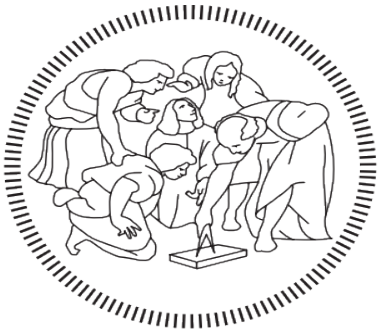
Open Innovation in the energy sector

Overview on the trends of Acquisitions, Corporate venture capital deals, and independent energy start-ups



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Abstract

The goal of this work is to investigate and examine the landscape of start-ups in the energy sector and how established companies are applying the open innovation mechanisms of acquisitions and corporate venture capital investments to acquire the value created by these young and flexible ventures. The energy industry is facing a radical change pushed by trends such as the increased awareness of the climate crisis and consequent need for an energy transition, the liberalization of the energy market, digitalization, and decentralization. These drivers are opening new opportunities for new entrants, in particular for small and innovative start-ups. At the same time, large energy incumbents are facing an enormous threat. They are not able to bring innovation fastly enough to the market. These corporations were used to compete only on price and leveraged on economies of scale to keep margins and market share. Thus, they are threatened today by new entrants that are introducing to the market disrupting innovations both from a technological and a business model point of view and they are changing the rules of the competition shifting them towards differentiation factors. As a result, these companies need to explore new ways of doing innovation. Acquisitions and corporate venture capital investments are proving to be effective tools.

In the thesis, a quantitative analysis is carried out of three samples:

- 1027 independent energy start-ups founded between 2016 and 2020 in Europe, the United States, and Israel;
- 42 Acquisitions of energy start-ups signed between 2018 and 2020 in Europe, the United States, and Israel;
- 188 CVC deals signed between 2018 and 2020 by power utilities situated in Europe, The United States, and Israel.

The analysis is divided into two parts. The first takes the perspective of the start-ups. We analyze the independent, acquired, and investee ventures to understand the main technological and business model trends in the energy sector with a threefold temporal perspective and where these trends are geographically distributed. The start-ups were classified and grouped according to geographical location, technological area, technological sub-area, and type of offer.

In the second part, the perspective shift towards established companies applying open innovation. The deals of acquisitions and CVC are classified according to the strategy behind the deal. Given the peculiarities of the phenomenon of Corporate venture capital, these investments have been also classified through syndication and governance. The work aims at giving a complete overview of the technological and business model trends that will influence the energy sector in the more and less near future and to understand how established companies are exploiting and/or exploring the value of new start-ups to keep a competitive advantage.

The results of this study can be of great use to anyone who is willing to interact with innovation in the energy sector, today or in the foreseeable future, including entrepreneurs, investors, companies, and policymakers.

Abstract - Italian

L'obiettivo di questo lavoro è quello di indagare ed esaminare il mondo delle start-ups nel settore dell'energia e come le imprese già consolidate applichino i meccanismi di innovazione aperta delle acquisizioni e degli investimenti di venture capital per acquisire il valore creato da queste imprese giovani e flessibili.

L'industria energetica sta affrontando un cambiamento radicale spinto da trend quali la maggiore consapevolezza della crisi climatica e la conseguente necessità di una transizione energetica, la liberalizzazione del mercato energetico, la digitalizzazione e la decentralizzazione. Questi driver stanno aprendo nuove opportunità per i nuovi entranti, in particolare per le start-up piccole e innovative. Allo stesso tempo, i grandi operatori storici dell'energia stanno affrontando un'enorme minaccia poichè non sono in grado di portare l'innovazione abbastanza rapidamente sul mercato. Queste società sono abituate a competere solo sui prezzi e hanno fatto leva su economie di scala per mantenere margini e quote di mercato. Perciò oggi sono minacciati da nuovi operatori che stanno introducendo sul mercato innovazioni sconvolgenti sia dal punto di vista tecnologico che da quello del modello di business e stanno cambiando le regole della competizione portandola verso fattori di differenziazione. Di conseguenza, queste imprese necessitano di esplorare nuovi modi di fare innovazione e le acquisizioni e investimenti corporate venture capital si stanno dimostrando strumenti efficaci. Nella tesi si effettua un'analisi quantitativa di tre campioni:

- 1027 start-up energetiche indipendenti fondate tra il 2016 e il 2020 in Europa, Stati Uniti e Israele;
- 42 acquisizioni di start-up energetiche firmate tra il 2018 e il 2020 in Europa, Stati Uniti e Israele;

- 188 accordi CVC firmati tra il 2018 e il 2020 da power utilities situate in Europa, Stati Uniti e Israele.

L'analisi è divisa in due parti. La prima prende la prospettiva delle start-up. Analizziamo le ventures indipendenti, acquisite e partecipate da corporations per comprendere le principali tendenze innovative in termini di modello tecnologico e di business nel settore energetico con una triplice prospettiva temporale e un'attenzione alla provenienza geografica. Le start-up sono state classificate e raggruppate in base alla posizione geografica, all'area tecnologica, alla sub-area tecnologica e al tipo di offerta.

Nella seconda parte, la prospettiva si sposta verso imprese consolidate che applicano strategie di open innovation. Le operazioni di acquisizioni e CVC sono classificate secondo la strategia alla base del deal. Date le peculiarità del fenomeno del Corporate Venture Capital, questi investimenti sono stati classificati anche attraverso syndication e governance.

Il lavoro mira a fornire una panoramica completa delle tendenze del modello tecnologico e di business che influenzeranno il settore energetico nel più o meno lontano futuro e a capire come le aziende consolidate stanno sfruttando e/o esplorando il valore delle innovative start-ups per mantenere un vantaggio competitivo.

I risultati di questo studio possono essere di grande utilità per chiunque sia disposto ad interagire con l'innovazione nel settore energetico, oggi o nel prossimo futuro, compresi imprenditori, investitori, aziende e policymakers.

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Last but not least my friends. I am very lucky to have so many friends with which I have always been able to find a good balance between life, study, and work. I could be very synthetic here, but they know I am logorrhoeic and each one of them was important for my personal growth. Thanks to Giulia, Lidia, and Carlo. Thanks to all the friends from the different groups I grew up in: the F(R)ighters, 5E, Patatrack, Cap esterel, and Seregny. Thanks to the wonderful italian and international people I met during my exchanges in Montreal and Porto: Vongole, the Fellows, and the crew of Maderia. Finally, I could not forget the colleagues that made me passionate about entrepreneurship, the team of Clash of Schools.

I owe to all of them my success.

Contents

Introduction

Today the energy industry is in rapid and constant evolution, pulled by the pressure of climate change and the widespread sensitivity towards environmental issues. Governments are implementing numerous programs of decarbonization. An example is the Green new deal of the European Union which declares its intention of making available 1000 billion euros over the next ten years to achieve the goal of zero its net emissions by 2050 [Europe, 2019].

Climate change is not a possibility anymore, it is a certainty. All industries must act towards a single direction: reducing the impact of climate change and keeping the increase of global temperature below 1.5 degrees Celsius, otherwise, the consequences will be not only catastrophic but also unpredictable, thus no safety plan can be drafted or implemented.

In this context of strong and fast transformations, Innovation is an opportunity for growth and the key to survival. However, the closed model for innovation we have known for decades throughout all 20th century is dying. Innovation cannot be kept anymore secret within the R&D laboratory of big companies. This approach, although it assures the exclusive appropriation of the value of the invention, is not fast enough to keep the pace of knowledge creation. Consequently established companies risk that while waiting for their latest invention to enter the market, a start-up disrupts and change completely the industry deleting the potential customers of the company's invention [Freeman and Engel, 2007a].

This is especially true in the world of energy, which is a mature market dominated by large players who provide similar offers and compete more and more on price. Large companies fail to make big changes due to their resistance to change and rigidity, while start-ups can flexibly adapt to changes

because they marry a lean approach that allows them to enter rapidly and consistently in new markets and tests their solutions. Corporations and start-ups can therefore end up becoming competitors and block each other. This approach is not good for the overall industry because it implies a slow-down of innovation and the creation of redundancies and duplication of resources to develop it. Consequently, another approach should be used. Collaboration between start-ups and established corporations can be a win-win agreement. This approach can be defined as Open Innovation. New highly innovative firms can be acquired or receive an investment by larger companies. The former would benefit from accessing the corporations' strategic resources (financial support, supply and distribution channels, etc...) and speed up the development and sale of their solution. The latter can make the ventures exploit them with the benefits of differentiating their offer without investing time, and going out of a deteriorating and mere price competition.

This work explores Open innovation in the energy sector from two perspectives. On one hand, we explore the point of view of the innovators, the start-ups, by identifying the main trends in terms of technological and business solutions and where they are geographically distributed. On the other hand, we consider the established corporation's perspective, analyzing why and how established companies are conducting open innovation programs, with a focus on CVC and acquisitions. We are going to analyze the technological trends of ventures that are independent, subject to CVC investments, and acquired in order to have a threefold temporal prospect on which technologies and business models are likely to disrupt the industry. Then the analysis will focus more on the corporations and the study will target the strategies behind deals of CVC and acquisitions and the structure of CVC units. In fact, as the literature review, highlights, the structure of the CVC unit influences deeply the success of an open innovation campaign.

This analysis can be beneficial for those who today or in the foreseeable future will have to interface with the energy industry and want to have a clear and systematic vision of it. Firstly, entrepreneurs who want to enter the world of energy may use this report to understand the trends on which startups and established companies are pursuing. Secondly, established energy companies are interested in open innovation strategies. The third group of actors that may find this report interesting are the investors who would like to understand the different trends ongoing in the energy industry to plan their investments at best. Finally, policymakers can benefit from the reading of this report because they would be able to understand the devel-

opment of the industry, assess the crucial importance of young ventures, and plan accordingly policies that can support and ease the growth of innovative start-ups.

This thesis is mainly structured into two parts. The first consists of an extensive analysis of the existing literature with which we try to frame the topics of greatest interest, from a purely theoretical point of view. The second part is a quantitative analysis of three samples: (1) acquisitions of energy start-ups, (2) Corporate venture capital deals made by power utitilities inside and outside the energy market of start-ups, (3) independent energy start-ups.

The thesis is structured as it follows. The first chapter contains the literature review. The theoretical framework begins with a general definition of innovation, then an analysis of the closed paradigm for innovation is carried out to understand the reason behind its decline. Right after, the concept of open innovation is introduced with an overview of the main mechanisms that corporations can use to apply this paradigm. The focus is put on Corporate venture capital and acquisitions while the other mechanisms are left outside the analysis. The main features of CVC and acquisitions are described with a wide use of reports of academics that analyze the advantages, disadvantages of the different ways with which these practices can be applied by established companies.

After the theory about open innovation is presented, it is brought into the context of the energy industry. First, the energy sector is presented with a historical perspective to understand which drivers brought the need for open innovation. Then a prior art of the acquisitions and CVC deals in the energy sector is conducted, highlighting their main consequences and effects on the industry. Finally, the gaps in the literature are highlighted and consequently, the Research questions are presented.

The second chapter presents the methodology of the quantitative analysis that has been conducted. After the presentation of the scope, it is explained the sources of and criteria with which data have been selected for each of the three samples analyzed: Acquisitions, CVC deals, and independent start-ups. Finally, the variables of interest are deeply explained.

The results of the analysis are explained in the third chapter. In the fourth and last chapter the reader can find the conclusions, the managerial implications of the findings and few last remarks on open innovation applied to the energy sector.

Chapter 1

Literature review

1.1 Collaboration between corporations and start-ups

1.1.1 What is Innovation?

The concept of innovation has always fascinated mankind and it evolved over the centuries and cultures. From ancient Greece in which the historian Xenophon (430–355 BCE) considered it intrinsically connected to politics, passing through periods in which it was considered negatively as in the 1600s where it was a synonym of "rebellion" [Mazzaferro, 2018]. Only in the 1900s, after the Second World War, innovation was tied to the idea of economic growth and competitive advantage because people started talking about innovative technological products. Joseph Schumpeter is often considered the father of the modern success of the concept of innovation by studying it in the context of business and economics. Scholars of business and economics widely discussed innovation and many definitions were written. [Baregheh et al., 2009] [Zawawi et al., 2016]; [Stenberg, 2017]; [Taylor, 2017].

Baregheh [Baregheh et al., 2009], aware of the multitude of dimensions encompassed by this notion, took up major components of different definitions and ended up writing that ***"Innovation is the multi-stage process whereby organizations transform ideas into new or improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace"***.

Innovation nowadays is considered the key to ensuring a competitive advantage, better performances, and survival [Menguc and Auh, 2006]; [Zawawi et al., 2016]. Porter [Porter, 1991] reminds that the success of an innovative company is not only given by its operating environment but also depends on its dynamic capabilities: the firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments. Dynamic capabilities reflect a firm's ability to achieve new and innovative forms of competitive advantage given path dependencies and market positions [Teece D. J., 1997]. This means that no company is "too big to fail" and being successful at one point in time is no guarantee of continued survival, there is the need for flexibility to adapt in a continually shifting environment.

The dualism between innovation and dynamic capabilities has brought start-ups, new, little and slender organizations, to disrupt and dominate entire industries that once were dominated by big and consolidated corporations, e.g. Spotify in the music industry. While the concept of corporation is perfectly embedded in our culture, the one of start-up is harder to characterize unequivocally through a standard definition.

"A startup is a human institution designed to create a new product or service under conditions of extreme uncertainty"[Reis, 2013].

" A startup is a temporary organization designed to search for a repeatable and scalable business model"[Blank, 2003].

These two very interesting definitions allow us to understand the main features that distinguish start-ups from established corporations. Start-ups work in an uncertain environment, they do not have a definitive business model and they have hypotheses of value proposition and business models which must be tested.

Start-ups usually aim at becoming a large and profitable company and successful entrepreneurs have different possibilities for successfully selling the majority of their ownership of the venture, often referred to as "successful

exit". They can go public with an Initial public offering (IPO) or a SPAC and collect capital by selling shares of their ownership to anyone interested in investing in their project. Otherwise, they can participate in an M&A that implies either merging with another firm or selling the majority of ownership to another firm. Usually, these counterparts are established corporations that have a strategic interest in the acquisition of the startup. [Kwon et al., 2018]

Until a few decades ago, the relationship between a start-up and a corporation had been quite hostile. Established firms have considered start-ups mainly a threat aiming at reducing their market power and margins. Start-ups have always feared the potential of investments of corporations that could recover very fast their technological or market advantage. Established companies and start-ups could interact only when the start-up was ready to exit and lose its freedom of operations by merging or being acquired. This relationship has changed, start-ups and corporations have started collaborating from early stages. It is interesting to highlight the reasons behind this shift and how it can help corporations to access innovation and introduce it in their value chain.

1.1.2 The crisis of the closed innovation paradigm and the rise of open innovation

Traditional business strategies are based on ownership and control as key levers in achieving strategic success. This way of thinking pushes firms to build barriers against the forces of competition [Chesbrough, 2003]. As a consequence, many firms have embraced the so-called "closed innovation paradigm" in which it is believed that the only way to innovate is through investments in internal R&D, both in terms of capital and labor. The R&D laboratory is the main locus in which innovation is produced, thus the larger it is, the better, due to the economies of scale. The best R&D projects are transferred to the market, according to a funnel model. The degree of the radicalness of innovations is usually positively correlated to the size of investments in internal research. The firm uses these innovations to make an extra profit that can cover also the R&D expenses. [Huizingh, 2011], [Chesbrough, 2003]. The Closed innovation paradigm is based on three pillars (1) Vertical integration in R&D (e.g through acquisitions of small high-

tech firms, which are integrated as R&D laboratories);(2) The key locus of firms' innovation strategy is the R&D laboratory and the firm has control over its process;(3) The firm produces and commercializes all (or at least most of) innovations generated by its R&D department.

According to Professor Rossi (2020), this closed paradigm was very successful for most of the 20th century but then it entered in a sort of crisis due to different elements:

- **Fast pace in knowledge creation.** In the last decades, private and public organizations have created a tremendous amount of knowledge across many domains. No organization can keep the pace of this tumultuous knowledge creation internally. It is a complexity that is not manageable by a single organization. E.g., Robotics, artificial intelligence, cybersecurity.
- **Raising costs of developing innovations.** Given that a lot of knowledge has already been produced in many domains, a firm needs higher investments in large projects compared to the past in order to radically innovate.
- **Strong cross-fertilization across several knowledge domains** To realize something new, a firm needs Interdisciplinarity in its teams.
- **High risks of unintended knowledge leakages.** This risk has increased over time due to the development of information and communication technologies. Tacit knowledge can be shared easily nowadays.

All these phenomena shrink the returns on internal innovation investments. It is no more possible to keep all the knowledge production internally. Moreover, research internal to a single firm is not fast enough to keep the pace of innovation.

In few words, innovation nowadays requires higher costs, and it is riskier since it is difficult to develop something radically new. This bundle of factors puts in crisis the traditional model of innovation based on command and control and gave birth to a new model, the Open Innovation paradigm. The logic will be, therefore, that the firm will turn to the external market as soon as it considers it cheaper to buy knowledge externally than to produce

it internally [Chesbrough, 2011].

Open innovation can be defined as *"a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model"* [Chesbrough and Bogers, 2014].
Instead of developing internally all the knowledge needed to innovate products, services, or business models; firms should search it around (inbound open innovation). On the other way, firms are not forced to commercialize by themselves the knowledge generated but they can directly "sell" it (outbound open innovation). [Huizingh, 2011]. For the purpose of my work, I will focus on Inbound open innovation because this thesis aims at analyzing the dynamics and features of two particular methods with which Inbound open innovation can be made: Acquisitions and CVC.

An overview on the concept of inbound open innovation is needed to understand further analyses.

1.1.3 Inbound open innovation

"Not all the smart people work for us. We need to work with smart people inside and outside our company" [Chesbrough, 2003]).

"In an industry with, say, 10 firms similar in output and investment in R&D, each member of a nine-firm technology cartel [or network] can expect to obtain immediate access to nine times the number of innovations that the remaining enterprise can anticipate on the average." [Saint-Paul, 2003]

"firms which do not cooperate and which do not exchange knowledge reduce their knowledge base on a long-term basis and lose the ability to enter into exchange relations with other firms and organizations."
[Koschatzky et al., 2001]

The quotes above support the idea that successful innovations depend on the creation and integration of new knowledge: technological, strategic, and market-related. Many authors have already analysed the positive effects that the exploitation of diverse knowledge sources, outside organiza-

tional boundaries and even sectorial limits, can have over radical innovation. These studies spread from evolutionary economic theory [Jensen et al., 2007] [Nelson and Winter, 2002] to management [Nemet, 2012]
[Rosenberg and Nelson, 1994]

Consequently, a corporation willing to innovate must be ready to do a shift: it is no more uniquely important to *know how* to do something, but it is even more crucial to *know where* knowledge is. The knowledge is dispersed across organizations and space, thus it is relevant to be able to spot it. Universities, competitors, and start-ups are crucial sources of knowledge. Each firm that wants to be innovative nowadays, is at the core of a network of relationships, and the relevant knowledge can be found in many places: R&D laboratories of other firms, universities, communities, start-ups, etc. An example is Tesla, which orchestrates a network of collaboration with organizations of different nature. This thesis work focuses on the analysis of start-ups as the source of external knowledge, consequently, no further attention will be given to universities, communities, and competitors with an established business model. Given that the organizations involved in these networks are very different from each other and very distant both physically and in the intents, it can be challenging for a firm to deal with the actors of its network. Thus, it becomes a priority for a corporation to improve its absorptive capacity which is usually defined as the ability to optimize the focus and intensity of external knowledge search and, once found, to assimilate it [Zahra and George, 2002].

To have a clearer view of this paradigm, let's take the perspective of a corporation and let's see how can it apply Inbound open innovation nowadays. There are many strategies possible. Here we consider a brief framework built by Professor Rossi from Politecnico di Milano after the elaboration of the literature on the subject. Then the focus will shift on the strategies that consider the collaboration between corporations and startups, the core of our study.

Firms can adopt different strategies to apply open innovation. The strategies can be classified in a 2*3 matrix. The Two dimensions of the matrix are: (1) Degree of externalization, meant as the degree to which the exchange of knowledge happen internally or externally to the corporation; (2) Method of interaction between actors that can be physical or through digital platforms.

