviced, the shareholders will receive all of the project's revenues in the form of energy to be self-consumed. Prior to the ICO program, investors must secure the revenue stream that will serve as the premise for loan repayment to decentralized lenders. The revenue stream is derived from the off-takers, or purchasers of the renewable generator's excess electricity produced. A conventional PPA between the shareholders and the off-takers ensures the revenue stream of the project. The parameters of this agreement are initially negotiated off-chain, after which they are immutably encoded in a smart contract. Through the smart contract, shareholders and decentralized lenders receive revenue streams from the off-takers once the project begins operations. For achieving this purpose, a blockchain-enabled smart meter acts as a hardware oracle, recording electricity consumption data from off-takers and passing it to the smart contract for settlement purposes. This decentralized and untrustworthy arrangement introduces a new obstacle: what if the off-takers do not have the funds or the motivation to pay for the electricity they have consumed? In order to mitigate the credit risk posed by the off-takers, an autonomous collateralization mechanism is proposed. The smart contract collateralization mechanism manages off-takers' collaterals autonomously to encourage them to accomplish their payment obligations to the SPV. As previously outlined, the holding of such collaterals can lead to margining risk. The off-takers' collateral account serves as maintenance margin and default penalty deposit. Every trading period, the maintenance margin of an off-taker reflects its credit exposure to the SPV. To ensure that off-takers have sufficient funds in their collateral account to make settlement payments inutility tokens due to the SPV, the minimum reserved maintenance margin must be greater than the off-takers expected future payment. The default penalty is used to penalize defaulting off-takers whose maintenance margin falls below the minimum requirement. A failure to maintain the maintenance margin results in a deduction from the default penalty deposit. Once the default penalty deposit is depleted, the off-taker's blockchain-enabled meter is notified, and electricity supply is subsequently cut off. In practice, the proposed collateralization mechanism results in zero off-taker credit risk for SPVs, because the smart contract incentivizes SPVs to meet their payment obligations. The autonomous settlement mechanism, which enforces prompt smart contract settlement as electricity is consumed and metered in real time, mitigates the margining risk. This mechanism reduces the credit exposure of the off-taker to the SPV in each instance, and consequently the margining risk.