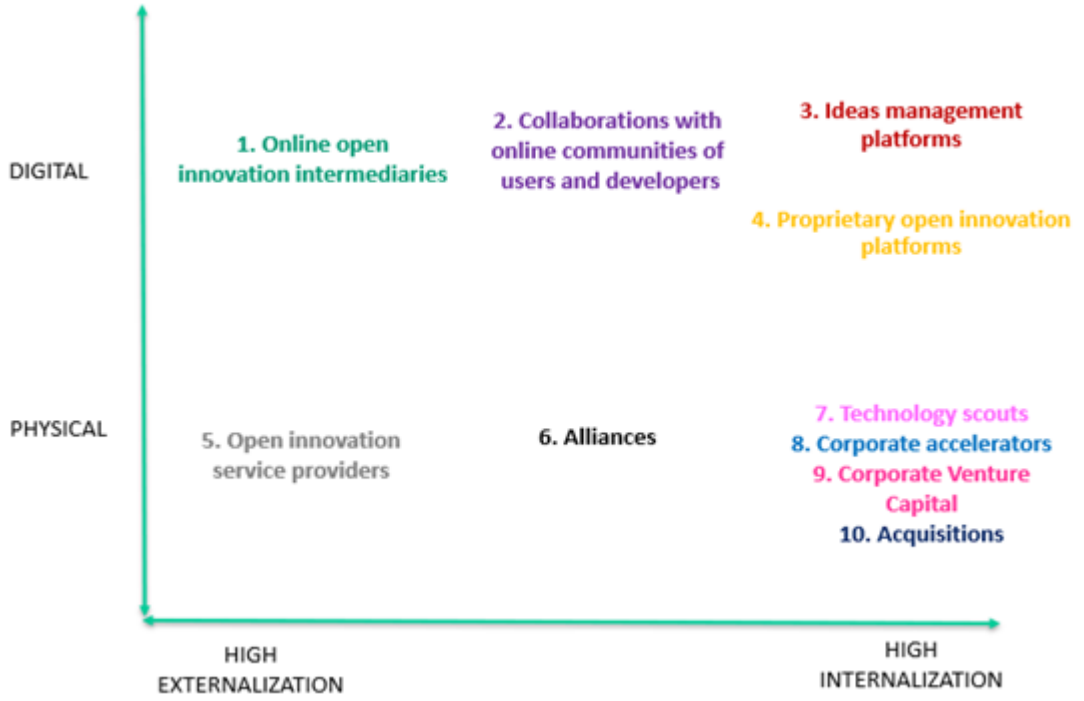


Figure 1.1: Inbound open Innovation strategies taxonomy. The taxonomy is adopted from the elaboration of the literature carried out by Professor Rossi, 2020

1. **Online Open innovation intermediaries.** OIOI match organizations that must solve innovation problems with potential problem solvers. These usually take the form of a platform. InnoCentive is a telling example.

2. **Collaborations with online communities of users and developers.** Individuals (users and developers) often engage in innovation, (e.g. snowboard invention or LINUX) the development of the Internet and Digital Technologies have boosted this phenomenon. One intriguing case is crowdfunding. In the case of a crowdfunding project, someone puts an innovation project on the web and does an open call for the provision of financial resources. Most of the innovators use dedicated

crowdfunding platforms. Through crowdfunding, they do not only receive money to solve the financing, but they also receive comments and suggestions.

3. **Ideas management platforms**. IMPs help organizations gather ideas from their employees, evaluate them and bring them to the market.

4. With a **proprietary open innovation platform** organizations can gather ideas from their employees, evaluate them and bring them to the market by using their own platforms. Some examples are Philips or Siemens.

5. OISP (**Open innovation service providers**) are firms that do business by helping other firms to engage in Open Innovation. They help firms in identifying relevant knowledge, transform it, and applying it to exploit the innovation on the market (Explore-Shape-Apply). An example is Blue Think.

6. **Alliances.** They require a contract that defines collaboration between independent entities, usually of similar size, that implies a long-term relationship that usually aims at a joint technological development or at joining forces to commercialize their products/services and share benefits and costs. It represents for Keil [Keil, 2000]: a "close interfirm relationships with the objective of creating or supporting the creation of a new business area".

7. **Technology scouts** are employees of an organization who spend 100% or a portion of their time creating connections for innovation with external stakeholders, residing in different geographical areas. This is the case of P&G

8. In **corporate accelerators**, large corporations enroll cohorts of very early-stage start-ups and support them in enacting business opportunities. Start-ups have a natural bent for innovation. This bent is nurtured by the fact that they are very flexible, they do not suffer from inertia. Large firms, which suffer from inertia, can exploit start-ups' tendency to innovation combining their large resources in corporate accelerators. Engaging in an accelerator program the relationship is mostly based

not on strict control, but trust. This reduces the fear of start-ups that large corporations steal their ideas.

9. **Corporate venture capital** consists of the investment of corporate funds directly in startups. A large firm takes an equity stake in an innovative startup, the firm provides business expertise to the startups and gains a technology window.

10. **Acquisitions.** A proper acquisition is when a firm A (acquirer) purchases the equity capital of firm B (acquired or target).
[Haspeslagh and Jemison, 1991].

The scope of this report is to give an overview of both the successful trends in innovation in the energy sector depicted by the start-ups that are developing in the last few years and the features of the collaboration between corporations and startups in this industry. Consequently, all the digital strategies of the precedent framework are out of scope. Alliances, as defined by Professor Rossi, usually do not involve start-ups, thus they are not coherent with our scope. Accelerators would be an interesting subject of analysis but they deal with very early-stage start-ups. These ventures are still far in developing a sustainable business model thus they have still a too high probability of failing and therefore not shaping the actual trends in the sector of our attention. That is why they are not considered further. Finally, technological scouts are an interesting subject to describe their impact on the success of a company in applying the open innovation paradigm. However, few pieces of information are available on the subject thus it was not possible to include it in the analysis. Corporate venture capital (CVC) and Acquisitions are the two strategies of open innovation that will be considered in detail because their analysis can show us trends that can impact the business in the energy field in a medium-short period. Moreover CVC represents a strategy the more and more corporations are considering as a driver for success.

"While we certainly make a lot of acquisitions, CVC has become such an important means for strategic growth that no companies in our industry can now neglect it. We are proud to be the industry leader, but we are also humble enough to know that we can't develop all the new products and technologies by ourselves. We have expanded our venture capital investment in the past several years, and we will maintain this strategy in the future."

Interview of a manager of a leading electronics company [Tong and Li, 2011].

Before entering the details of how Acquisition and CVC works and what features have been considered in the empirical study. It is worth highlighting that a company should never leverage only on Open Innovation, Relying only on external sources of knowledge determines the loss of strategic and unique skills of a company. Thus, the future lies in an appropriate balance of an open innovation approach, where the company or the institution uses every available tool to create successful products and services faster than their competitor, and, at the same time, a closed approach by still fostering the building of core competencies and protecting their intellectual property. A wider and more diverse pool of knowledge sources fosters innovation as it enables building new competencies through the combination of complementary knowledge sets from internal and external sources [Bergek et al., 2013] [Teece D. J., 1997]. At the same time, internal knowledge sources are needed to strengthen the impact of external knowledge sources by improving absorptive capacity [Zahra and George, 2002].

In the following paragraphs, a more detailed analysis of CVC and Acquisition will be carried out to have a clear overview of the reasons behind the empirical analysis explained in chapter 2 and the theoretical background of variables analyzed.

1.2 CVC: Corporate Venture Capital

1.2.1 Introduction to CVC

Corporate venture capital can be defined as "a minority equity investment by an established firm in an entrepreneurial venture that seeks capital for growing its operations" [Dushnitsky, 2012]. CVC investments often confront substantial uncertainty because they focus more on early-stage to mid-stage ventures [Drover et al., 2017], i.e. entrepreneurial projects that have rarely found a sustainable business model yet. An important distinction must be made between traditional independent VC (IVC) and corporate venture capital (CVC). While the former consists usually in funds managed by expert venture capitalists and created to bring financial returns to the investors; the latter are units created as an extension of the corporate they belong to, thus they usually aim at bringing not only financial but also long-term strategic

value to the parent company. Corporate venture capital is now a widespread concept linked to open innovation, but it is not a new methodology. CVCs started about 20 years after the constitution of the first VC fund in the mid-1960s. From that moment it followed the same economic cycles as VCs, coming in waves. Experts believe that Corporate venture capital programs are currently in their fourth "wave" [Dushnitsky, 2011]. CVCs are touching record peaks and the number of deals has almost doubled from 2015 to 2020, as shown below in the figure 1.2.

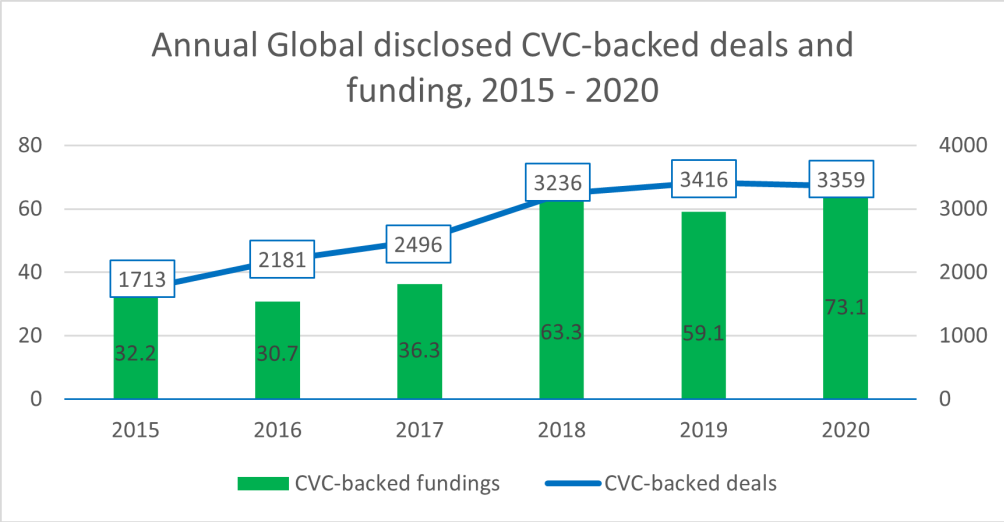


Figure 1.2: Annual global disclosed CVC-backed deals and funding, 2015 – 2020 Source: CB Insights

1.2.2 Drivers influencing CVC adoption

The literature provides many analyses on the drivers influencing the firm's adoption of corporate venture capital as well as the intensity of usage. The drivers can be clustered in three main categories: firm, industry, and geographic level.

A) **Firm's drivers**

Certain features of the parent companies, as the age of the firms, their size, and the degree of diversification strongly influence the activity of the corporate venture capital. Age shows a negative correlation with CVC investments because the former usually implies higher obstinacy in exploiting existing businesses [Sørensen and Stuart, 2000]). On the contrary, larger firms have more resources to deploy uncertain investments and diversified firms have access to more investment opportunities in their different operating areas. Thus, the size and degree of diversification of its portfolio impact positively the use of CVC. [Basu et al., 2011].
The relationship between CVC activity and firms' characteristics is not mature yet, a relatively small number of articles use historical accounting data or other firm-specific measurements to examine the conditions under which established corporations are most likely to support ventures through CVC investments. Until now articles supported the positive correlation between CVC investments and marketing expenditure and corporation's technological resources [Basu et al., 2011]. Moreover, Dushnitsky and Lenox [Dushnitsky and Lenox, 2005] highlighted the role of corporation's cash flow and innovation stock as antecedents of CVC investments. Finally, a major finding of the of study of Gaba and Bhattacharya [Gaba and Bhattacharya, 2012] is that corporations tend to fund a CVC unit when their innovation performance is close to their social aspirations.

B) **Industry drivers**

Several studies have concluded that the industry and environmental context shape the value of CVC. Industries characterized by strong growth and the turbulences of technological change are fertile fields for CVC [Basu et al., 2011];[Dushnitsky and Lenox, 2005];
[Sahaym et al., 2010]. The abundance of appropriate resources in a particular environment and the average industry R&D intensity support CVC investments. [Sahaym et al., 2010].
From a managerial perspective, CVC may be more or less incentivized by the behaviors of the corporation's peer group. [Gaba and Dokko, 2016]. Managers involved in innovation-related goals are often evaluated considering the peers' performance as a benchmark. Thus, we could be led to think that a difference between this latter and the actual firm's per-

formance may support more risk-taking strategies as CVC. However, the reality is more complex. Gaba and Bhattacharya
[Gaba and Bhattacharya, 2012] found out that a firm is more likely to maintain a CVC unit active when the innovation performance is closest to that of its peers. If performances are too below to the peers' ones, this could constraint the firm's ability to change, if they are above, a firm has a low incentive to invest in innovation.

C) **Geographical drivers**

Creating and maintaining a CVC unit is a strategic decision for a firm, consequently, it is heavily influenced by the geographic position of the parent company. Villemeur and Nayaradou
[Villemeur and Nayaradou, 2006] stated that geographic clusters, ranging from a local industrial area to the well-known Silicon valley, ease the transfer of knowledge and practices between companies, necessary for open innovation. This is because clusters determine positive externalities such as information spillovers and easy access to skilled labor. It has been demonstrated by Gaba and Meyer [Gaba and Meyer, 2008] that, by considering the weighted average of the geographical distance of the three predominant VC clusters (SiliconValley, NewYork, and Route 128) the probability of a CVC adoption increases, if the firms' headquarters are located close to one of the VC clusters.

Moreover, geography also influences the managerial culture and business practices [Khan and Law, 2018]. An important role in encouraging firms to adopt CVC is played by institutions and regulations, especially those affecting business entrepreneurship. In countries where CVC activities are faced with costly regulations, such as severe personal bankruptcy measures or the market for early-stage investment is not yet developed, the adoption of CVC may be less likely [Drover et al., 2017].

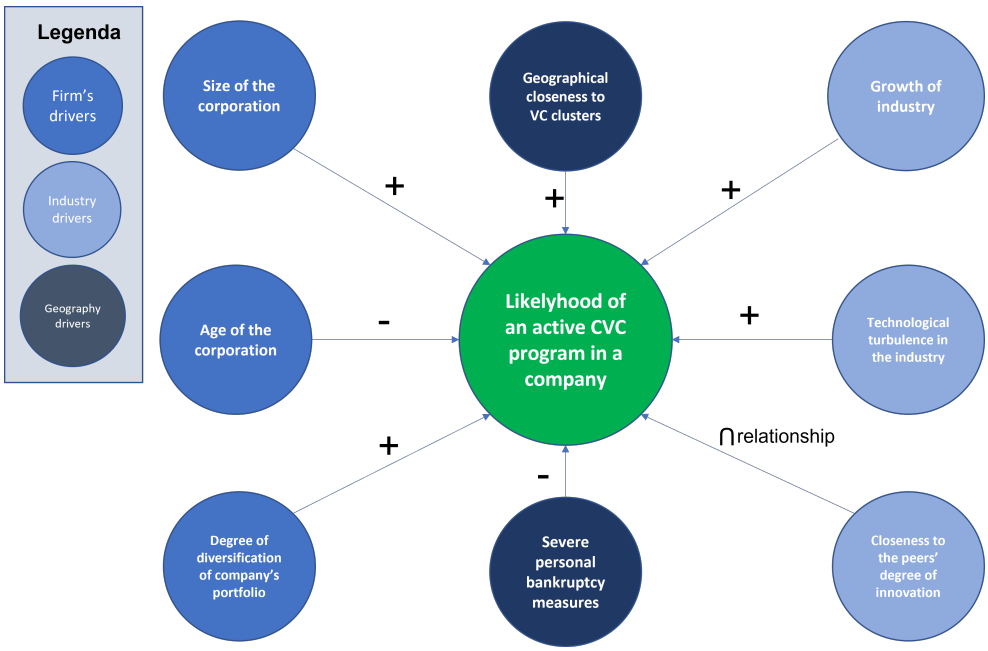


Figure 1.3: Framework of the drivers influencing the likelyhood of an active CVC program in a company

1.2.3 Parent company's strategy and CVC

This section aims at explaining why firms could strategically benefit from adopting CVC

A) **Alert Mechanism: monitoring of markets**

Corporate venture capital is crucial in helping top managers monitoring technological disruption and transform them from a threat to an opportunity. [Maula et al., 2013]. Indeed, technological change is often a process characterized by incremental innovation subject to shocks of disruption. This derangement occurs usually at the periphery of the industry, in a niche where innovative start-ups, entering the market with a more or less validated business model, are then often able to change radically the overall sector in ways difficult to predict by incumbents. [Christensen, 1997]. Consequently, CVC supports the incumbent's management in keeping the firm updated on important tech-

nological innovations thanks to inter-organizational relationships. The interactions with different partners give the corporation crucial information on events happening at the boundaries of their industry, thus allowing it to adapt the strategy to their potential implications for the firm [Maula et al., 2013].

B) **Real option on new technologies**

Another CVC benefit is considered the one of allowing firms to learn about innovative ventures and support knowledge transfer by building a relationship with them [Keil, 2000]. The relationship, built upon a minority investment, requires a low initial commitment while it allows retaining the possibility to capitalize on the growth potential of good ideas through subsequent investments. Indeed, thanks to CVC activity, incumbents position themselves as privileged customers/partners of the targets they invest in, if the technology offered by the target proves successful. Consequently, the downside risk is much lower if compared to an acquisition. In this aspect, a CVC unit provides the firm with a real option that may or may not be exercised depending on the evolution of the technological environment and the development of the funded venture. CVC can therefore be compared to a call option which gives the investor the right, but not the obligation, to inject larger resource commitments into the future [Ceccagnoli et al., 2018]. CVC provides internal information about the ventures allowing the firm to reduce uncertainty and to decide more consciously about the eventual exercise of the option. This feature of CVCs gives corporations the right flexibility needed to deal with the uncertain environment of early-stage start-ups [Trigeorgis, 1993];[Triantis and Borison, 2001]; [Cossin et al., 2002]. Finally, a consistent and long-term CVC activity helps the firm to increase its ability in detecting soon interesting technological opportunities [Benson and Ziedonis, 2009], and in exploiting at best the benefits deriving from the acquisition of innovative start-ups [Cohen and Levinthal, 1990].

C) **Impact on the R&D activity and the internal innovation rate**

CVC represents a mechanism with which corporations can apply an open innovation paradigm. Consequently, CVC influences the role of the R&D laboratory in knowledge production. The rise of open innovation, and consequently CVC, has made internal R&D spending a smaller piece in the overall innovation investments compared to the past [Dushnitsky and Lenox, 2005]. Although Dushnitsky and Lenox [Dushnitsky and Lenox, 2006b] found evidence that CVC investments could increase a firm's innovation rate, these results are too simplistic according to other scholars studying the relationship between CVC activities and corporations' innovation rate. Wadhwa and Kotha [Wadhwa and Kotha, 2006] found that the relationship was only valid when corporate investors have a high level of involvement with their portfolio firms. Otherwise, there is a negative correlation between the number of CVC investments and the innovation rate. A similar discrepancy can be found in the analysis about the impact of the usage of CVC and the patenting activity. Schildt et al. [Schildt et al., 2005] found a positive linear relationship, whereas, Lee et al. [Lee et al., 2015] showed that, beyond a certain point, the engagement in CVC can also diminish patent-driven activities. This is probably due to how the corporation exploits the knowledge of the venture in its portfolio. A parent company could decide to collaborate and take inspiration and knowledge to push further internal innovation. On the contrary, it could decide to leave autonomy to the startup and further exploiting the real option for further investing and lastly eventually acquiring it to incorporate all their inventions. Further studies on this field could be interesting to further develop this topic.

D) **Market enactment**

CVC can also have an exploitative purpose. CVC can support the enactment of markets or technologies so that the firm can leverage its existing resources and capabilities for example through the promotion of its standards [Keil, 2000]. Many companies are also investing in CVC investments for exploitative learning to strengthen their existing business model [Lee et al., 2018].

In conclusion, we can assess that CVC programs can be used both for exploration and exploitation. A corporation could be willing to analyze the borders of its sector and beyond to develop a new business or it can exploit new capabilities to create competitive advantages in its existing business. Some authors have analyzed the factors that may favor one strategy over the other. Basu and Wadhwa [Basu and Wadhwa, 2013] investigated how the use of external venturing mechanisms could influence the strategic renewal tendencies of corporations. Relying on longitudinal data, the authors argued that CVC investments are mainly used to enable growth opportunities in existing and new businesses, but that such investments did not result in a withdrawal from a corporation's core business. This negative relationship between strategic renewal and the use of CVC is heightened for corporations operating in highly dynamic environments and with strong technological capabilities. In dynamic industries, the high intensity of competition may preclude the firms to completely change business because it would imply a change in all the firm's dimensions creating the risk for a complete failure. Moreover, the strength in technological capability is a feature built over years of effort and it would make little sense to completely detach from it while doing CVC activity. It is more convenient for a firm of this kind to exploits CVC to improve its developed resources and therefore creating further competitive advantage. On the contrary, in a mature and stagnated industry, CVC can be a useful tool to exit from a business with little hope of growing and being profitable and enter in what Boston Consulting Group would call a "star business". Interestingly, a study by Hill and Birkinshaw [Hill and Birkinshaw, 2012] shows that CVC units relying on an ambidextrous approach in the form of the simultaneous use of CVC as an instrument to explore and exploit capabilities have a higher survival rate than those with a clear focus.

After having understood the possible reasons behind the adoption of CVC programs, we can therefore understand the difference between CVC and traditional independent venture capitalists. If the latter is mainly interested in financial returns, the "raison d'etre" of the CVC exceeds this objective. Even though financial goals are still important, firms adopt CVC actions to also get strategic benefits [Dushnitsky and Lenox, 2005].

"Firms that engage in CVC for strategic objectives contribute more to overall parent firm financial performance. In contrast, those that pursue

VC-like objectives can erode the parent's performance"
[Dushnitsky and Lenox, 2006a].

To better understand the strategic orientation that a CVC deal can have, it is useful to present an organized framework that analyzes carefully the distinction between objectives that can be sought using CVC. This scheme is the fruit of the work by Professor Henry Chesbrough. His analytics framework intends to help firms in their decision-making process to know where and how to invest according to the benefit sought to turn their CVC program into a strategic growth tool [Chesbrough, 2002]

The Chesbrough framework [Chesbrough, 2002] proposes to analyze a CVC deal according to two fundamental dimensions: (a) the corporate investment objective and (b) the degree of linkage between the activities of the parent firm and that of the invested start-ups. As regards the first dimension of analysis, the author states that, beyond the multiple objectives that push them to invest in CVC described in the previous section, firms invest in start-ups for two dominant reasons. On one hand, the company could be willing to identify and take advantage of the synergies and connections it has with the invested venture to boost its sales and increase its profit (strategic motive). Formal alliances are often established between the investee venture and the parent company to support these strategic objectives. On the other hand, the motive could consist of purely high financial return (financial motive). This is the usual fuel of traditional venture capital funds (IVC). With CVC parent companies try to do better than their financial counterparts, or at least as well as them, leveraging on superior market knowledge, longer investment horizon, and benefiting from a "signaling effect" due to their brand image. The second axis of analysis corresponds to the degree to which the operational capacities, i.e. the resources (manufacturing plants, distribution channels, technology, or brand, etc.) and processes (company's business practices in building, selling, or servicing its products) of the parent company are linked to the target venture. The link can be either tight or loose. A tight relationship may emerge when the venture can use the resources or adopt the practices of the parent company.

4 typologies of behaviors towards CVC emerge from the two dimensions defined above:

- **Driving Investments (strategic objective, tight link):** The in-

vestment is intended to support the parent company's current strategy. The comprehension of the start-up and the integration of its offer with that of the parent company is facilitated by their tight link. In this context, the parent company minimizes its risk and the start-up is exploited to support the firm's current business. This strategy will not be adequate if the firm has to respond to a major disruptive force or apply an explorative attitude.

- **Enabling Investments (strategic objective, loose link):** The parent company is still investing in a strategic goal but it is far from the start-up in terms of operational capabilities, industries, knowledge, and technology. The parent company can introduce complementary capabilities by broadening its portfolio of activities.

- **Emergent Investments (financial objective, tight link):** The parent can take advantage of the proximity with the start-up's operations, knowledge, and industry by leveraging on its expertise to identify ventures with potential, short-term high financial returns. For their parent company, these start-ups represent an exploratory tool tested in real market conditions, providing incomparable insights. Emergent investments are seen as real "strategic" options. These options represent a strategic opportunity because they may be exercised if the market changes and it requires a shift in the parent company's strategy.

- **Passive Investments (financial objective, loose link):** Investing in those start-ups becomes comparable to pure financial investments. These investments are outside the parent company's strategy and the two organizations are far in terms of capabilities

This framework highlights the typologies of investments that can be done by the CVC unit of a company. Little has been said about the possible structures and the governance of the deals. The independence from the corporation board with which the CVC unit can act differs a lot among corporations. Moreover, it is not always the case that a corporation invests in an early-stage venture alone, it may agree to be supported by a VC fund or other corporation. An explanation of the different types of structure and governance of the CVC deal will e explain in the following sections.

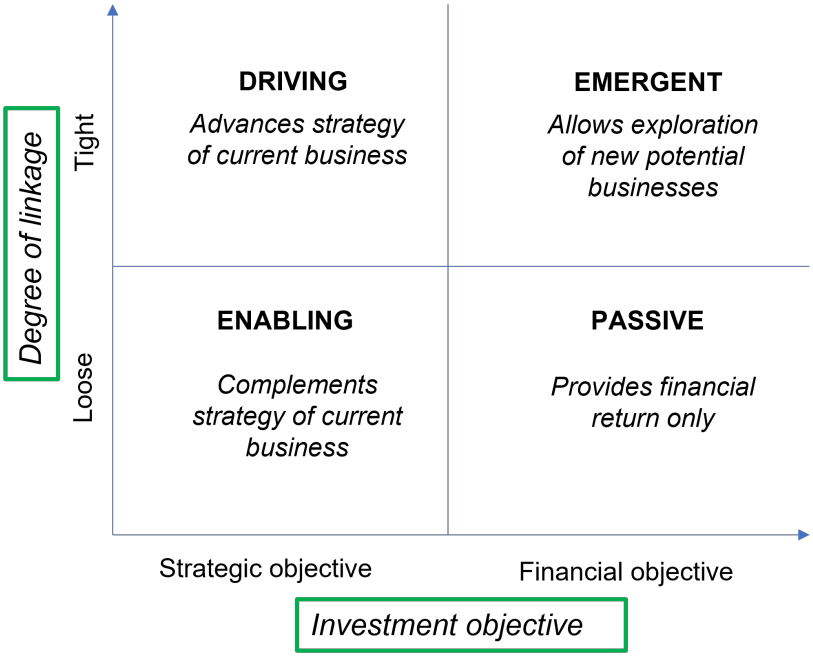


Figure 1.4: Chesbrough Framework

1.2.4 Structure of CVC's deals

The following section discusses the issue of how CVC investors structure and monitor their investments.

A corporation can decide whether to invest in ventures on its won (stand-alone investment) or to participate in an inter-firm alliance in which all the partners involved take equity participation in an independent legal entity, a start-up, and share benefits and costs. The latter structure is usually called syndication [Wright and Lockett, 2003]. The partners can be both traditional VC funds or investors, which in our analysis we called financial partners, or with CVC unit of other corporate, in the analysis corporate partners. The work of Maula et al. [Maula et al., 2013] has given empirical evidence that the presence of top-tier VCs in a syndicated investment gives CVC better equipment to prepare and react to technological discontinuities. Syndication has proved to be beneficial also for traditional VCs which are looking for prestigious companies to make investments with to

access a multitude of resources that are different from their own but complementary [Röhm, 2018]. Syndication allows an incumbent to reduce further the risk of the investment not only because the investment is shared among different actors [Jääskeläinen, 2012], but also because the presence of other valuable well-informed partners enables a CVC unit to "double-check" the value of an investment [Gompers and Lerner, 2001]. Moreover, syndication grants a CVC to position itself in the center of a VC network which may lead to access more easily to new resources [Jääskeläinen, 2012], and further investment opportunities [Gompers and Lerner, 2001]. Leveraging on the expertise of other VC investors, an incumbent can also improve its ability to find a venture that represents an optimal strategic fit [Yang et al., 2009].
The size of the syndication, which is the number of co-investors investing money in the same financial round, si influenced by many factors. Interestingly the presence of a CVC unit seems to increase the size of the alliance [Dushnitsky and Shapira, 2010].

Even though syndication has proved to positively impact the financial performance of a CVC unit, Hill et al [Hill et al., 2009] noted that CVC investors may prefer a stand-alone approach if the exclusivity may increase their capability of appropriation of the investee's value. Other authors highlight the potential drawbacks of syndication. Anokhin et al. [Anokhin et al., 2011] argue that, in highly concentrated industries, CVC units could limit the potentiality of their venture investments by placing themselves in the center of a VC network. Thus, they should keep away from this position by investing in portfolio companies without the participation of well-positioned co-investors.

A network of partners in a syndication always presents lead investors. There are some advantages in being the lead investor. While the other co-investors simply provide the money at the set price, the lead investor is generally in charge of defining the transaction price. Moreover, it has the privilege of receiving the right to sit on the board of directors to monitor the management's behavior and to receive first-level information. Board representation is the main post-investment monitoring tool for a CVC arm [Gompers and Lerner, 2000] because it can reduce the cost of principal-agent problems and thus prevent opportunistic behavior of managers
[Fama and Jensen, 1983]. This representation can also give precious pieces of information about market trends and on new technological innovation [Gompers and Lerner, 2000]; [Yang, 2012].

1.2.5 Governance of the CVC

There are different ways in which CVC activities can be managed. The CVC unit is the intermediary between the parent company and the start-ups subject to investments but is situated within the corporate organization. Hence, the parent company decides the governance of the program the CVC unit sets up. P. Rohm [Röhm, 2018] states that the governance of venture investments has an impact on the performance and the achievement of the firm's goals. Although the governance of the CVC unit is, therefore, a crucial topic, it has been less under the spotlight of academics compared to other arguments about CVC due to the limited availability of data [Dushnitsky and Lenox, 2006b].

A) **CVC unit's organizational structures**

Managers have different structures with which they can set up the CVC unit according to the degree of involvement of the parent company [Keil, 2000]. According to the analyses of Dushnitsky and Lenox [Dushnitsky and Lenox, 2006b]; Keil [Keil, 2000]; McNally [McNally, 1995]) and Rohm [Röhm, 2018], 3 main organizational structures can be identified: (1) direct investment also called "Balance Sheet", (2) self-managed Fund or "General Partner", (3) indirectly managed fund or "Limited partners".

In order to keep consistency with the definition of corporate ventures accepted in this thesis, the Limited partner structure will not be considered in detail in the further sections. This is due to the fact that it represents a pure injection of money from the parent firm into a traditional venture capital fund aiming only at gaining financial returns without any strategic implication and it precludes the company to have a direct influence on the investments' program. [Hill and Julian, 2008].

The Direct investment or "Balance Sheet" corresponds to the situation where CVC activities are under the responsibility of the current business units of the parent company. Thus, the parent invests directly into the ventures. The self-managed structure or "General Partner" implies the setting up a self-managed and quite independent structure within the parent company, solely dedicated to pursuing CVC activities. This fund can be organized similarly to a traditional VC fund or

simply as an investment subsidiary. Finally, in the indirectly managed funds or "Limited Partner" structure, the parent company acts as a limited partner because it leaves the management of the CVC unit to a third-party, typically independent venture capitalists, in a dedicated or pooled fund. A dedicated fund is conjointly created with an independent venture capitalist while a pooled fund is set up by several companies.

Hence, CVC demonstrates to not be an identical organizational copy of an independent VC (IVC). The strategic dimension of the purpose of a CVC unit implies different obligations from those of a IVC (areas of investment, potential conflicts, changing political priorities, etc.). Thus it is logical that even though adopting some aspects of the IVC model can improve the survival rate of the CVC unit, a "blind replication" of the IVC model will not allow the parent company to reach its venture capital goals. [Hill et al., 2009]

B) **Choice of the structure**

The choice of the governance of the CVC unit is influenced by several factors. The level of autonomy impacts the capital allocation process and the independence in the decision-making
[Dushnitsky and Lenox, 2006a];[Lee et al., 2018]. An autonomous CVC unit could easily decide to invest more adventurously in ventures not closely correlated to the parent company's current business model in the short term [Yang et al., 2016]. A Balance Sheet structure will be considered much more rigid compared to the setting-up of an independent fund as in the General and Limited partner structure. Interestingly, many authors found out that there is a positive correlation between the degree of autonomy of the CVC unit and both financial returns on investments and the achievements of strategic objectives. [Gompers and Lerner, 2000], [Siegel et al., 1988] , [Teppo and Rolf, 2011].
Finally, Yang et al [Yang et al., 2016] studied the link between autonomy of the CVC unit and diversification of the portfolio of investments concluding that a major degree of autonomy has a positive impact on the learning process of CVC managers.
Although it seems, from what was said before, that a more autonomous structure is always the most beneficial, a broader perspective is ex-

plained in the work of Lee et al. [Lee et al., 2018]. The choice of the degree of autonomy should be adapted to the objectives that a CVC unit has: explorative or exploitative. If the CVC unit aims at exploring outside the traditional boundaries of the parent company's business, it is logical to conclude that a more autonomous structure is a better fit because it allows the CVC unit to act unconstraint and invest rapidly in targets unrelated to the current parent activities. On the contrary, an autonomous structure could be detrimental for CVC units aiming at exploiting the investee to complete the offer of the parent company in the short term. This is due to the disconnection between the CVC unit and the resources of the parent company. Close interaction with the current business units is crucial to understanding their needs and, thus finding suitable opportunities. Lee et al. [Lee et al., 2018] propose even to divide the CVC unit into two separate sub-structures, one for exploration and exploitation with a coherent degree of autonomy.

Other factors play a role in the choice of structure. The attitude towards risk of the company influences the choice because the degree of risk exposure both from a financial and legal perspective increases moving away from a Limited partner structure in which the management and responsibilities are left to a third party. [Keil, 2000]. Moreover, the level of maturity of the CVC activity of the firm should guide the choice of the structure. A company that has just entered into the corporate venturing activities, would be wise in signing a partnership with an IVC because it would have easier access to deal flows, learn the typical VC procedures as due diligence, valuation, development of startups, etc.) and exploiting their support [Keil, 2000].
Other authors [Hill and Julian, 2008] found CVC's success to be dependent on a unit's ability to build strong relationships internally (i.e., with senior executives as well as business unit managers) and externally (i.e., with independent VC funds). It is therefore essential to balance the advantages and disadvantages of each structure to ensure coherence with the goals of the corporate venture capital program.

1.2.6 CVC Outcome: Principles for CVC success

From the perspective of the parent company, CVC programs can have different objectives. However, a CVC investment can still be recognized as successful, on average, if it has both positive financial returns and a positive strategic impact on the parent company's business. The latter could consist in an increase in patenting rates and/or the ability to respond timely to technological discontinuities thanks to the real option available in emerging ventures. Leten and Van Dyck [Leten and Van Dyck, 2012], after an extensive literature review and interviews with corporate venturing managers of twelve European multinational firms, argue that there are a few principles to success that apply to all venturing strategies across industries. These are goal clarity, long-term commitment, adjacency between the parent company and start-up's knowledge domains, autonomy of the CVC unit, and critical mass of the investment.

Why a start-up should accept a CVC deal?

CVC programs are spreading among early-stage ventures and we cannot believe that this is due only to the major interests of parent companies. It is necessary that also ventures find some benefits that traditional VCs are not able to give them. It can be agreed that both CVC and IVC can allow early-stage ventures to overcome financial restraints allowing them to increase their R&D investments and outperform their counterparts lacking VC backing [Bertoni et al., 2012]. CVC stands out from traditional VC because it allows a link with a corporation and, consequently, access to complementary assets that can represent crucial technical support to the venture [Chesbrough, 2002]. The benefits of this last aspect have been demonstrated by Alvarez-Garrido and Dushnitsky [Alvarez-Garrido and Dushnitsky, 2016] and Park and Steensma [Park and Steensma, 2013]). By Comparing ventures based in the US, the work of both demonstrates that the innovation output of these ventures is sensitive to the relevant investor type. In both studies, the innovation output of CVC-backed ventures outperformed that of their IVC-backed counterparts, whether measured through patents granted or patent applications. Of course, a strategic fit between venture and corporate mother is needed for the CVC vehicles to add this value to the entrepreneurial venture [Ivanov and Xie, 2010]. Finally, the study of Maula et al. [Maula et al., 2013] highlights that CVC units outperformed their

independent counterparts by helping their portfolio companies to attract new foreign customers and acquire valuable information on new technologies. The results regarding the internationalization behavior of CVC-backed ventures emphasize that corporations can support their portfolio companies by bridging the so-called "liability of alienness"(i.e. firms are likely to be very wary of entering into trading relationships with unknown firms) through their track records. Regarding the internationalization of CVC-backed ventures, LiPuma [LiPuma, 2006] found contradictory results. Based on a sample of 1348 ventures the author could not find a positive relationship between CVC funding and the internationalization intensity of ventures.

1.3 Acquisitions

1.3.1 Introduction to acquisitions

An acquisition involves a firm buying a target company, and it has been the focus of a large body of strategy research [Haspeslagh and Jemison, 1991]. There is often confusion in distinguishing the concept of acquisitions from one of the mergers. The former refers to a takeover of one entity by another, usually larger. It usually implies an exchange of the acquirer's cash for the target's Equity. The acquirer can leverage on money borrowed by a bank through loans or bonds (leverage acquisitions) or it can leverage only on its liquidity (non-leveraged acquisitions). On the contrary, mergers occur when two separate entities combine forces to create a new, joint, organization. It usually does not require cash but only a reciprocal exchange of common stock [Grant, 2016].

Nowadays, the two terms have become increasingly blended and used in conjunction with one another and the practical differences between the two concepts are gradually being consumed by the new term M&A (merger and acquisitions).

In this report, the term M&A and Acquisitions will be used as synonyms for simplicity. However, it is worthy to recall that this work focuses on the acquisition of innovative start-ups by incumbents and not mergers.

Similar to CVC, also M&As' intensity follows economic cycles.

1.3.2 Benefits of Acquisitions from the perspective of the Acquirer and the start-up

This work will consider the specific context of the acquisitions of innovative start-ups by corporations, thus some aspects generally referred to M&A will be neglected to avoid confusion for the reader.

A) **Acquirer perspective: strategies behind an acquisition** An Acquisition of an innovative startup can benefit the acquirer in many ways. It can strengthen its competitive position by allowing the corporation to eliminate potential future competitors or avoid existing rivals to access the start-up's resources. It is the case of Google acquiring YouTube or Facebook acquiring Instagram. As regards innovation, an incumbent could incorporate the technologies, patents, and human resources of the young venture. The acquisition price is usually lower than the hypothetical costs for internal production. Moreover, this difference becomes even larger if we would consider the opportunistic costs linked to the time needed to develop everything inside the acquirer's organization [Rhoads et al., 2012]. Finally, an acquisition could help a corporation in strategic renewal. On one hand, it could bring external sources of growth because it could help the firm go out of its current business model, entering new markets, and internationalize. On the other hand, the entrepreneurial spirit of the start-up's employees and founders can stimulate the incumbent's management to overcome the inertia to change and increase their adaptability to rapid circumstances change by transferring the culture of the lean approach [Puranam and Srikanth, 2007].

The Literature provides several taxonomies with which we can classify M&As. The different categories of M&As have wide implications on the benefits that the acquirer can get. One of the most diffused taxonomy distinguishes between four types of M&A:

- **Horizontal M&A:** It comprehends two or more firms that compete in the same industry and/or geographical market (e.g. PSA+FCA, LVHM+Tiffany).
- **Market expanding M&A:** It happens between two firms in related, but not overlapping, industries. (e.g Microsoft+Nokia).

- **Vertical M&A:** this M&A integrates two firms along the value chain. If a supplier is incorporated, the deal is defined as Backward M&A, while if the integration consists of a distributor we are in presence of a Forward M&A
- **Conglomerate M&A.** In this context, the actors are firms in totally unrelated businesses, which do not fit into any other category. This usually happens for big firms that do acquisitions in many different industries. A large conglomerate firm has a lot of cash to burn, and engaging in an M&A is a way to burn cash Or to exploit the bank effect, thus little strategic purpose is intended by the acquirer.

Rumelt [Rumelt, 1974] presents another interesting distinction between related and unrelated M&A. The former tackles businesses that produce the same product, while businesses that do not produce the same product are the subjects of unrelated M&A. A firm can improve its competitiveness while, at the same time, keeping intangible assets and tacit knowledge through related M&As. On the other hand, unrelated M&As facilitate diversification of the risks in its active sectors and helps improving its profitability [Rumelt, 1974]. However, there are some drawbacks to the strategy about unrelated diversification. Palepu [Palepu, 1985] supports the idea that the strategy of related diversification is significantly more profitable than the strategy of unrelated diversification. Kim et al. [Kim et al., 2016] analyze the relationship between firm growth and technological diversification. Results show that excess diversification can worsen the firms' growth rate. Moreover, they found out that the risk of diversification strategy can be reduced by core technology competence.

The above classifications may be used as the main reference in the analysis on the purposes that each type of M&A could aim at. However, to keep the same line of interpretation as we had with CVC, we have considered the Chesbrough's framework as model for the analysis and classification of the strategies behind the acquisitions in the energy sector (Chapter 2). Consequently, the categories of Strategies behind acquisitions are the same as the ones described in Section 1.2.3 but we would apply them to Acquisitions of innovative start-ups.