The emergence of DAOs will likely accelerate as blockchain and smart-contract-based technologies advance. Establishing a consistent roadmap requires a legal organizational framework that facilitates political, legislative, and social debate on the governance of DAOs and codifies the current standard of governance for all legally registered DAOs. Once there is a set of standards, default rules by which a DAO must abide in order to organize under a state statutory scheme, there will be a benchmark for investor protection, duty allocation, disclosure, and liquidity expectations. In addition, mandating compliance with applicable securities regulations regarding the solicitation, sale, and transfer of DAO-Tokens can facilitate more gradual, controlled DAO launches that prioritize investor or token-holder protection. Despite the possibility that this will not result in an infallible system for governing primary blockchain markets, investor protection is a necessary consideration that must be given adequate weight. The purpose is to move from this presumption and provide a detailed analysis of what an ICO is, as well as to determine whether the proposed blockchain-based SPV satisfies both the US requirements of the *Howey Test* and the European notion of "*Transferable Securities*". When determining whether to regulate a new investment instrument, both the SEC and the courts consider the purpose of the Exchange Act, which is to prevent significant abuses in the largely unregulated securities market. In order to render a verdict in the *Slock.it v. SEC* case, the "*Howey Test*" for investment contracts was applied to determine whether Coins issued during ICOs are securities. The economic realities of the agreement should take precedence over the literal form of the contract. Over time, the Howey Test has been reduced to four factors that must be met in order to classify an investment contract as a security: (1) there must be an investment of money; (2) in a common enterprise; (3) with a reasonable expectation of profits; and (4) derived primarily through the efforts of others' management. The "investment of money" test may require determining whether the contract was engaged into for investment or consumption purposes. Similar contract forms can be categorized as either investments or consumption, with the distinction based in part on the economic motivation underlying the transaction. In addition, the first factor of the Howey Test questions if an investment was made with "money." According to this criterion of the Howey Test, the SEC determined that "money" had been "invested in "The DAO." According to the "common enterprise" condition, each DAO investor's success is dependent on the success of the other investors. However, vertical commonality is more debatable in this case, and some justices rely heavily on it. The success of an investment in The DAO is facilitated by the pool of Ether contributed by each investor. For satisfying the broad commonality requirements, profits have to distributed proportionally to the number of tokens held by each token holder, or, more generally, when an investor's fortunes are tied to the promoter's success rather than to the fortunes of his or her fellow investors. In cases where there is no horizontal commonality, the Ninth Circuit will look to a strict version of vertical commonality, which requires that investors' fortunes be intertwined with and dependent upon the efforts of those seeking the investment of third parties. The DAO Curators provide comparable threshold services, such as approving voting pitches. Token holders are unable to vote on a smart contract proposal without Curator approval. Neglecting curation would unquestionably result in the scheme's failure, so broad vertical commonality is met here. However, strict vertical similarity is difficult to apply in this circumstance. The "reasonable expectation of profits"" application to The DAO is relatively straightforward, so the SEC Report only devoted a brief paragraph to its analysis. The potential for financial returns attracted DAO investors to the novel investment model. Hence, there is no doubt that purchasers of DAO tokens invested capital with a reasonable expectation of profit. The fourth factor is the most controversial in the SEC's application of the Howey Test to "The DAO". Although, the SEC argued that the efforts of Slock.it, its co-founders, and The DAO's curators were essential to the enterprise, hence satisfying the "managerial efforts of others" criterion. *Slock.it* is the group of programmers who initiated "The DAO"; they wrote the code, issued and promoted the ICO, selected the initial Curators and proposed the first pitch, and then stepped back to address technical questions regarding how to participate in "The DAO". The SEC determined that these activities were "crucial" to the "success or failure" of the business. However, EU regulators and courts cannot merely adopt the Howey test. According to the statutory definition provided in Article 4(1) (44) of MiFiD2, "*transferable securities" are those classes of securities that are negotiable on the capital market, excluding instruments of payment"*. Article 4(1) (44) of MiFiD2 specifies shares, bonds, and respective derivatives as transferable securities. Notably, no definition of 'securities' as such is provided. Furthermore, the CJEU has not issued a single decision regarding the definition of securities in general. Although this creates uncertainty among market participants and necessitates a cautious approach to the definition, it also offers an opportunity for easily integrating tokens within the definition of securities once "transferability", "capital markets", "negotiability" and "standardization" requirements are met. A security must be transferable in order to be negotiable. Transferability of the units does not necessitate a physical embodiment, such as a certificate. Therefore, the intangible character of tokens does not affect their transferability. The token issuer can restrict the transferability of tokens. Non-transferability would result, however, if the unit could not be transmitted at all. A simple contractual restriction does not alter the fact that tokens are generally transferable. Some token issuers provision their tokens with transfer-impossible lock-up mechanisms. In these instances, the subscriber retains and can only retain proprietorship of the token. As a result, these tokens are not transferable securities in accordance with Article 4 of MiFiD2, thus making the EU financial markets regulation inapplicable. Consequently, from a structural standpoint, the token would not be a transferable security during the initial offering on the primary market but would become one later on the secondary market. Article 4(1) of MiFiD2 specifies the categories of markets that fall under the definition of "capital markets". The ongoing relationship between the issuer and the investor, based on the traded instrument, is typically the primary distinction between capital markets and other portions of the financial markets, such as money markets or commodity markets, or markets other than financial markets. Bonds create an ongoing flow of funds from the issuer to the investor, whereas stocks provide investors with membership rights in the respective company. In both instances, the investment is motivated by the expectation of a profit. Profits should be broadly construed to include dividends and recurring payments. Consequently, a token awarding a flow of funds from the issuer to the investor, either at a fixed rate or based on the company's profits, is potentially negotiable on the capital markets. To be regarded 'transferable securities', according to Article 4(1) (44) of MiFiD2, tokens must be "negotiable". In contrast to 'transferability,' which refers to the mere prospect of being exchanged, a unit is negotiable if its format permits its sale or purchase in a structured-market environment (such as the capital markets). Typically, tokens are regarded 'negotiable'. The use of the word 'negotiable' rather than 'negotiated' indicates that the tokens are not required to be traded on an exchange. If the securities in question are of a type that can be transacted on the trading facilities, then this clause applies. Despite tokens are not currently transacted on traditional stock exchanges, but rather on various crypto exchanges, any investment instrument that is listed on a cryptocurrency exchange is a tradable security. For units to be negotiable, they must be "standardized". This follows from the concept of anonymous capital markets transactions, which necessitate the respective units to be identifiable and enumerated. This does not imply, however, that tokens are not "standardized" under Article 4(1) (44) of MiFiD2. It is not required that all tokens from various issuers be standardized, which means that certain 'typical' tokens circulate on the markets. Rather, the purpose of the standardization requirement is to exclude securities that have been customized for specific consumers, as doing so would create market volatility. The standardization requirement is met if all tokens in a particular ICO are of the same type, or if the ICO contains distinct classes of tokens that are easily distinguishable and therefore negotiable. Typically, this is the case with ICOs. The blockchain-based SPV appears to adhere the "*Howey Test*" and to the notion of *Transferable Securities* in place in the EU and, consequently, the "*Howey Test*" also. Indeed, being the issued investment token transferable, negotiable, standardized and potentially operating on a secondary market which could be compliant to the definition of "capital markets", the potential public of investors would be granted with the set of rights listed in the *2014/65/UE* when dealing with RE investments through DAO-like SPVs within the EU territory. Obviously, the same conclusion could not be drafted for other types of DAOS and it is therefore not intended to set as a generally applicable rule. In fact, for investments through DAOs to be subject to the US and EU investor protection regimes, the underlying "*dry code*" within the smart contracts must conform to the aforementioned specifications, known as "*wet code*".