B) **Start-up perspective: strategies behind an acquisition**

At the very beginning, the founders could create a start-up with the intent of making it an established firm. However, after years of work, they could be willing to relieve some personal stress and gain the profits of their job. The founders could be also pushed or forced to abandon their ownership by eventual funds or investors that want to sell their shares and get the desired positive financial return. An acquisition is one of the main ways with which the main owners of the equity of a start-up can exit. This acquisition can be pursued by a corporation with strategic interest in the venture, such as a competitor, a supplier, or a distribution. In this case, the exit is called Trade Sale. Another potential buyer could be another financial investor, usually a private equity fund. In this case, it would be called Secondary Buyout. [Demaria, 2013]. The former owners of a venture could still decide to stay in the organization after the acquisition, therefore, it is logical that there are other possible advantages in following this choice. A start-up could benefit from an acquisition also from accessing to complementary financial and non-financial assets. The acquirer can give to the venture the liquidity needed to grow and develop further. In a Trade Sale, the start-up could receive guidance from the expert acquirer, technological assets to improve their offer, and preferential supply and/or distribution channels to increase sales and profits. (Rossi, 2020)

1.3.3 Impacts of acquisition on innovation and moderating factors

Acquisitions are complex phenomena that can have multiple effects on the new emerging firm. Large literature studied the different consequences that an acquisition can have on both the target and the acquirer. This work is focused on M&A as a tool to engage innovation. This paragraph analyses the literature about the relationship between Acquisitions and innovation in the new entity created. We marry an approach that supports the idea that whatever the deal's specific characteristics or motivation of an acquisition may be, its exploitation in terms of innovation will be affected by the ability of the acquirer to identify and exploit those opportunities.

In this context, many authors use two measures to assess the performance

of the innovation tackled by a company. First, the innovation input, proxied by R&D intensity which is measured by the ratio of R&D expenditure to total assets. Second, the innovation output, proxied by R&D productivity and measured by the ratio of successful patent applications per $million of R&D expenditure of the acquirer.

Many theoretical arguments support the idea that M&As are beneficial for both aspects of innovation performances. According to a resource-based view, an acquisition enables a company to access useful and complementary resources avoiding time-consuming internal research [Barney, 1991]; [Dierickx and Cool, 1989]; [Teece D. J., 1997]. At the same time, an acquisition can bring to an established firm a revitalization of the knowledge base that can make it overcome eventual stagnation due to its continuous exploitation that leads to nothing fruitful[Capron and Mitchell, 1998];
[Vermeulen and Barkema, 2001]. Traditional economics literature states that acquirers, with an acquisition, can become larger and therefore exploiting the advantages of R&D economies of scale. The acquirer can reach more easily critical mass and, consequently manage better indivisibilities. In this way, the inventions coming from R&D can be economically more competitive [Calderini and Garrone, 2003]; [Cassiman et al., 2005]. A larger R&D department can spread its fixed costs on a major number of outputs, minimizing underutilization of assets' capacity, and increasing its productivity. An acquisition can also bring economies of scope in the R&D department because more R&D projects in the same lab can make the company exploit the opportunities of cost-saving and risk-sharing [Baumol et al., 1982];
[Henderson and Cockburn, 1996]. The combination of different knowledge domains should bring also synergies and super-additive effects.

However, empirical studies on acquisitions in different sectors are, on average, not coherent with these theoretical predictions. Studies focused on the impact of acquisitions on the R&D intensity report a neutral effect [Danzon et al., 2007]; [Hall, 1999]; [Healy et al., 1992] or a negative effect [Hitt et al., 1991]; [Hitt et al., 1996]; [Ornaghi, 2009];
[Ravenscraft and Scherer, 1987]. Equivalently, analysis on the relationship between acquisitions and R&D productivity shows a neutral effect
[Prabhu et al., 2005] or a negative effect [Hitt et al., 1991]; [Ornaghi, 2009].

Scholars studying the relationship between acquisitions' activity and innovation performances have attempted to reconcile theory and evidence. They

developed different frameworks focused on those characteristics of the environment and of the actors that may diminish the positive impact of the acquisition on innovation input and output. These aspects are usually referred to as moderating factors. Moderating factors are mainly acquirer's characteristics. Desyllas at al. [Desyllas and Hughes, 2010] explain this aspect can be explained in two ways. First, it has been argued by Zollo and Singh [Zollo and Singh, 2004] that most post-acquisition decisions, including those about innovation, are mainly taken within the acquirer's departments without a heavy representation of the target's labor. Moreover, the acquirer tends to impose to the target its management tools [Cannella Jr and Hambrick, 1993] and therefore the target's innovation activity will follow strictly the acquirer's guidelines because its R&D process will be governed by the acquirer's incentive mechanisms. Second, in a highly technological environment, where knowledge loses its value quickly, the acquirer's absorptive capacity is the key to the success in the post-acquisition innovation performances [Glazer and Weiss, 1993]. As a consequence, the moderating factors are usually aspects that are likely to influence the acquirer's absorptive capacity and selecting the appropriate target for its innovation purpose.

One of the most studied moderating factors is the size of the knowledge base of the acquirer. Desyllas and Hughes [Desyllas and Hughes, 2010] drafted analytics research which concluded that the size on the knowledge base of the acquirer has different impacts on Innovation performances if we are referring to a related or unrelated acquisition. Moreover, this relationship is moderated differently if the acquirer has a concentrated knowledge domain or if is interested in different businesses. In related acquisitions, there is a positive correlation between knowledge base size and R&D productivity. However, this correlation becomes statistically insignificant when the acquirer has very specialized (i.e. concentrated) knowledge. This can be due to the minor potential for learning and to a smaller potential for cross-fertilization [Cohen and Levinthal, 1989]; [Kapoor and Lim, 2005]; [Prabhu et al., 2005]. In unrelated acquisitions, a positive relationship between acquirer's knowledge base size and R&D productivity holds only for acquirers with a very wide knowledge base. These results imply that a concentrated knowledge base can prevent acquirers to have the skills' variety and experience to deal with the complexity of absorbing information and resources coming from outside their current business [Day and Schoemaker, 2006]. Consequently, a firm aiming at acquiring companies from outside their sector, should be sure

to have a degree of knowledge diversity in their R&D department such that they can select a suitable target for their purpose and exploit its intellectual resources. Professor Rossi (2021) tried to synthesize these concepts by suggesting an inverted U-shaped relationship between R&D productivity and knowledge distance between acquirer and target. If the two actors are too similar in terms of the knowledge domain, there is a high risk of duplications and redundancies, which decreases the efficiency of the R&D activities. However, if the distance is too wide, it would be almost impossible for the acquirer to exploit the knowledge of the target [Prabhu et al., 2005].

Looking at other moderating factors, the acquirer management's characteristics play a crucial role in influencing the success of the innovation strategy with an acquisition. The integration of two organizations is tough and long work. Consequently, the acquirer seniors' energy and time could be diverted from R&D activities. This diversion negatively impacts both innovation performances. [Hitt et al., 1991]. Moreover, if the acquirer is not used to apply a flexible and lean philosophy, typical of start-ups, it will need high costs of restructuring that will reduce the amount of money that can be dedicated to R&D, thus R&D intensity will decrease. Finally, cultural conflicts may arise bringing to the potential loss of the target's talents and the interruption of the innovative momentum of the start-up. [Calderini and Garrone, 2003]; [Chaudhuri and Tabrizi, 1999];
[Ernst and Vitt, 2000]; [Ranft and Lord, 2000]. An old-fashioned corporation could still try to reduce the negative effects of acquisition if they opt for a structural separation between the acquirer and the target. The established firm can decide to leave large autonomy to the target and still getting the returns of their work.

1.4 The energy sector and Open innovation

The group of established companies working in the energy industry is extremely wide and diversified both from the perspective of the geographical distributions of activities and, foremost, the composition of the portfolio of businesses. They represent a very good example of how the closed innovation paradigm has left more and more the floor to open innovation. Energy companies, that relied for decades on strong internal R&D departments, now need to acquire knowledge from external sources, such as energy start-ups

and also young ventures not strictly related to this industry. Supporting the demand for open innovation is the urgency for an energy transition to fight climate change. As we already explained in section 1.1.2, open innovation represents the fastest way to bring to the market new disruptive inventions. In this industry, speed is even more crucial than for other sectors because only radical inventions in all the fields related to generation, distribution, and use of energy can protect our planet from overcoming the increase of the average global temperature of +1.5 degrees Celsius. This threshold represents the limit beyond which the consequences will be not only irreversible and catastrophic but there is no way to predict exactly what will happen, thus any counter-measure is impossible to plan in advance. [IPCC, 2018]. The new objectives of decarbonization set by global agreements like the Paris convention and the repercussions of climate change on customers' needs and desires are the most known reasons behind this shift the energy companies are making. However, other mega-trends are converging in this sector, pushing its actors to innovate openly. Digitalisation, big data, and the new threat of highly high-performing disruptive ventures are also constraining companies to speed up the development of innovative products, services, and business models. All these factors combined are re-defining the energy sector. New companies coming from outside are re-inventing businesses considered mature (e.g. Uber with mobility), and energy utilities are enlarging and differentiating their portfolio of activities, including businesses concerning a smart building, energy efficiency, smart mobility, etc.

1.4.1 A brief historical background

To understand how we arrived at a shift in how innovation is made in this sector, the story of power utilities is essential. Power utilities represent "de facto" the main actors in this industry and the ones that are changing the most in the last decades. All countries around the world have consistently asked for more and more energy over the years [Ritchie and Roser, 2020]. Companies working in this sector have exploited the growth of demand for their products. Influenced by traditional business techniques they opted to invest in scale and large batches to drag down costs per unit. In this way, they were able to increase margins and at the same time satisfy the growing demand. Starting from the 1900s the companies who succeeded were the ones developing large infrastructures [Patel, 2020]. Energy power utilities needed to be large to afford heavy investments necessary to push costs

down, increase efficiency and level of output and make their products an affordable commodity. This philosophy then pushed the leaders in the market to increase entry barriers and costs advantages as main levers for blocking small new entrants, making scale increasingly significant. Moreover, with the intent to bring universal access to energy, many governments acted to protect the investments of these companies by regulating entry barriers and guaranteeing the recovery of initial investments. Hence, energy power utilities became "de facto" a natural monopoly [Byrne and Mun, 2003]. These companies have grown taking advantage of the insatiable demand for energy, the benefits coming from economies of scale, and the public insurance of recovering initial investments [Bryant et al., 2018].

Although the formation of these massive industrial groups enjoying a protected position allowed universal access to energy, it has also caused various negative externalities. High entry barriers reduced competition and therefore the incumbents were not encouraged in doing further both incremental innovation to increase efficiency and, foremost, radical innovation that would have risked cannibalizing the old offers reducing the recovery of past investments. It is not surprising that the energy industry is one of the sectors that spend the least amount on R&D. The amount of R&D as a percentage of sales is barely 1% when compared to 5.9% for the automotive sector or the record of 15% in the pharmaceutical and biotechnology industry [EFPIA, 2018]. Consequently, many countries started a movement of liberalization called 'power liberalization' with the aim to rationalize the development of the sector by seeking a more optimal allocation of roles and more efficient operations along the electricity value chain, allowing markets dynamics to regulate the sector instead of political decisions [Byrne and Mun, 2003].

This democratization of the energy industry opened the doors of the market to new entrants. They were aware that the costs advantage due to scale was unreachable and therefore married a strategy based on differentiation competitive advantages by investing in radical innovation that could cut costs and completely disrupt traditional energy business models. At the beginning of the 21st century, the companies in the energy sectors were considered mature industries with limited growth and profits eroded by new entrants [Fukasaku, 1998]; [McKinsey, 018b]. The situation for incumbents is even more deteriorating because, as predicted by Christensen [Christensen, 1997], threats are rising not only from new lean and adaptive players but also from

ventures belonging to unrelated sectors, such as IoT and big data, that are adapting their technologies to the mature energy sector. Tesla is a good example because from being only a car manufacturer, now is diversifying its core knowledge about batteries in the utility industry with its large-scale energy storage capacity [Tesla, 2019].

The convergence of mega-trends is disrupting the energy sector for the long term. Incumbents have historically focused on their essential activities and always struggled in introducing new services.
[Accenture and Berthon, B., 2019]. Thus they have rarely been technology innovators but mainly technology integrators [Teppo and Rolf, 2011]. Fortunately for them, they can use open innovation mechanisms to survive and potentially start a revolution in the energy sector that can trigger new growth opportunities. It is necessary to understand these mega-trends to further analyze the strategies and the activities that incumbents and start-ups are managing.

1.4.2 Major disrupting factors in the energy sector

A more detailed analysis of the major trends bringing the enormous shift in the energy sector is presented here.

1) **Digitalisation** The energy sector is not excluded by the group of many sectors that are subjected to the disruption of digitalisation. Creating a digital copy of physical systems allow to model better complex systems. This brings higher productivity and efficiency in all the processes of the energy value chain. It optimizes the management of the power production, transmission, distribution and improves the customer relationship by giving more flexible choices for their energy consumption and use. [McKinsey, 2016]. Moreover, it is the base of the implementation of highly interconnected energy systems in which every traditional consumer can become also a producer offering their eventual energy surplus to someone in need. Digitalisation is also giving opportunities to newcomers, experts in digital business, to challenge the position of power utilities [General Electric, 2021].

2) **Climate change and the need for energy transition** Human activity caused an increase of slightly more than 1 degree Celsius of the

global temperature compared to the pre-industrial levels. All around the globe, we are experiencing more frequently the catastrophic consequences of climate change, extreme events like drought, heavy rains, and extreme heat. As the IPCC [IPCC, 2018] reports, these phenomena are going to become more and more frequent. This crisis is due to an exaggerated emission of CO2 that is mainly caused by a misappropriate generation and use of energy [IPCC, 2018]. There is the need for an energy transition that is only possible if power utilities and the other players involved in large energy consumption innovate their product, service, and business model.

Today renewable energy seems to be the solution to reduce one of the biggest causes of climate change: fossil fuel consumption. However, the application of this solution is not simple. The International Energy Agency's World Energy Outlook 2018 [IEA, 2018] highlights that the pace of deployment of renewable energy sources is not fast enough to cover the increase of energy demand, mostly in developing countries. Moreover, the production of clean energy implies more complex power plants portfolio and electricity networks. This is because the generation and distribution of renewable energy are not stable and continuous over time. After all, its sources have intermittent nature. Consequently, these aspects raise the crucial need for an economical, distributed, and efficient storage system to avoid the permanent obligation to have energy demand and offer perfectly balanced [Bryant et al., 2018]. There is an urgent need of making renewable energy systems cheaper than fossil fuels, and this requires disruptive innovations.

The case of renewable energy is the perfect example to show how the innovations needed to have a timely and successful energy transition must cover many disciplines. Unfortunately, the vast majority of power utilities, who are the actors that should drive this transition, find many barriers for innovation starting from the lack of competencies, entrepreneurial spirit, financial and time constraints
[Energy Strategy, Politecnico di Milano, 2021]. Thus, it seems reasonable to consider Open innovation as the possible solution to overcome these obstacles and try to change how we live the energy before the dangerous threshold of +1.5 degrees Celsius is reached.

3) **Decentralization** The traditional approach of power generation based on centralized plants is characterized by high transmission and distribution costs which are eliminated with the new paradigm of distributed generation (DG) which provides electric power at a site closer to the consumer. DG also reduces fossil fuel emission, defers the capital cost, reduces maintenance investments, and improves distribution feeder voltage conditions. These results are demonstrated by Labis et al. [Labis et al., 2011]. They show that optimally located DGs, renewable in nature, are more economical in the long run compared to a centralized power plant if we take into account also carbon dioxide emissions and fuel costs.

These trends are increasing the complexity of the portfolio of activities the energy actors should manage. They are challenging energy companies to increase their scope and position beyond the traditional meter because the value is shifting to IoT, home ecosystem, energy efficiency solution, smart building, smart appliances and devices, etc. [Franzo, 2020]. Even though large power firms have still a strong and close relationship with clients, they are not bringing technological innovations to the energy sector. Because of their history, they are not used to create competitive advantage through innovation [Teppo and Rolf, 2011]. Large energy players should enlarge their traditional business and becoming "comprehensive energy solution providers" [Bryant et al., 2018].

In few words, the mega-trends converging in the last decades in the energy sector are forcing traditional players to embrace a radical and environmental innovation, which is far more complex than in the past and involves several inter-dependencies across diverse knowledge domains [G. et al., 2015]; [Grubb et al., 2017]. These include areas such as product design and production system operation [McNerney et al., 2011], end-user behavior [Iorio et al., 2017], and interaction of regulatory (environmental taxes and technological standards) and accommodating policies (e.g. innovation or adoption subsidies) [Unruh, 2000]. Established energy firms are not used to develop this kind of innovation and consequently accessing external sources of knowledge and apply Open innovation mechanisms seem the only solution available to deal with these challenges in a timely and effective manner. The literature supports that openness is particularly beneficial to renewable energy technologies [Lee et al., 2015]; [Popp, 2017]. All these aspects explain

why, to achieve this turnaround, ever more energy firms are leveraging on CVC and Acquisitions to acquire knowledge and entrepreneurial skills with a scarce use of time and financial resources.

The motivations and main features of Corporate venture capital deals and Acquisitions have been already explained in previous sections. Given the peculiarities of the industry we are analyzing, and considering that the benefits and costs of these open innovation mechanisms depend on the sector characteristics, it is worth analyzing the literature assessing specific pros and cons of CVC and Acquisition in the energy industry.

1.4.3 CVC in the energy industry and Research Gaps

Few academic papers have focused on Corporate venture capital from a sectorial perspective, even fewer have focused on CVC in the energy industry. The radical changes and trends touching the energy sector have pointed out innovation as the key mean for the survival and growth of established companies. Open innovation, and in particular collaboration with start-ups, has been recognized as the main approach for incumbents to keep their leading position in this tumultuous industry. CVC fits particularly well sectors subjected to paradigmatic changes as they allow parent companies to gain insights into new and fast-evolving ventures and developments at the borders of the normal attention spectrum of companies [Dushnitsky, 2011].

So far CVC activities in the energy sector have shown that the start-ups subjected to the investments are tightly linked to the current operations of the parent company. This may be explained by two reasons. First, the range of activities of the parent companies is usually wide, thus a link is probable. Second, the turbulence in the industry pushes companies to not abandon their core competencies in order to survive [Fontana and Forer, 2013]; [PwC, 2014]; [Eurelectric, 2013]. As a consequence, CVC‘s portfolios are moderately diversified to avoid incurring exaggerated costs implications [Wadhwa et al., 2016]. Other studies focused on the ability of parent companies to create synergies with the supported ventures. Creating synergies and linkages is a tough task for all CVCs and energy firms are not an exception. However, they are used to deal with the difficult task of managing dispersed business units because their operations are spread in many different geographical areas. Consequently, it should not surprise that parent companies

have faced this challenge by putting in place several management practices to enhance inter-organizational learning [Dushnitsky and Lenox, 2006c]; [Vanhaverbeke et al., 2008] and Top management is highly committed to CVC programs either by being directly involved or leaving complete autonomy.

Academic researchers have dedicated fair attention to CVC. However, the vast majority of publications focus on the U.S. and Canada, while European and Asian CVCs are quite left behind [Rossi and Meglio, 2013]. Moreover, the literature so far has always had a global perspective while analyzing CVC, Few papers have approached the problem with a sectorial perspective. According to Livieratos and Lepeniotis [Livieratos and Lepeniotis, 2017], only two specific studies exist on CVCs in the energy sector
[Teppo and Wüstenhagen, 2005]; [Teppo and Rolf, 2011] and neither of those focuses on European CVCs during the fourth and last wave of investments.

1.4.4 Acquisitions in the energy industry and research gaps

The literature provides studies in which there are highlighted the positive and negative impact of acquisitions specifically for the energy sectors.

As regards the benefits, it has been assessed by Yoo et al. [Yoo et al., 2013] that companies working in businesses related to the conventional energy industry, usually characterized by non-green assets, can have a positive impact on cash flows after the acquisition of companies supporting sustainable projects. This is because consumers, now sensitive to the minimization of CO2 emissions, are prone to recognize a premium to companies showing an environmentally-friendly image that can be obtained with the acquisition of "green" ventures. In addition, nowadays governments are setting fines related to environmental goals, thus, an acquisition of a sustainable start-up may help reduce these environmental costs [Yoo et al., 2013].

Most acquisitions in the energy sector are related acquisitions. They proved to allow financial and operational synergies and an increase in market power. However, the unrelated acquisitions can be still useful in this sector and in particular for companies working with renewable energy sources.

Given that renewable sources rely on nature to generate electricity, there can be huge volatility in the production levels. Consequently, a company is incentivized to diversify the technologies in its portfolio in order to mitigate the risk of blockage of electricity production [Yoo et al., 2013].

Acquisitions have been demonstrated to bring also negative effects to the energy acquirers. These firms work in a market that, after liberalization, has become always more competitive. Competition, according to the Schumpeterian view, reduces the returns on investments in innovation and may bring negative returns because incumbents cannot take the privilege of insourcing external innovation without paying an acquisition price that often grows exaggeratedly because of competition among acquirers [Kwon et al., 2018]. These returns may be reduced even further by the high costs for integrating star-ups with low experience in the energy industry.

The literature provides various results and contradictory evidence about the contribution of Acquisitions for the energy sector and the acquirer. It is difficult to draw conclusions on this topic. Considering the importance of the research on acquisition in the energy sector, the inconclusive results highlight the need for more studies. Moreover, as Know et al. [Kwon et al., 2018] suggests, previous research about Acquisitions' effects is much more focused on the short term rather than the long term and this could be incoherent with the magnitude of the trends energy firms have to face. Fortunately nowadays, the attention to private acquisitions has brought attention to the collection of much more data about start-ups which have always been scarce. An interesting example is the raise of CrunchBase, a database born specifically to help the research of private companies whose data were often almost impossible to find.

1.5 Research objectives and questions

The energy sector is living a profound disruption and a desperate need for innovation. The literature recognizes that start-ups as one of main vehicle for innovation both in term of technology and business model [Freeman and Engel, 2007b]. However, as we have previously explained, in order to (1) reduce the time to market of inventions, (2) avoid redundancies and duplications in the market, and (3) reduce development costs; the ecosystem of established firms and start-ups should collaborate through inbound open innovation strategies

such as CVC and Acquisitions.

The Research shows some gaps and there is the need for further research, with a more actual perspective in order to continue the study of these still quite new phenomena.

This thesis is driven by two main objectives:

- **Trends in technological and business model innovation likely to affect the energy sector** First we are interested in the trends in term of both technological and business model innovation that are characterizing the energy sector. We will address the currents that are rasing from the deals of CVCs and Acquisitions. In this way, we will have an overview of the trends that are likely to impact on the sector in different time horizons. In fact, Acquisitions usually target start-ups that are mature enough to be worthy of an exit, and thanks to this deal, venture access to preferential resources and assets with which they can potentially penetrate the market with much more ease compared to the independent ventures. This implies that these start-ups represents the technology and business model's trends that are likely to impact the energy sector in the short term. CVC units are interested more in early-stage ventures, whose value is not quite defined yet and consequently their offer and way of doing business is likely to influence the sector in the medium term. To conclude, for the sake of completeness, we decided to analyze also independent start-ups in the energy sector to extrapolate insights about trends likely to be the subject of future collaborations with incumbents and therefore impact the energy sector more in the long term. This large topic bring to the following research question:

  What are the most relevant technological trends and the most popular types of offers among innovative startups in the energy sector, distinguishing short, medium, and long term impact?

  In the literature review has assessed the influence of geography on the success of open innovation. Thus it is interesting to reason on the geographical origin of the independent start-ups and the ones involved in deals of CVC or Acquisitions. The lack of analysis on European CVCs highlighted previously, brought us to focus our analysis on both CVCs and Acquisitions not only on the US. But also Europe and Israel.

The latter is demonstrating to be a powerful innovation hub worth discussing [Deloitte, 2020]. Consequently, the last question arises:

Where are the innovative startups interesting for the energy sector most concentrated? How are they geographically distributed?

With these two research questions e cover the temporal and spatial dimensions of the trends likely to impact the energy sector.

- **Features of CVCs and Acquisitions' deals** The question above focuses more on the start-ups and we have shown that they are not the only actors impacting the innovativeness of an industry. Established firms have a crucial role because they are the main promoters of open innovation, they are the protagonists. As we have shown in the literature review, the strategies and the structures at the base of the deals of CVC and Acquisitions can be various and they can influence the success of the deal in terms of both input and output of the innovation. The research gaps in the analysis of the CVCs and Acquisitions in the energy sector make it worthy to give an overview of these phenomena with a specific and sectorial perspective and with a focus closest to our current period. In this way, in case of CVC, we can assess whether the results of past studies are still valid today. Instead , in the case of Acquisitions, we can provide another perseptive in the chaotic bundle of analytical evidences fruit of past articles. Consequently the research questions would be:

  What are the strategies behind the acquisitions and the corporate investment in venture capital of energy star-ups? What are the structures of corporate venture capital units, belonging to power utilities, in the investments of star-ups?

In other words, our analysis focuses on the context of U.S., Europe and Israel by analysing a large sample of acquisitions of start-ups, corporate venture capital investments, and independent start-ups. The study provides an overview of the main trends of innovation that will characterize the sector in the short-medium term, highlighted by the Acquisitions and CVC, and long term, embedded in the independent start-ups. Moreover the thesis will highlight the features of these deals in term of strategies, structures and geographical location.

Chapter 2

Methodology

2.1 Scope of the analysis

The scope of the analysis is double. On one hand, this work aims at studying which innovation is likely to shape the energy sector in the more or less near future, highlighting new business models, types of offers, and emergent technologies. On the other hand, there is an interest in understanding how this innovation can be fastly brought to the market without redundancies, duplications, and waste of resources. Open innovation can be the key. Among Open innovation mechanisms, CVC and Acquisitions are ways with which established corporations can not only avoiding to be disrupted by new entrants, but they can participate and grow in this wave of innovation brought by new ventures.

The "fil rouge" of the first part of the scope consists of start-ups. It is given a triple temporal vision which depends on the degree of independence of start-ups and the time horizon in which they are likely to impact the sector. We start by the energy start-ups that have been acquired from players inside and outside the energy industry because they are consequently demonstrated to be most interesting for the market in the short term. Then we will focus on start-ups that received investments from energy incumbents, these start-ups are triggering interest by the established players of the sector. In this part, we want to show also how some incumbents are enlarging their vision by investing in unrelated businesses outside the energy industry boundaries. Finally, we are interested in understanding the innovation that can influence

the industry in the longer term by studying independent start-ups.

The second part of the scope takes more into consideration the incumbents and the features of their collaboration with the new ventures. The analysis focuses on the strategies behind both Acquisitions and CVC deals. Finally a study on the structure and governance of CVC deals is carried out.

2.2 Methodology

We distinguish three different objects of the analysis: Acquisitions of energy start-ups, CVCs deals of energy utilities, and independent energy start-ups. For each of these, we present the sources of data and criteria of selection used to conduct the study. Then we will show the variable of interests. Given that the subjects share some variables of interest we will present first a framework highlighting which variables they have in common and which do not, and then we will present each variable once. Finally, we will present the results following the logic of the research questions, first, our focus will be on the start-ups and the trends in the innovation with a triple temporal perspective, then we will focus more on the features of the collaboration between corporations and start-ups showing the structures and strategies behind the open innovation programs of Acquisitions and CVC.

2.2.1 Data sources and criteria of selection

Acquisitions of energy start-ups

The data sample was obtained from the triangulation of two databases. The first is Zephyr, the database of the Bureau van Djik group, specialized in the mapping of extraordinary operations of companies all over the world (M&A, joint venture, venture capital deal, corporate venture capital, and private equity). The second is the PitchBook platform. This database is the core product of PitchBook Data, Inc., a SaaS company founded in 2007 that delivers data, research and technology focusing on private capital markets, including venture capital, private equity and M&A transactions.

In order to be selected, the Acquisitions had to have as target a start-up active in the energy sector (we will define in section 2.3.2 what technological fields are considered belonging to the energy sector). The target must have

the headquarter located in the US, Europe or Israel.Finally, the Acquisitions selected were the ones closed between the 01/01/2018 and the 31/12/2020. The sample counts **42 Acquisitions**.

CVCs deals of energy utilities

The data sample was obtained from the triangulation of two databases. The first is Zephyr, and the second is Cruchbase, a platform founded in 2007 by Michael Arrington as a tool to track the start-ups that its parent company techCruch featured in its articles. Nowadays it offers various information of financial and strategic nature about companies and start-ups object of investments, among which CVC deals.

The main criterion for the selection of the deals of corporate venture capital was the presence, among the investors, of at least one energy utility. We considered utilities as companies that had commodities codes related to the production, distribution, or transmission of electricity; and/or the distribution, transmission, and sales of gas and/or waste and water management. To be included the utilities must have the headquarter in Europe, the Unites States or Israel. The deals selected are characterized by direct involvement of the utility through one of its business units (Balance Sheet) or a more indirect participation. In this latter case, the utility invested through a captive investment fund linked to the enterprise (General Partner model). If the utilities invested in a CVC deal through an independent venture capital fund (Limited Partner model), the investment was excluded from the analysis. This is due to the fact that the Limited Partner model represents a pure injection of money from the parent firm into a traditional venture capital fund aiming only at gaining financial returns without any strategic implication and it precludes the company to have a direct influence on the investments' program. On the contrary, the General Partner model implies a strong strategic influence over the investments.

The deal of corporate venture capital selected were the ones closed between 01/01/2018 and 31/12/2020.

The deal selected were not constrained to the geographical location of the target because we wanted to keep the perspective wide enough to capture as much as possible the interest of energy utilities of exploring outside of

their business, and geographical boundaries. The sample counts **188 deals** of corporate venture capital.

Independent energy start-ups

The Sample of data was built combining two databases: Cruchbase and PitchBook.

The start-ups were selected according to these criteria:

- Data of foundation between the 1/1/2016 and the 31/12/2020;
- headquarter located in the US, Europe or Israel;
- the venture must be active in a technological field included in the "Energy" category (see definition in section 2.3.2);
- active and independent status. This implies that they have never been the object of acquisition;
- the startup should have raised at least one round of financing throughout its history.

The sample counts **1027 start-ups**

2.3 Variables of interest

In this section, the variables of interest will be presented and explained. Firstly, it is shown below a Table synthetizing which variables were considered for each of the three topics of research. This table has the objective to highlight which variables are analysed for more than one object of research and therefore, their explanation can be done once.

Now an explanation of these variables is carried out.

2.3.1 The geographical location of start-up headquarters

This variable defines the reference geography of the start-up, with particular focus on the location of the headquarter.

	Objects of Analysis		
Variables of Interestes	**Acquitions**	**CVC deals**	**Independent start-ups**
Geographical location of start-up's headquarter	x	x	x
Technological area of start-up	x	x	x
Technolgical sub-area of start-up	x	x	x
Type of offer of start-up	x	x	x
Type of Acquirer / incumbent	x		
Technological field of Acquirer/incumbent	x		
Strategy behind the deal	x	x	
Governance of the deal		x	
Syndication		x	

Table 2.1: Variables of Interest for each object of analysis

Coherently with the Methodology, if with Acquisitions and Independent start-ups we have limited the analysis to Europe, the United States and Israel, for the CVC deal we kept a wider and global perspective.

2.3.2 Technological area of start-up

With this variable, we aim at determining the field of activity of the start-ups and thus be able to classify it according to the categories we have selected. The first step before being able to determine the technology area of the investee company was to understand its value proposition and how it delivers it. To do so, the descriptions of the start-ups provided by Crunchbase and the other data sources were used. Then, additional information research was done through the websites of the start-ups and press reviews. This allowed the description provided by Crunchbase to be compared with the start-ups' current activities. In some cases, the company had pivoted from its historical focus.

The second step was to leverage these descriptions to classify the start-ups in one of the technological areas belonging to the framework below.

As regards the technological area, a macro-subdivision was initially carried out into two main areas:

- Energy technological area
- Not-strictly-Energy technological area

Seven technological fields which are closely linked to the energy world (Energy technological area) have been identified:

1. **Energy efficiency/Facility management:** not only hardware solutions such as thermal insulation, windows, boilers, heat pumps, lighting that improve the energy efficiency of buildings, but also the services performed in ESCo logic or those relating to the facility management area.

2. **Energy storage:** all the energy storage solutions including not only the electrochemical but also mechanical and thermal ones, as well as the accessories/services associated with them regardless of their possible application (residential, industrial, utility-scale, and e-mobility).

3. **Smart grid:** hardware or software digital solutions that allow intelligent and efficient management of electrical distribution networks.

4. **Resource management:** Solutions (hardware, software, or service) related to targets active in the waste and re-use of waste, scraps, or water management.

5. **Smart building:** solutions enabled by components and digital technologies for the management of energy consumption and automation in the building sector, both in the civil (residential, offices, public administration) and industrial sectors (e.g. Building energy management system-BEMS).

6. **Smart mobility:** solutions relating to the world of mobility, including software solutions (for example, algorithms for autonomous driving), hardware (for example, components for electric cars, motion sensors for autonomous vehicles, charging stations), and services (for example, car-sharing platforms).

7. **Renewable energy:** solutions (hardware and software) related to components or plants for the production of energy from renewable sources (e.g. hardware solutions for plants or software related to monitoring or forecast of production).

8. **Energy – other:** solutions (hardware and software) related to targets which, despite having an explicit offer for the world of energy, do not

specifically fall into the previous categories. A relevant area in which they are activities these targets are represented by the world of the circular economy (e.g. sensors to monitor atmospheric pollution).

While concerning the non-strictly energy sector, five main fields have been identified in which the considered startups operate:

1. **Smart manufacturing:** hardware solutions and digital systems for the automation and efficiency of production processes and the tools that allow you to monitor and optimize processes productive through the management of related data (e.g systems of industrial processes' energy management, industrial robots).

2. **ICT and Cybersecurity:** hardware solutions, software, and services related to the ICT world aimed at optimal management and protection of data and plants/machinery.

3. **Data analytics:** solutions concerning data analytics that can be used by companies for activities such as marketing or the management of people flows. Those already classified in the technological fields are excluded from this category "Smart Manufacturing", and those related to sectors such as agriculture, medical, mining.

4. **Other:** solutions covering all technologies that cannot be included in the previous categories (e.g. surgery robots, digital measurement systems of biological metrics).

Not all the technological areas will be present in the object of analysis. According to the methodology we have used, the selected deals of CVC include targets active in both Energy and non-strictly energy technological areas, while the targets of the selected acquisitions and independent startups are related only to energy technological fields

2.3.3 Technological sub-area of start-ups active in energy areas

This work aims at identifying the technological trends that are likely to influence and disrupt the energy industry. Consequently, it seemed appropriate to define deeper research of the energy technological areas. For each of them, different sub-areas have been identified. (Table 2.2)

Energy efficiency / Facility management	Energy Storage	Resource management	Smart Grid
Sensors	Electrochemical storage	Water management	Grid management platform
Energy production systems	Thermal storage	Waste2Energy	Components
ESCo	Chemical storage	Recycling	Microgrid
Energy management platform	Components	Other	Metering
Insulation	BMS		Grid maintenance
Lighting	Other		Other
Other			

Renewable energy	Smart Building	Smart Mobility
Solar power	Building devices and Solutions	Autonomous driving
Wind power	Connectivity	Sharing
Asset management	Management and Control platforms	Charging infrastructure
Off-grid energy	Automation technologies	Electric vehicle and components
Solar and wind power forecasting	Other	Fuel cell
Green hydrogen		Parking management
hydroelectric		Fleet management platform
Other		

Table 2.2: Technological sub-area of start-ups active in areas strictly related to energy

As regards the non-strictly-related-to-energy areas, this further classification would have brought to an exaggerated number of sub-areas. Thus, this analysis has been excluded from this work.

2.3.4 Type of offer of start-up

The type of offer refers to how the venture delivers its value. The focus is on the content of the offer. Three main categories have been identified:

- Hardware
- Software
- Service

The three categories are neither rigid nor mutually exclusive, therefore mixed offer types have also been considered, which merge two or more of the categories listed above (e.g. Hardware + Software, Hardware + Software + Service, etc.).

2.3.5 Type of Acquirer

This variable consists of the core activity of the acquirer. Acquirers can be active in energy-related technological areas or non-strictly energy areas. So Acquirers will be classified in **Energy** or **Non-Energy** acquires

2.3.6 Technological area of Acquirer

This variable represents the same concepts as seen in Section 2.3.2 but applied to the Acquirers and an M&A deal. It consists of the same categories.

2.3.7 The strategy behind the deal

The analysis of this variable aims at understating which strategy the incumbent has defined behind a deal of Acquisition or CVC. This variable has been defined following the Chesbrough framework explained in Section 1.2.3 of the Literature review.
Based on both the degree of linkage in terms of core business between the start-up and the Acquirer/utility involved in the CVC deal and the corporate investment objective, four categories of strategies have been defined.

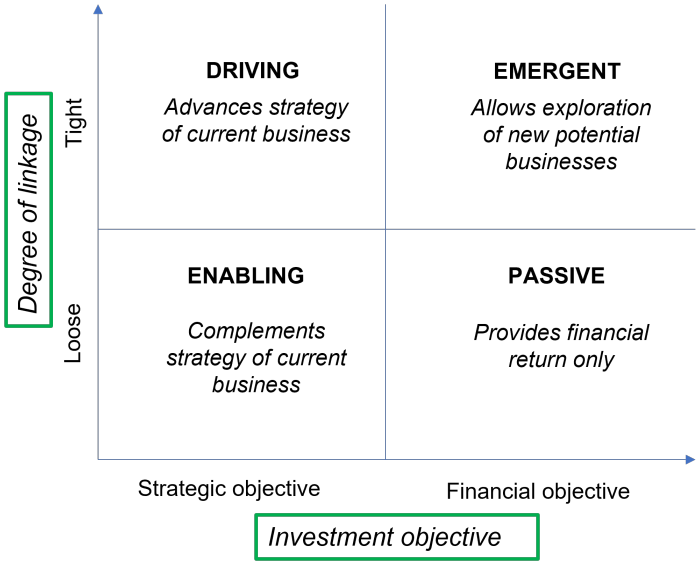


Figure 2.1: Chesbrough Framework

2.3.8 Governance of the CVC deal

As stated in Section 1.2.5 the company has different possible structures with which it can run a CVC program. The company can either invest directly through the corporation's operating/strategic budget or invest indirectly in the venture through a financial intermediary. The CVC units active in the selected deals will have one of the following structures:

- **Balance Sheet:** CVC investments are made directly by the parent company, using internal budget, structure, and capital allocation processes.
- **General Partner:** The investor is a General Partner of a CVC fund making the deal, where the parent company retains strong, if not complete, control over strategic decisions.

Coherently to what has been stated in Section 1.2.5, the deals with units characterized by the structure of Limited Partners have been deliberately excluded from the analysis.

2.3.9 Syndication of the CVC deal

By analyzing the nature of the investors involved in the CVC deals, we categorized each deal according to one of the following categories of syndication:

- **Stand-alone:** No other investors than the parent company in the round;
- **Investment with financial institutions:** There is typically the presence of one or several independent venture capital funds as investors and other financial organizations like banks;
- **Investment with industrial companies:** There is typically the presence of one or several corporates active in a CVC deal as investors;
- **Investment with both financial institutions and industrial companies:** There is both a mix of companies active in CVC and independent financial organizations (e.g. IVCs, banks) as investors

Chapter 3

Results

The framework of the scope and the research questions will be followed to present the the main empirical evidence from the analysis of the collected data. First, we are interested in highlighting the Trends in technological and business model innovation likely to affect the energy sector and the geographical distribution of the start-ups that are developing these inventions. To ease the comprehension of the results we will start showing the results for Acquired start-ups, then for the ones subject to CVC deals, and finally for the independent start-ups. Then the perspective will shift towards the corporations that are investing in start-ups and in particular the analysis will focus on strategies behind Acquisitions and CVC deals and how these latter are structured.

3.1 Start-ups' Technological trends and Geographical distribution

3.1.1 Acquired start-ups

Overview of the Acquisitions deals and geographical distribution of the targets

Figure 3.1 shows that the number of acquisitions is decreasing over the three years of the analysis. In 2020 Covid-19 has brought many difficulties to the whole global industrials system, thus it is not surprising to see this decrease. It will be interesting to analyze in the following years whether this crisis

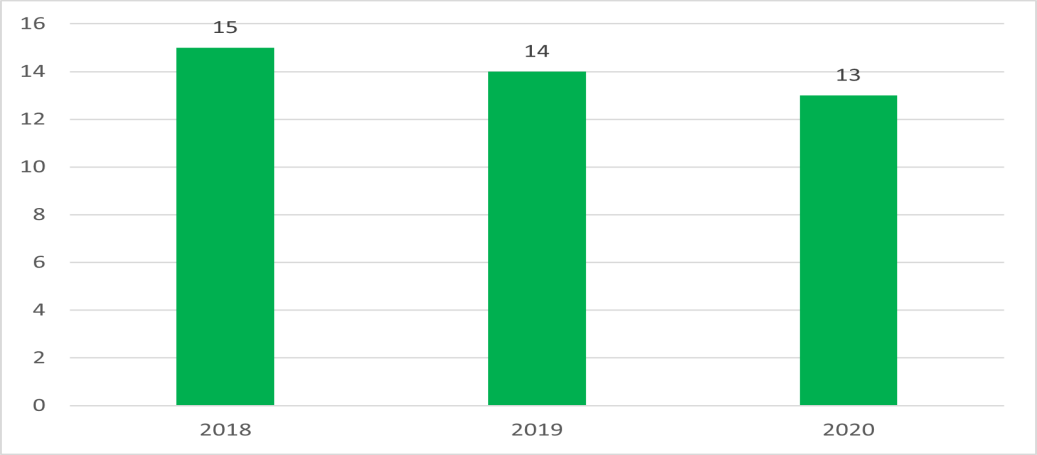


Figure 3.1: Number of Acquisitions for each year from 2018 to 2020

will bring financial constraints able to reduce for a long time the power of purchase of big corporates. In that case, it is likely to see a decrease in acquisitions and an increase in other open innovation mechanisms as CVC or Alliances that require a lower amount of money.
The average seniority of start-ups acquired is 3.6 years, demonstrating the interests of acquisition for quite mature start-ups.