The thesis case study focuses on an Italian SME operating in the dairy industry, encompassing the processing of milk and its derivatives, the production of dairy products, heat treatment activities, and the bottling of raw milk. By virtue of its established reputation, "*Centrale del Latte del Molise*" is likely to offer a promising opportunity to investigate the viability of a blockchain-based SPV for simulating the financing of an already existing proprietary RE generator. The mission of *Centrale del Latte del Molise* is centered on sustainability and environmental stewardship. By investing in the development and implementation of an advanced system, *Centrale del Latte del Molise* aims to pioneer the integration of existing technologies. This strategy is consistent with the company's commitment to creating a positive environmental impact and achieving carbon neutrality. The findings of this study have the potential to inform policymakers, industry stakeholders, and SMEs operating in energy-intensive sectors regarding the viability and applicability of blockchain-based SPVs in advancing sustainable development and Energy Transition objectives.

Specifically, the present case study answers the following research question: "Are blockchain-based SPVs a feasible and workable investment solution for allowing energy-intensive SMEs to become promoters of RE projects?". Firstly, there is the need to determine, both autonomously and thanks to insiders' descriptions, whether or not the present company can be considered as a suitable project promoter both in terms of potential token buyers' attractiveness and from a purely operational point of view. In general, four criteria can be investigated: 1) Company Reputation. 2) Favorable Regulation. 3) Off-Takers Availability. 4) Equity Contribution Affordability. Considering these criteria, *Centrale del Latte del Molise* emerges as a suitable project promoter.

A thorough blend of financial and project-specific inputs were sourced in the methodological approach used to present and gather results from the case study, including insights from corporate insiders, particularly the organization's CEO. This systematic approach revolved around simulating an already existing investment scenario through the utilization of a blockchain-based SPV. Hence, the methodology of this study is structured into two distinct phases, each serving a crucial role in answering the central research question:

I. The initial phase, named as the **Preparation Phase**, includes several crucial features critical to the successful operation of the blockchain-based SPV. This phase encompasses the design and implementation of the project's specific smart contracts, which serve as the fundamental foundation for the SPV's activities. The specific areas addressed within this phase include the SPV's incorporation and capital structure, interaction dynamics with off-takers, token issuance and distribution strategies, the determination of interest rates, conditions for anticipated SPV termination, and a comprehensive summarizing table outlining the specifications and key agreements of the project - "*Serum Recovery Cycle Case Initiative*" -

promoted by the focal company, "Centrale Del Latte Del Molise". These aspects work together to build the framework for the subsequent execution phase.

II. The following phase, referred to as the **Execution Phase**, is critical to comprehending the financial complexity of the blockchain-based SPV. This stage requires developing three distinct financial schedules: The Decentralized Lenders Debt Repayment Schedule, the Profit and Loss Statement (P&L), and the Cash Flows Estimation. These schedules allow for an in-depth evaluation of the project's financial performance, offering insights into profitability and financial sustainability. The Debt Repayment Schedule outlines the timetable and amounts for repaying decentralized lenders, the P&L statement provides a thorough overview of the SPV's financial performance, and the cash flow estimation assists stakeholders in determining available cash flows and assessing the project's financial viability.

By adopting this comprehensive methodology, which integrates both the Preparation and Execution Phases, the study aims to provide a holistic assessment of the feasibility and viability of utilizing blockchain-based SPVs as an investment solution for energy-intensive SMEs seeking to promote renewable energy projects.

The results obtained provide a sound basis for answering the research question of the present work, namely, whether blockchain-based SPVs are not only a feasible alternative for raising external debt capital but also, and more importantly, whether such a solution is workable for *Centrale Del Latte del Molise* and, more generally, for any energy-intensive SME interested in undertaking such a project. Analyzing its feasibility is simpler and more straightforward, however, it is necessary that the external exogenous factors, first and foremost the legal framework inherent to investor protection presented in the preceding paragraphs, is favorable and suitable for the inclusion of DAO-like SPVs within it. If ever the answer were to be affirmative, it can be asserted that raising capital by issuing debt-tokens in order to bridge the project's financing gap is an obviously beneficial alternative both for the sponsoring company, which would benefit from a pool of international investors and make up for all the shortcomings associated with traditional SBL crowdfunding, and for the decentralized holders of such debt instruments. The latter would benefit from relatively high interest rates, up to *9.22%* in this specific case, and less risk, due to the execution guarantees, including the eventual automatic termination, allowed by the smart contracts inherent in the blockchain, compared to traditional debt investment in sovereign and corporate bonds. More importantly, it would give retail investors access to a credit market that until now has been marked by a monopolistic presence of commercial banks and other traditional financial intermediaries.