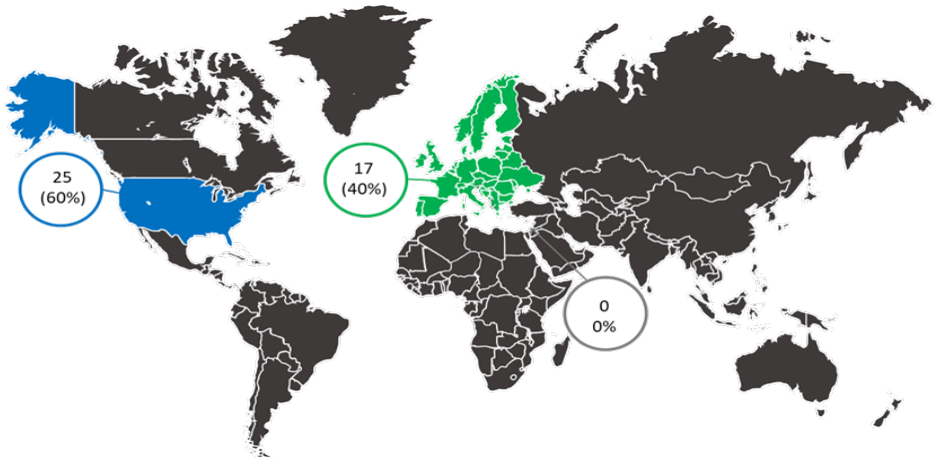


Figure 3.2: Geography of the start-ups acquired

Analyzing the geographical distribution of the sample of startups acquired

(Figure 3.2), it is noted that 60% (25 start-ups) have their headquarters in the United States, while 17 (40%) start-ups are located in Europe. Israel does not host any start-up acquired between 2018 and 2020. At the European level, Germany is confirmed as the country with the largest number of startups acquired.

Technological area of Acquired start-ups

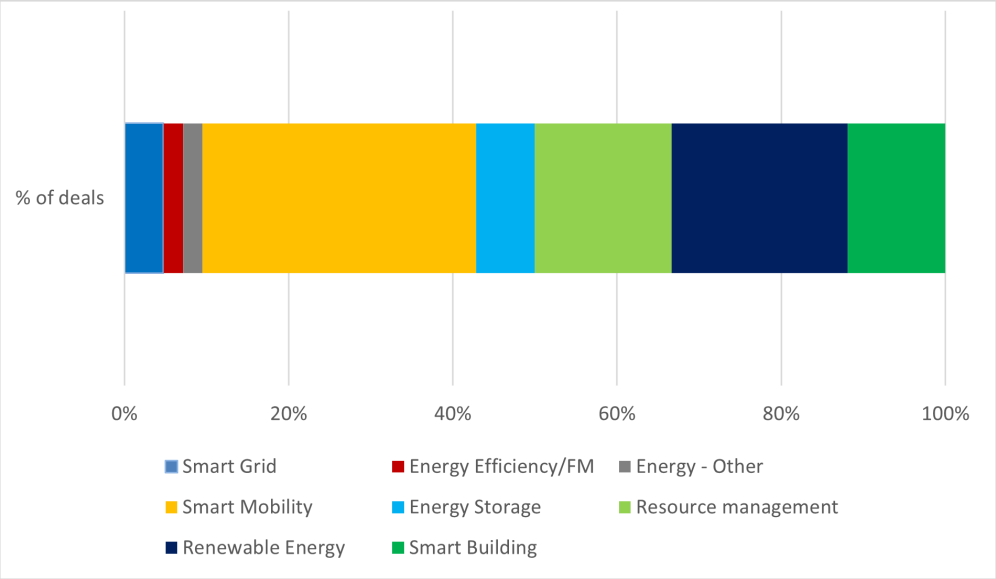


Figure 3.3: Distribution of tech areas in the sample of acquired start-ups

Coherently with the methodology, the selection of the Acquisitions consists of targets active only in technological fields strictly related to energy. As we can see in the Figure 3.3, the prevailing technological area for the number of acquisitions it includes is, without a doubt, Smart mobility, with 33% of acquisitions. On the contrary energy efficiency/ facility management (2%) and Energy-Other (2%) seem quite insignificant. While considering the distribution of the technological areas in the period analysed, Smart mobility acquisitions have decreased in 2020. On the contrary, energy storage, resource management, and smart building have increased. This is likely to be linked to the shift in life habits during the pandemic in 2020. People were forced to be locked down in their houses, and this implied an increase in the production of household solid and water waste and a reduction of mobility.

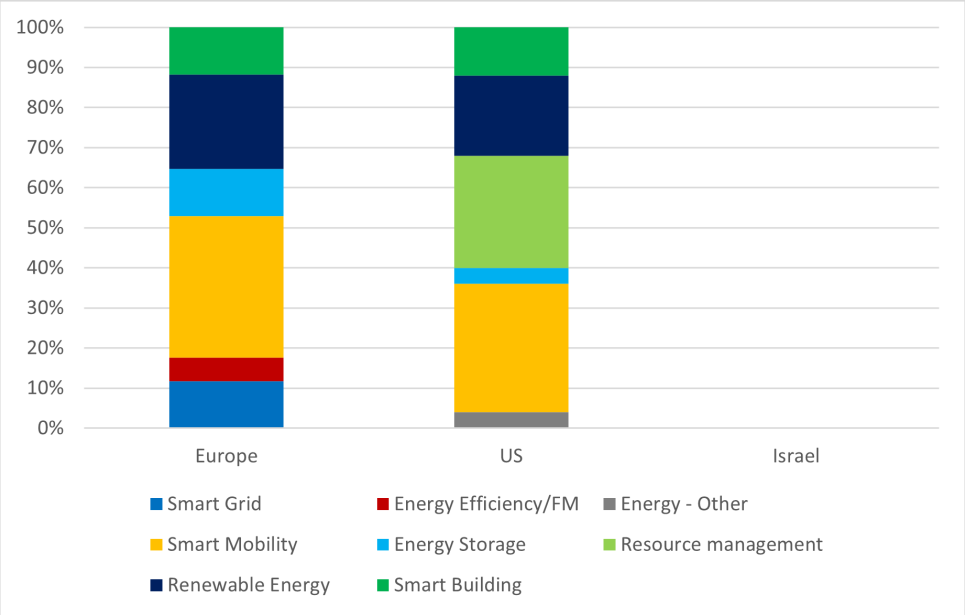


Figure 3.4: Distribution of tech areas in the sample of acquired start-ups - Comparison between Eu, US, and Israel

Figure 3.4 shows a comparison between the US and Europe as regards the technological areas most developed in their territory. It is interesting to notice that both are investing heavily in smart mobility, highlighting that it is perceived as a priority at this moment. In the US it seems to exists a major interest in the acquisition of target active in resource management activities (28% of the overall acquisitions in the US) . While Europe seems more interested in developing solutions for Smart Grid and Energy Storage, each representing 12% of the overall European acquisitions.

For each technology field of energy startups, the table below highlights the main focus of the startups acquired, that is the specific field to which the greatest number of startups acquired relates.

The technological sub-areas that involve the major number of acquisitions are Sharing services, water management, and Solar power. The dominance of sharing is probably due to the fact that the solutions in this sub-field are technically simpler than the other and they have spread quickly around the globe. Consequently the acquisitions of these kind of venture can be perceived as safe investment. The acquisitions of ventures active in the development

Tech field	Main focus	# deals of the focus
Energy efficiency/ Facility Management	Sensors	1
Energy Storage	Residential storage; charging infrastructure; Electrochemical Storage	1
Renewable Power	Solar power	4
Resurce management	Water management	4
Smart Building	Management and Control platforms	2
Smart Grid	Grid management platform	2
Smart mobility	Sharing	7

of Solar power solutions are probably pushed in these years by the growing interest in energy transition that translates in governmental incentives for the installation of solar panels in residential and commercial buildings.

Type of offer of acquired start-ups

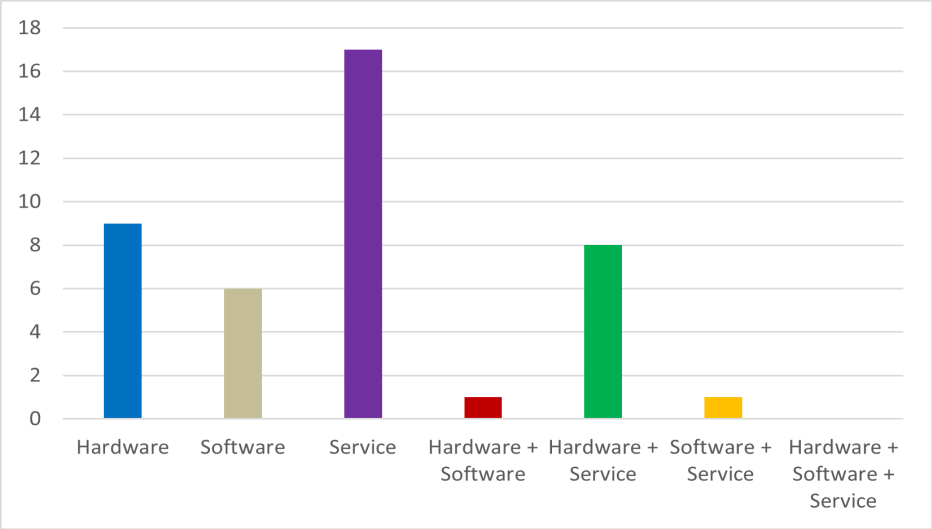


Figure 3.5: Distribution of different types of offers among the acquired start-ups

Figure 3.5 shows that services are the main kind of offer of the acquired targets, with 17 ventures, followed by hardware (9) and hardware+service (7) solutions. However, while the two latter offers have grown by 1 acquisition in 2020, service has drastically dropped from 8 acquisitions both in 2018 and 2019, to only 1 in 2020 (Figure 3.6). This evolution of the acquisitions of start-ups offering a service should be studied further in the incoming years. This analysis could be interesting to understand if this decrease of

the number of acquisitions is just a consequence of the lockdown due to Covid that blocked any human interaction and consequently many services or it may represent a more radical change in the preferences of the acquiring companies.

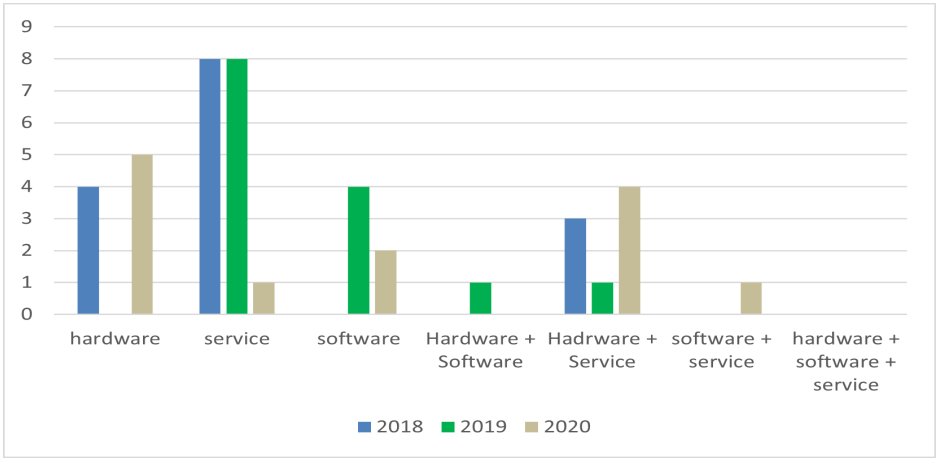


Figure 3.6: Distribution of different types of offers among the acquired start-ups

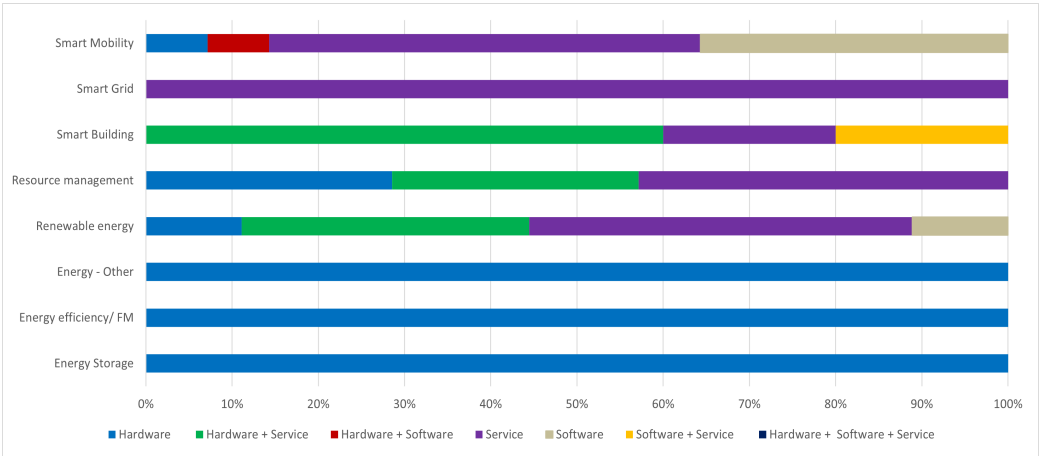


Figure 3.7: type of offer - Distribution in the Energy technological areas of Acquired start-ups

Figure 3.7 shows that technological areas as Smart mobility, Renewable energy, Smart building and Resource management present targets with di-

versified kind of offers, going from the hardware to the software. On the contrary, the acquired ventures active in Energy storage seem to be focused only on hardware solutions.

3.1.2 Start-ups object of Corporate venture capital deals

Overview of the CVC deals and geographical distribution of the targets

The corporate venture capital deals in 2020 were 43 while in 2019 and 2018 they were respectively 78 and 67. Although the number of deals decreased over the three years of the period under analysis, the actual sum of money raised by the start-up has decreased from 2018 ($954 Mln) to 2019 ($840 Mln) but it stayed quite constant throughout 2020 ($843 Mln), regardless the pandemic.

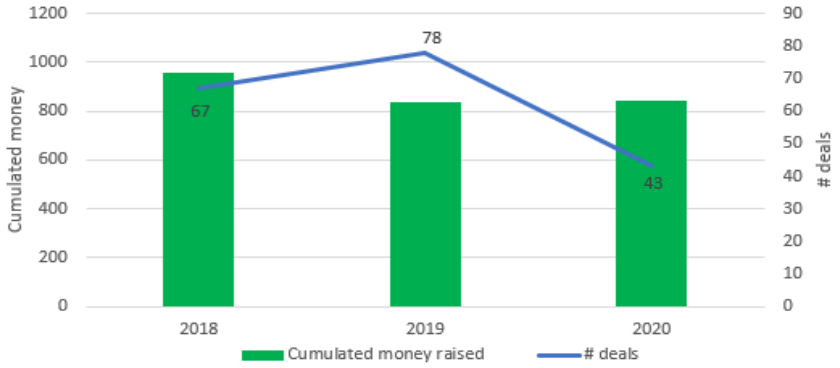


Figure 3.8: Number of deals and Cumulated money raised by CVC from 2018 to 2020

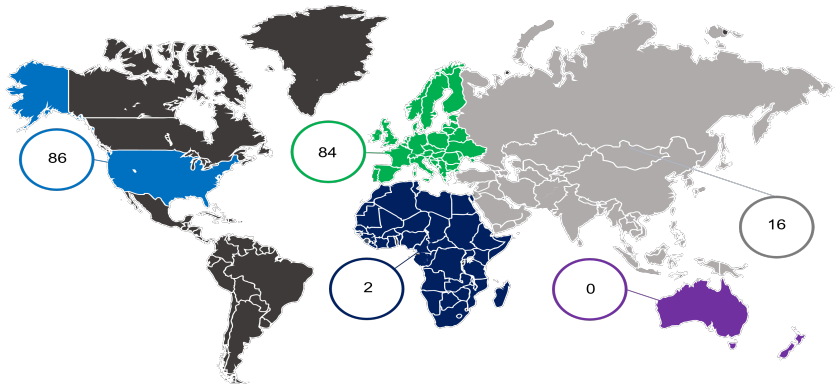


Figure 3.9: Geography of start-ups target of CVC deals

In figure 3.9 it can be observed the geographical origin of the target enterprises of CVC investments by utilities. From the graph, it is noted that:

- 84 target companies are European
- 72 companies from the American continent (66 US)
- 13 companies are from Asia (13 of which from Israel, 2 form Bangladesh and 1 from Singapore)
- 2 are based in Africa
- No target company is based in Oceania

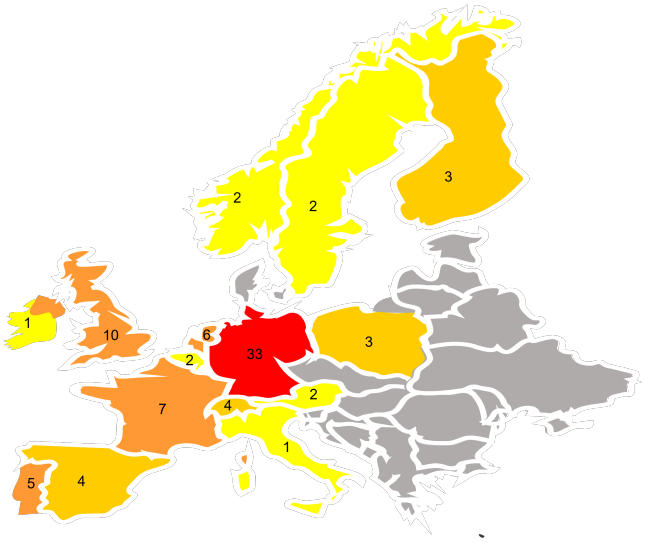


Figure 3.10: Geography of start-ups target of CVC deals - Focus Europe

Figure 3.10 confirms Germany as the country with the largest number of enterprises by analysing intra-European results in more detail CVC investments by utilities, with 33 target enterprises. Its advantage is evident if we consider that the second European country as regards target ventures in the United kingdom with only 9. The latest two countries in the European ranking are Italy and Ireland with 1 target venture each.

Technological areas of CVC's targets

Concerning the technological areas in which the targets are active, in CVC analysis we have considered fields that are strictly related to Energy and those that are not. The data available allowed to visualize also the sum of the money raised by the targets of CVC deals. Thus we have more visualizations compared to the sample of Acquired start-ups.

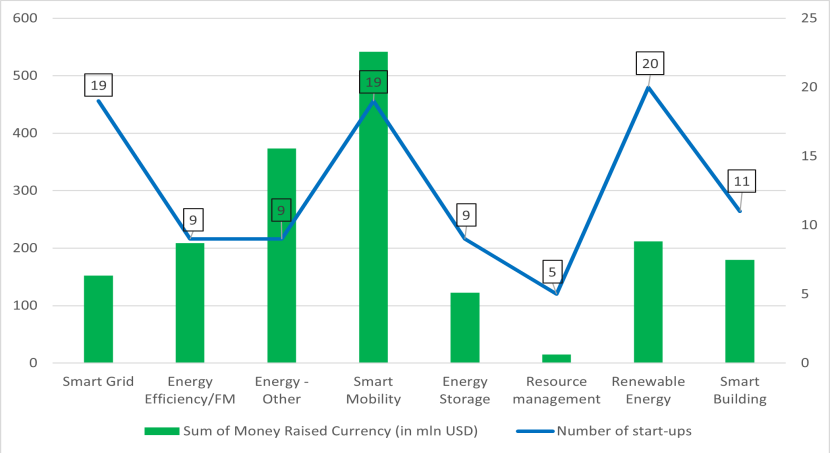


Figure 3.11: Number of targets and sum of money raised(mln USD) for each technological area (ENERGY)

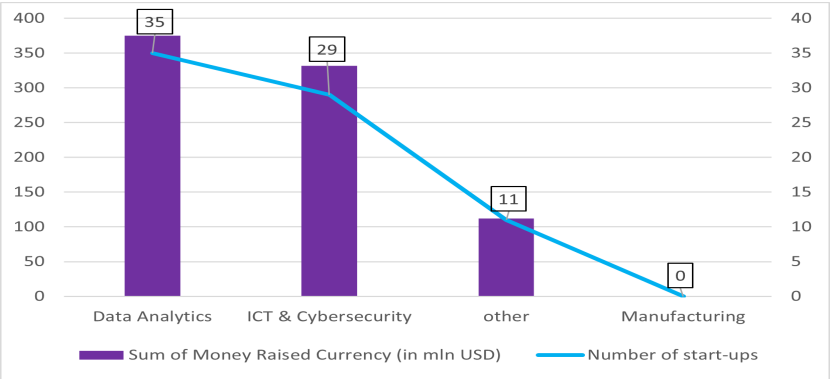


Figure 3.12: Number of targets and sum of money raised(mln USD) for each technological area (NON-ENERGY)

First let's have a wide overview on both energy and non-energy techno-

logical areas in which the targets of CVC deals are active. In figure 3.11 and 3.12 we focus on the number of targets and the cumulated money raised for each technological area (Energy and not-Energy). Smart mobility is the most relevant area with 541.6 M € raised in 19 deals. Utilities in the energy industry are interested in Data Analytics (375.3M€ in 35 deals) and ICT and Cybersecurity (331.9M€ in 29 deals). This demonstrates the willingness of acquiring the complementary know-how necessary to apply digitalization to their operations. In terms of the number of deals, it is worth highlighting the areas of Renewable energy and Smart Grid.

Let's focus now on the Technological areas related to Energy.

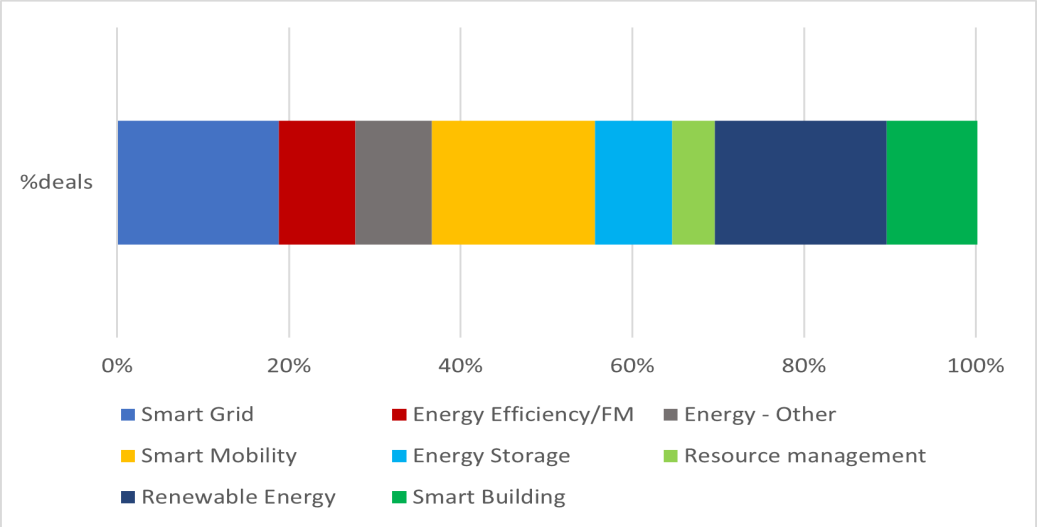


Figure 3.13: Distribution of tech areas in the sample of start-ups subject to CVC investments(ENERGY)

Considering the distribution of targets according to their technological area on the whole period of analysis (Figure 3.13), it is evident that Smart Mobility, Renewable energy, and Smart Grid are the three main fields of interests for corporation in term of number of deals. In fact, each of them represents approximately the 20% of the overall sample. Smart building, Energy efficiency/Facility management, Energy storage, and Energy- Other follow with approximately 10% each. Resource management seems the area of minor interest. It constitutes only the 5% of the CVC deals.

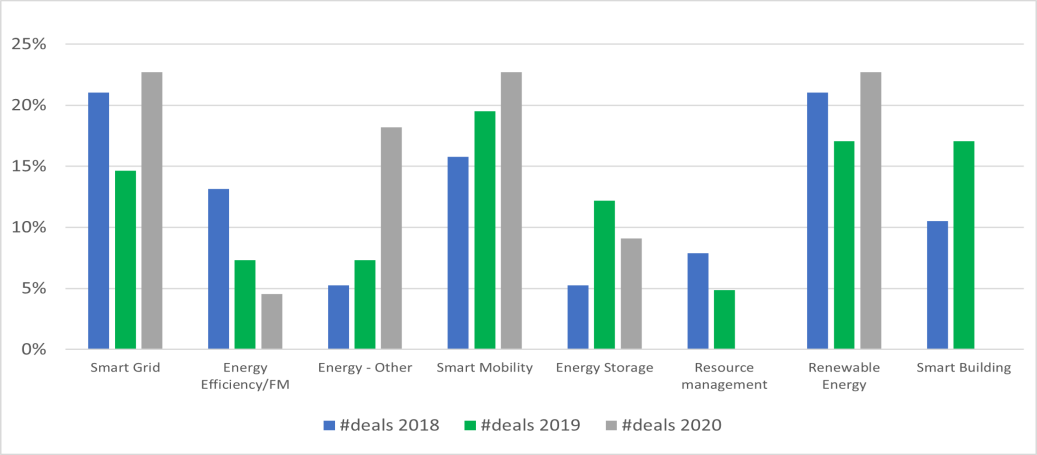


Figure 3.14: Distribution of CVC deals among tech areas (Energy). 2018 - 2020

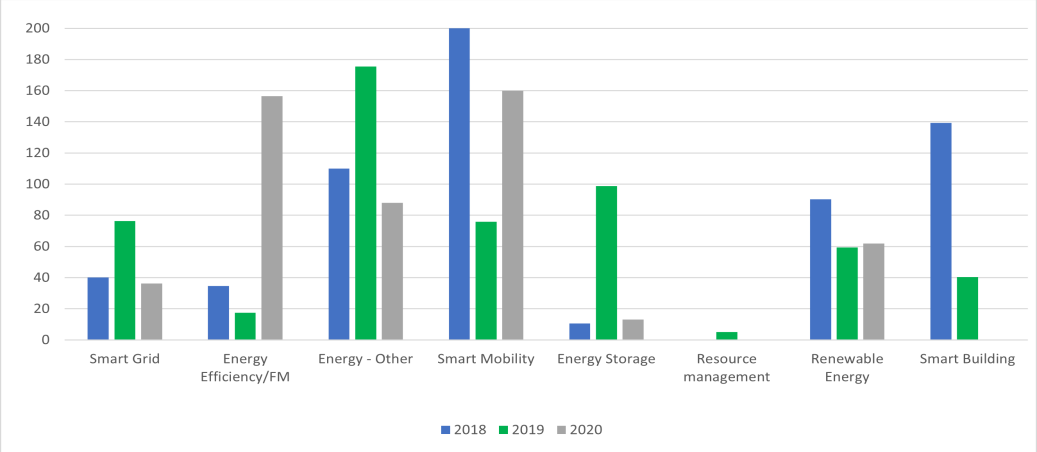


Figure 3.15: Sum of Money Raised Currency (in mln USD) for each tech area. 2018 - 2020

The data available in our sample allowed us to enlarge the analysis to the the evolution of the number of targets (Figure 3.14) and the cumulated money raised (Figure 3.15) for each Energy technological area throughout the period analyzed.

Each of these three fields: Smart Mobility, Renewable energy, and Smart

Grid, represent, every year, more than 15% of the sample. Among these three, Smart mobility has collected more money each year. It is worth noticing that, in 2020, Smart grid and Smart mobility represent the same percentage of the sample (23%). However the sum of money raised by Smart mobility ($159.9 Mln) is almost 5 times the amount raised by smart grid ($36.2 Mln). Consequently, it can be assumed that CVC deals focused on Smart grid are considered riskier than the ones in Smart mobility, thus worth investing less money.

Energy efficiency / Facility management shows an interesting pattern. Even though the number of targets of CVC deals active in this field decreased on the overall total of deals from 2018 to 2020, the money collected increased, passing from $34 Mln in 2018 to $156 Mln in 2020.

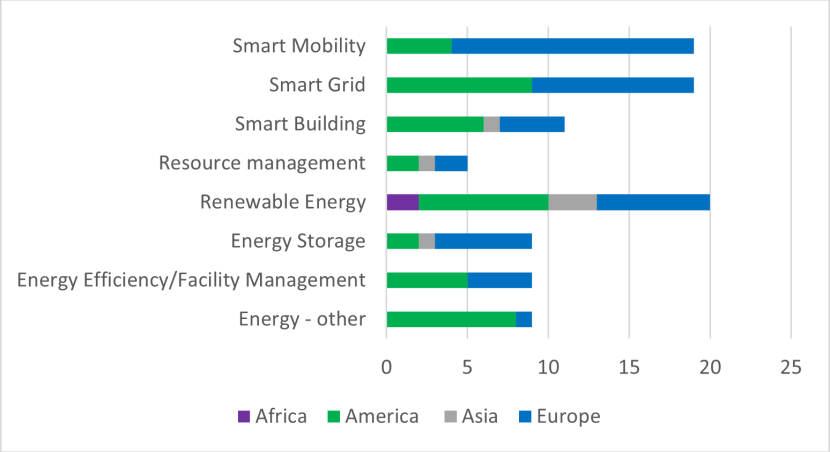


Figure 3.16: Geographical distribution of technological areas (Energy), number of deals per continent

As we can see from Figure 3.16, CVC deals with investees active in Smart mobility and energy storage are more concentrated in Europe. Europe and America seem equally fertile continents for Smart Grid and Energy efficiency/ Facility management ventures. While Renewable energy proves to be the area that is triggering entrepreneurial activities also in other continents, Africa (2 ventures) and Asia (3).

When detecting the most relevant sub-field of focus for each energy-related technological area, the following table is defined.

Technological Fields	Main Focus
Energy Efficiency/Facility Management	ESco (181 mln)
Energy Storage	Electrochemical storage (89.7 mln)
Renewable Energy	Solar Power (89.8 mln)
Resource management	Recycling (4.0 mln)
Smart Building	Building devices and Solutions (111. 98 mln)
Smart Grid	Grid management platform (113.78 mln)
Smart Mobility	Charging infrastructure (474. 04 mln)

In particular, we note that regarding the Energy Efficiency/ Facility Management the deals are mainly related to the Esco sub-field (investment volume of 181 million dollars).

Electrochemical storage is the reference sub-field in 44% of the target companies involved in Energy Storage businesses and it represents a large part of the volume of investments received (89 million dollars) in this technological field.

The area of Renewable Energy is mainly constituted by ventures focused on the category: Solar Power. It includes mainly actors active in the development and sale of services linked to solar energy projects that overall have raised $ 90 million in funding. A characterizing example is Solshare, a start-up that developed a platform for IoT-driven trading that allows citizens to commercialize the eventual excess of the energy produced by their solar panels.

To the level of the deals within the category of Resource Management, it is found a particular interest in Waste2energy and Water Management solutions, but in terms of funding received, Recycling predominates with $4 million received.

The control and management platforms represent 45% of the solutions of target companies in the field Smart Building and include mainly Software + Service solutions that allow you to monitor data from sensors and to manage the facilities in the building. In terms of funding received, instead, prevails

the sub-field Building devices and solutions ($112 million), which includes the different systems and technologies present within the smart building.

In the field of Smart Grid, there is a clear predominance of platforms for network management, which counts 74% of the target companies and contributes to a total investment volume of 113 million of dollars, confirming the increasing interest of utilities towards tied platforms not only in the world of interoperability and the provision of flexibility services to the network but also to energy community theme.

Finally, the charging infrastructures are the most attractive among the target companies in the field of Smart Mobility. The volume of investment in this sub-area accounts for more than 87% of the total volume of the technological field to which belong. This data emphasizes the meaningful trend that is carrying from one side startups to develop solutions related to charging infrastructure (public and private) also in on the subject of interoperability and on the other utilities to show interest in these solutions to complement the supply of the electric carrier with a value-added service.

Our analysis of CVC deals focused also on cases in which utilities invested in ventures active in technological areas not strictly related to the energy industry.

The following visualizations (Figure 3.17 and 3.18) help to understand which technological areas not strictly related to Energy are more interesting for the energy utilities.

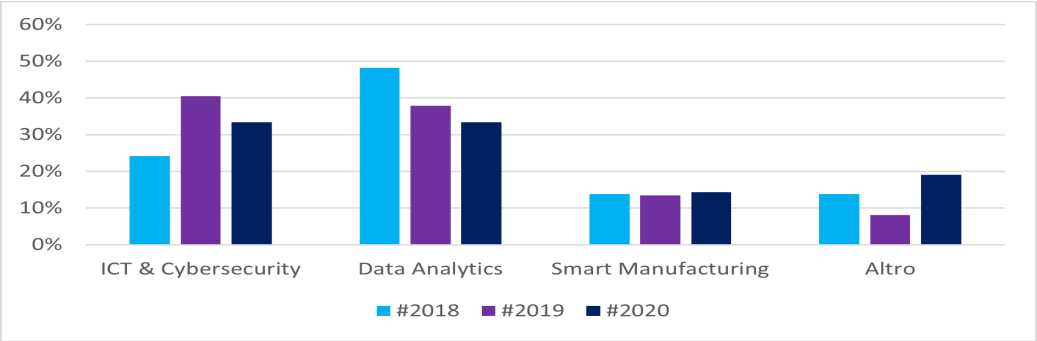


Figure 3.17: Distribution of CVC deals among tech areas (Not-Energy) for each year

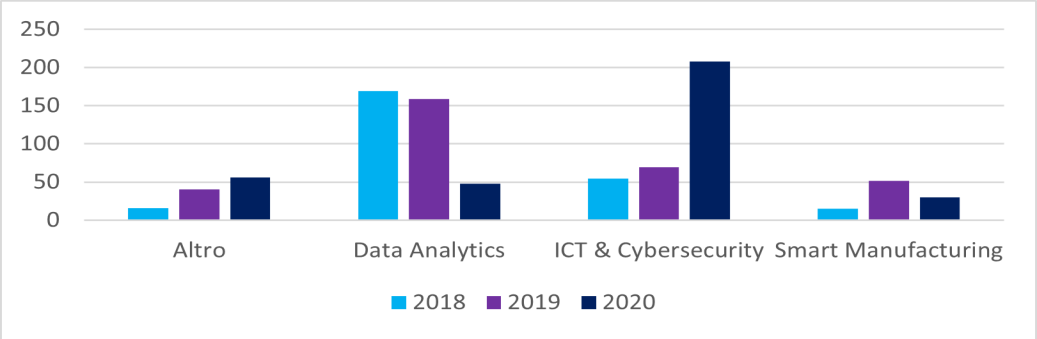


Figure 3.18: Yearly distribution of cumulated money raised for each tech area (Not-Energy)

Data analytics shows a decrease both in terms of the number of deals and cumulated money raised, from 14 deals in this area in both 2018 ($169 Mln) and 2019 ($158 Mln) to 7 deals with a cumulated value of money raised of $48 Mln. ICT and Cybersecurity shows an up&down pattern in term of the number of deals (7 in 2018, 15 in 2019 and 7 in 2020) but a great increase in term of money raised, from$ 54 Mln in 2018 to $208 Mln in 2020. Utilities are interested in finding solutions to protect themselves from cyber-attacks, after some events have demonstrated their vulnerability, as the attack of the Los Angeles Department of Water and Power. It took only six hours to hacked it. [Bloomberg, 2021]

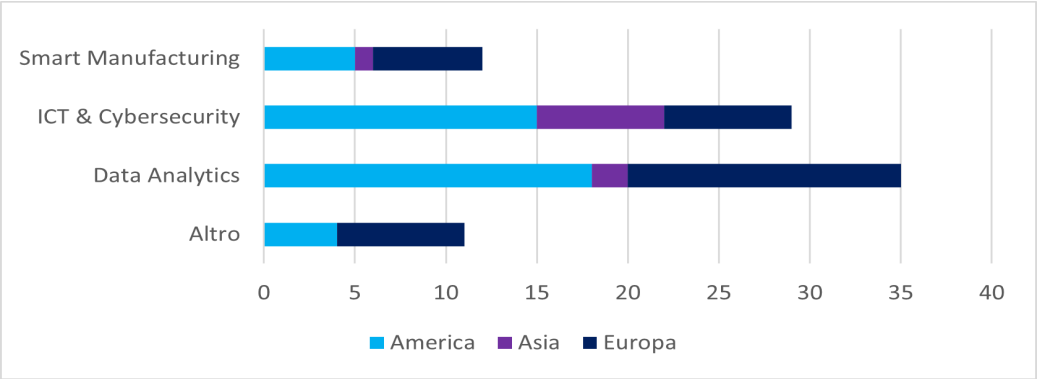


Figure 3.19: Geographical distribution of non-Energy tech areas

As regards the geographical distribution of the targets active in the areas not strictly related to Energy (Figure 3.19), and Europe seems to be both

competitive at a similar level. However, it is interesting to notice the relevance of countries like Israel and Bangladesh in the development of ICT and Cybersecurity ventures.

Kind of offer of the CVC's targets

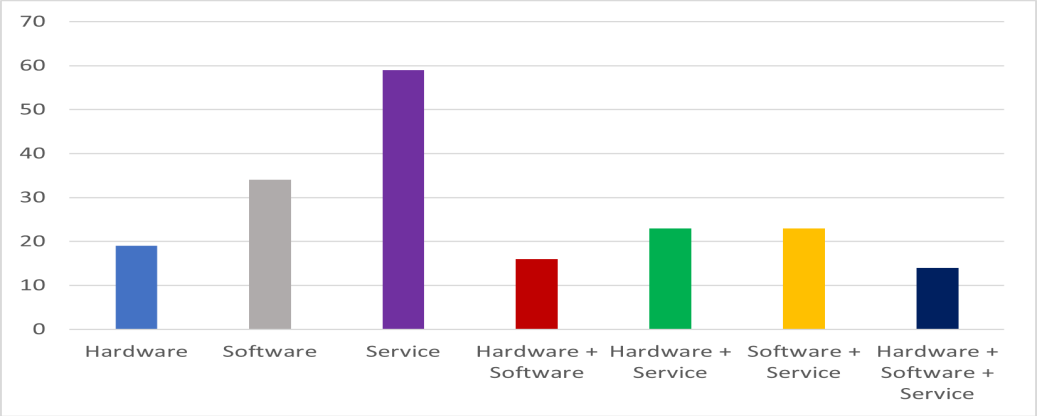


Figure 3.20: The overall distribution of kinds of offer – Number of deals from 2018 to 2020

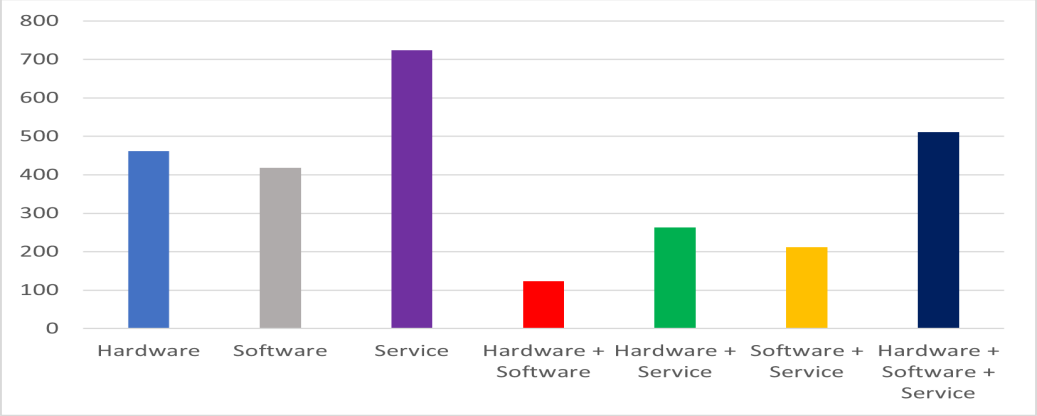


Figure 3.21: The overall distribution of kinds of offer – Cumulated money raised from 2018 to 2020

Figures 3.20 and 3.21 highlights that Service is the dominant kind of offer in the investee in CVC deals both in terms of the number of deals and

cumulated money raised (59 deals and $724 Mln raised). Software is second in terms of the number of targets subject to deals (34) while Hardware is second considering the cumulated money raised ($462 Mln).