To conclude whether such an initiative is, however, always workable for each enterprise that puts it in place, it is good to break down the matter into several subparts: 1) Trade-off among self-consumption of produced energy and disposal of external collateralized capital. This trade-off is a central issue in assessing the workability of the specific project. In fact, since the debt is collateralized to the cash flows, which in turn are linked to PPAs agreements, it is logical to expect that the consumption of the energy produced will be subordinated to the repayment of the debt installment year after year, until its expiration. In the specific case of the "*Serum Recovery Cycle Project*," considering the business shutting set for each Sunday of the year, during the other days of the week between project inception and closure the company will be able to consume an increasing amount of energy produced up to almost 50% of revenues forecasted for the tenth year. In absolute terms, this value per se could be positive for some SMEs but limiting for others, just as in the case of *Centrale Del Latte Del Molise*. Indeed, after having accounted for *€6 million* funded via the Italian PNRR ("*Development of biomethane, according to criteria for the promotion of the circular economy*" - *Mission 2, Component 2, Investment 1.4*), considering that out of a remaining total investment of *€9 million*, whose only 20% is reported on the SPV's balance sheet, the tokenized debt consists of only 8% of the total, for such a small contribution it would arguably be preferable to opt for an alternative financing solution that does not sacrifice more than half of the energy produced for pay back purposes. It should be added, however, that the power technology adopted, even after deducting the cost for installing the dedicated building, is itself historically and still inefficient when compared with wind and solar power plants in terms of MW generated per euro invested. 2) Availability of alternative capital sources. The issue of trade-off is inextricably linked to the theme of alternative sources of capital. Indeed, it should not be forgotten that structuring an SPV via blockchain is an innovative proposition that, before becoming completely stand-alone over time, will likely remain complementary to other better-known forms of capital injections. In fact, the project in question still relied on a capital allocation from the Italian National Plan Di Recovery e Resilience, which, in the current assumption, allowed for € 6 million in non-repayable funding as well as for the sale of the energy produced through a premium tariff equivalent to *€ 236/MW*. What's more, according to the CEO statement, the company obtained a 30-year bank loan directly recorded on its balance sheet. It is evident that for a company with a *€ 42 million* turnover the traditional alternative of bank debt persists, despite the fact that the purpose of this thesis paper is precisely to formulate a financing model that goes beyond the involvement of bank intermediaries since, as already explored in the previous paragraphs, they are generally reluctant to lend money to small and medium-sized companies for projects of this magnitude. Nevertheless, even this aspect still prompts the determination that the blockchain solution, for the company and the project in question, is not workable. 3) Multiple Shareholders for fostering project scalability. In the context of renewable energy projects, scalability refers to a project's ability to increase its energy production capacity more than proportionally to the amount of investment or funding. As a result, depending on the specific technology, project design, and market conditions, it is feasible for renewable energy projects. Because of technological breakthroughs, economies of scale, and better efficiency, several renewable energy systems, such as solar and wind power, have exhibited scalability. As these technologies improve, the cost of energy per unit falls, making larger projects more economically viable. Scalability is also applicable to biomass-based renewable energy projects, such as the one under consideration. However, the degree of scalability might vary depending on a number of factors, technology advances, feedstock availability and logistics above all. This is the reason why formulating the presence of multiple shareholder- companies, in this case peers of *Centrale Del Latte Del Molise*, operating in the same industrial cluster, would favor additional equity capital to finance a RE plant with efficiency greater than *0.1 MW/h* while ensuring relatively few difficulties in terms of logistics. Indeed, the issue of energy sharing in the context of industrial clusters acting like proper energy communities turns out to be central. Consequently, the blockchain system inherent to the SPV would be further enriched by smart contracts concerning internal governance and thus the regulation of shareholder interactions, eventually codifying, automating and making this aspect transparent as well.

In the light of the above, even if the DAO-like SPV can in all respects be feasible, it cannot be considered workable for the examined company. However, it can be said that the perfect candidate is an energy-intensive company whose turnover and balance sheet strength are not so solid as to be considered eligible for an onerous bank loan and which is therefore willing to wait several years before fully exploiting the energy produced by the RE plant. Decentralized lenders would always be protected by the blockchain since cash flows will depend on the RE plant and will be independent from the company's profitability itself. Without a doubt, this financing system can be combined with the various national and supranational incentives and then gradually become self-standing, once the incentive era comes to a definitive end. The issue of multiple shareholders deserves a separate evaluation: the amount of energy self- consumed must always be evaluated and forecasted for both cases, decisions and actions will have to be taken accordingly.