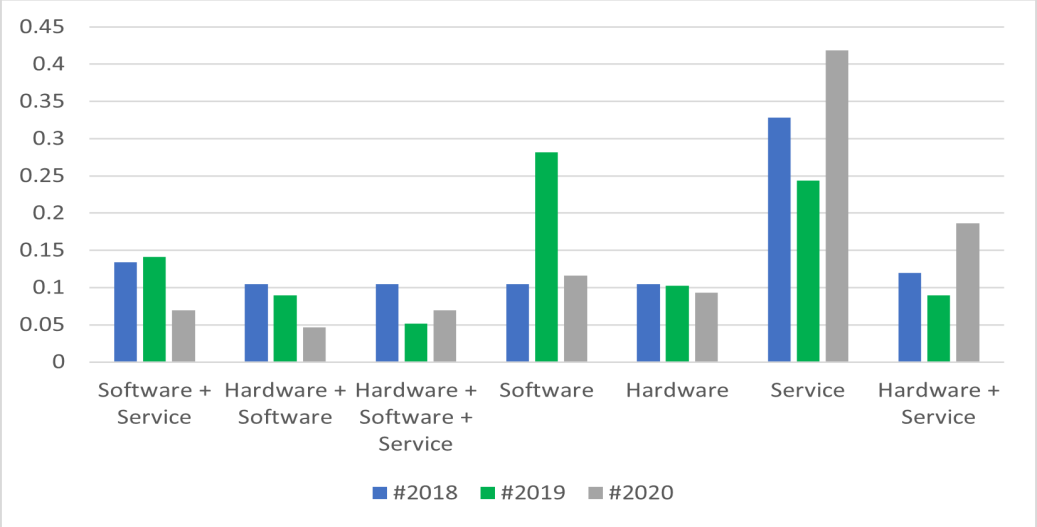


Figure 3.22: Yearly distribution of the number of deals grouped according the type of offer - 2018 to 2020

As regards the evolution of the distribution of kinds of offer over the years (Figure 3.22), Service was always the main proposition in terms of the number CVCs' targets adopting this kind of solution. Only in 2019 it was overcome by Software offers that counted for the 29% of the overall deals in 2019 against the 25% consisting of Services.

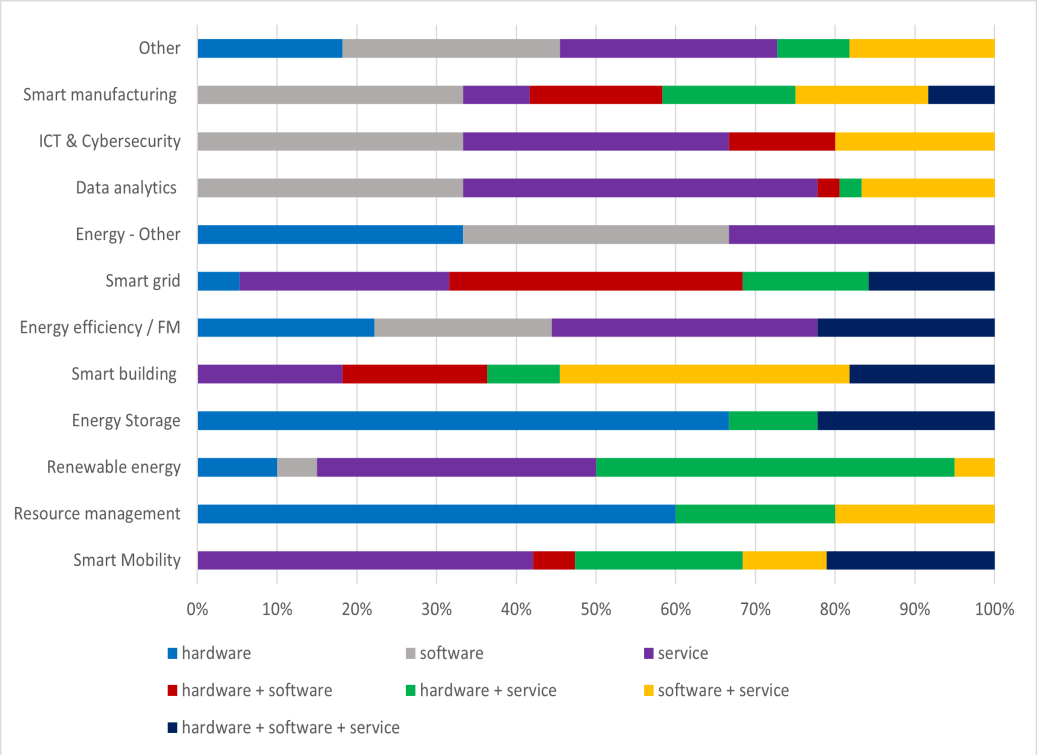


Figure 3.23: Kind of offer - Distribution in the technological areas (Energy and Not-energy) of targets of CVC deals

In Figure 3.23 we cluster the targets of CVC deals according to their kind of offer grouping them by technological area. From the visualization above it can be seen a diversified portfolio for each technological area (energy and not-energy) in which no kind of offer represents a clear majority. Only in Energy storage and Resource management Hardware solution represents more than 50% of the sample.

3.1.3 Independent start-ups

Overview of the independent start-ups and their geographical distribution

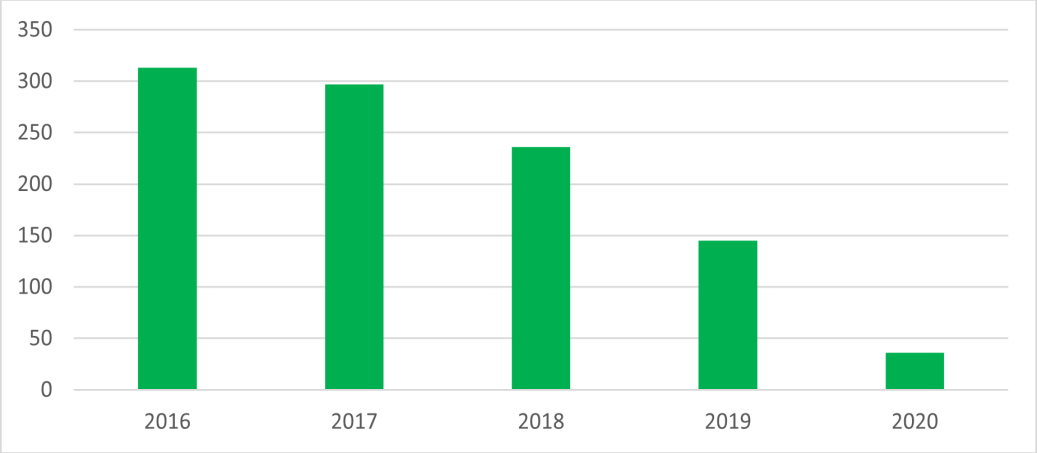


Figure 3.24: Number of founded energy independent start-ups for each year from 2016 to 2020

The number of independent start-ups founded decreases over the years: from 313 in 2016 to 36 in 2020. This drop may depend more on the fact that the databases used as source of data struggled to keep that pace of the foundation of startup in 2020 than on an actual slowdown of the start-ups economy. It is not surprising that even a platforms like Statista and the World Bank have updated to 2018 the number of new created business only in july 2020. [Statista, 2020]

Analyzing their geographical distribution (Figure 3.25), it can be noted that the vast majority is distributed between the two largest areas, with 531 startups (corresponding to 53% of the total) in Europe, 473 (i.e. 46%) in the United States, and only 23 (i.e. 2%) in Israel. At a superficial glance, the number of Israeli startups may seem insignificant, as it represents only 2% of the total. However, 23 are not few if we take into account that Israel is more or less large than Sicily and has less than 9 million inhabitants. Thus it is not surprising that Israel is known as a "Start-up nation" [Senor and Singer, 2011].

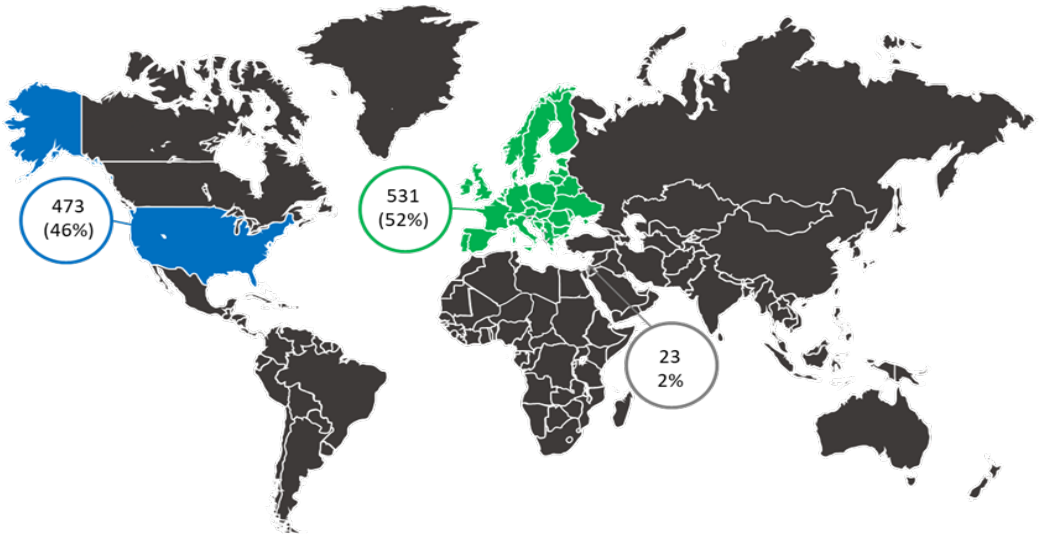


Figure 3.25: Geographical distribution of independent energy start-ups

Technological areas of independent energy start-ups

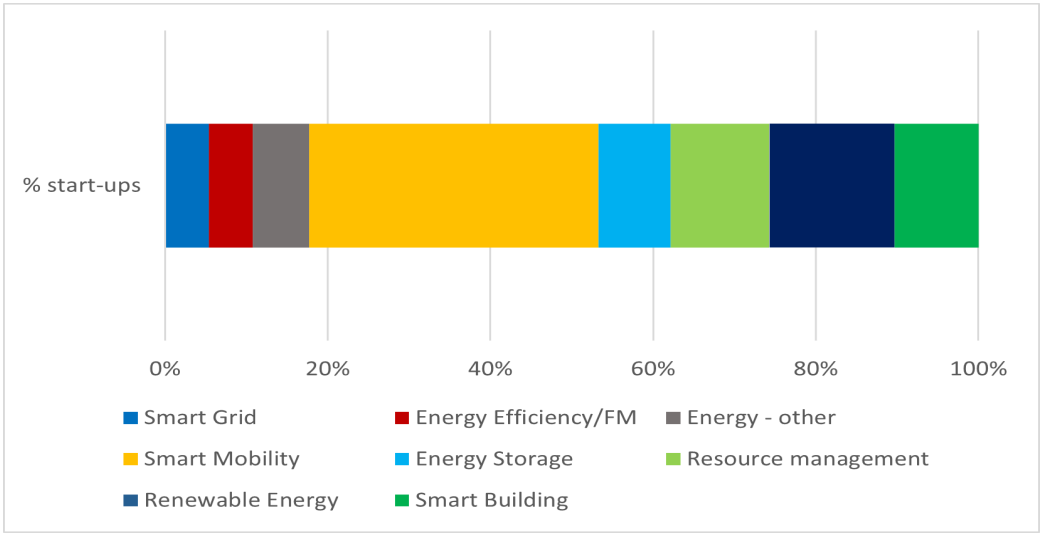


Figure 3.26: Distribution of tech areas in the sample of independent energy start-ups. 2016 - 2020

Coherently with the methodology, we have focused on start-ups active in

technological areas strictly related to energy.

In Figure 3.26 it can be noted that the prevailing technological field is Smart Mobility. With 365 start-ups active in this field, Smart Mobility represents the 36% of the sample. Renewable Energy comes in the second place representing 15% of the sample with 158 start-ups active in this field. Next we can find Resource management (12%), Smart building(10%), Energy Storage(9%) and Energy-other (7%). The last positions of the list are occupied by Energy efficiency / Facility management (56 start-ups) and Smart Grid (50 start-ups), each of them represents only 5% of the sample.

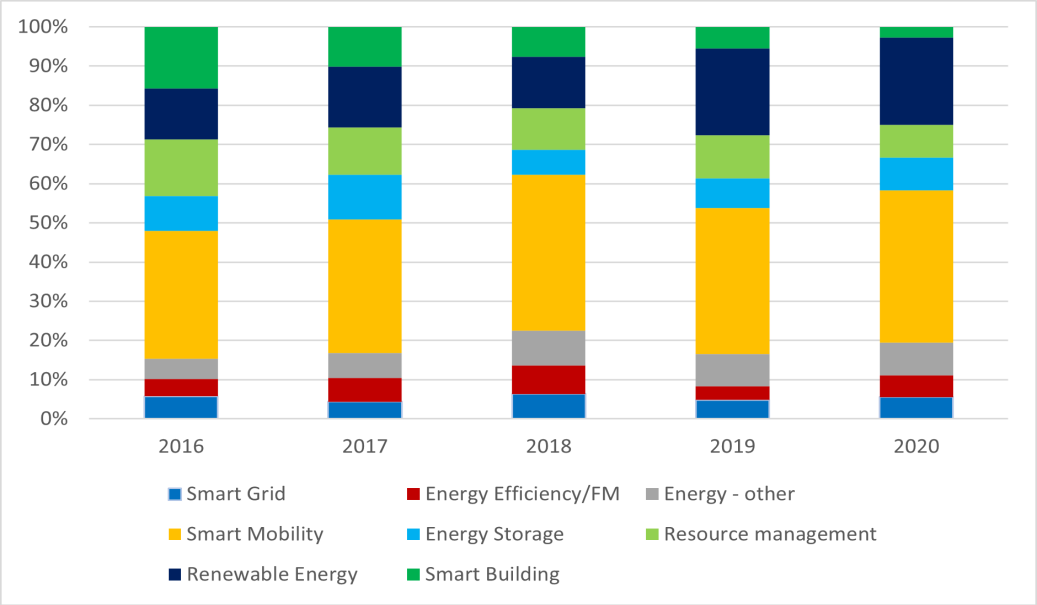


Figure 3.27: Yearly distribution of independent start-ups among energy tech areas. 2016 - 2020

As regards the the evolution of the distribution of technological areas over the years (Figure 3.27), Smart Mobility is the fastest-growing field. In only five years, it has gone from 33% of the total in 2016 to the 39% in 2020. The Smart Building field, on the other hand, has been declining in the last five years, passing from 16% in 2016 to 13% in 2018 and finally 3% in 2020. All the technological areas related to Energy are characterized by a decrease in the number of start-ups founded over the years. With an average CAGR of

-36%. Particularly deep is the drop of the start-ups in Smart building that decreased over the five years with a CAGR of -54%.

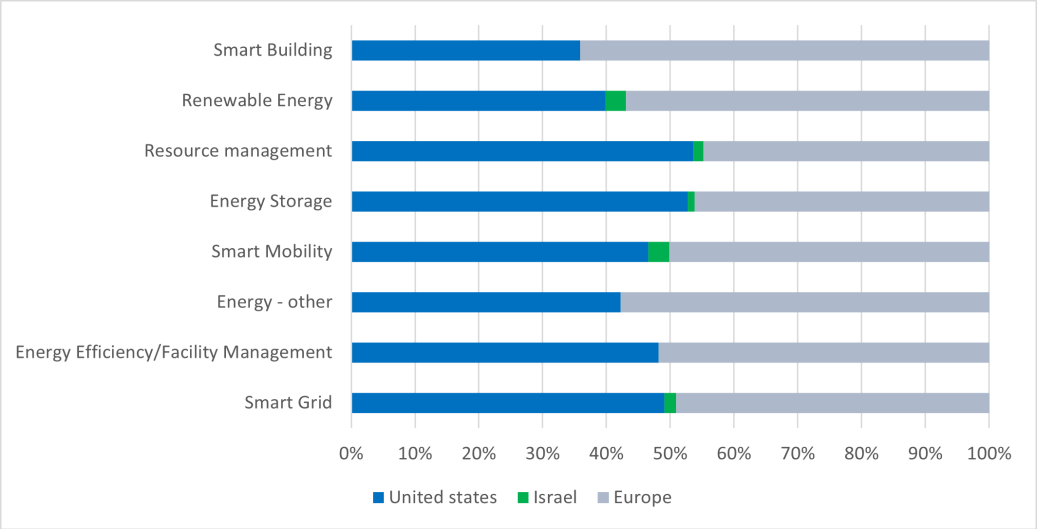


Figure 3.28: Geographical distribution of tech areas of independent start-ups

Figure 3.28 shows the geographical distribution of independent start-ups grouped according to their technological areas. Europe is "beating" the US as regards founded start-ups active in Smart building (68 vs. 38), Renewable energy (90 vs. 63) and Energy-other (41 vs. 30). The United States is more fertile for start-ups in Resource management (67 vs. 56). Finally, it seems evident that Smart mobility represents a competitive area in which also Israel is playing a role. Europe hosts 183 start-ups developing solutions in this field, the US 170 and finally Israel 12.

Technological area	Main Focus
Energy Efficiency/Facility Management	Energy production systems (19)
Energy Storage	Electrochemical Storage (33)
Renewable Energy	Solar Power (80)
Resource management	Water management (60)
Smart Building	Building devices and Solutions (47)
Smart Grid	Grid management platform (36)
Smart Mobility	Electric vehicles and components (100)

The table above analyses the main focus of the independent energy start-ups. The ones active in the Energy efficiency/ Facility management are mainly focusing on systems for energy production. This sub-category consists, for instance, of solutions for more efficient heating and cooling oriented to lower energy consumption. Energy storage has as main focus electrochemical storage with 33 ventures. 51% of the ventures working in renewable energy are interested in Solar Power solutions (80 start-ups). Water management is the main focus of the Resource management field. This sub-field counts 60 start-ups, i.e. the 48% of the total of start-ups active in this technological area. Considering Smart Building, Building devices and Solutions (47 ventures) are ranked as first focus only by an advantage of one start-up compared to sub-field of Management of control platform (46 ventures). A clear predominance of grid management platforms exists in the Smart grid. This sub-field consists of 65% of the sample active in this technological area. Finally, independent start-ups interested in Smart Mobility are focusing more on businesses about Electric vehicles and components (100). However, Sharing (97) services and Autonomous driving solutions (82) are still very relevant.

Kinds of offer of independent energy start-ups

An observation of the distribution of the type of offer is carried out for the entire sample of analysis.

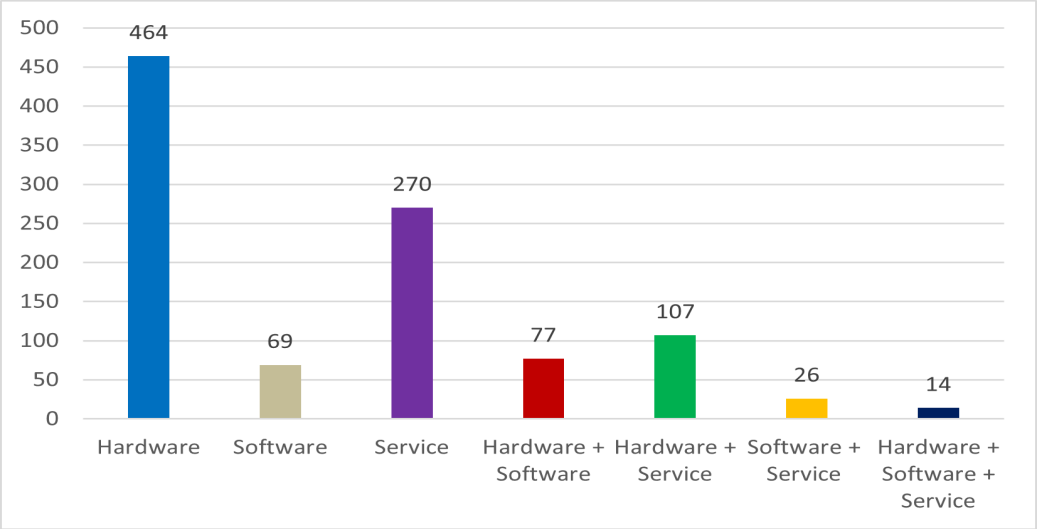


Figure 3.29: Distribution of different types of offers among the independent start-ups

As can be seen from Figure 3.29, the most widespread type of offer among the independent energy start-ups is certainly Hardware. This offer alone represents almost half of the sample (45%). The Service category is also relevant, with 270 units contributes to 26% of the total. Among the "pure" categories, Software is, therefore, the least widespread, with 69 units (7% of the sample considered). Among the "mixed" type of offer, the most successful is Hardware + Service, which consists of 10% of the sample with the 107 organizations that fall into this category.

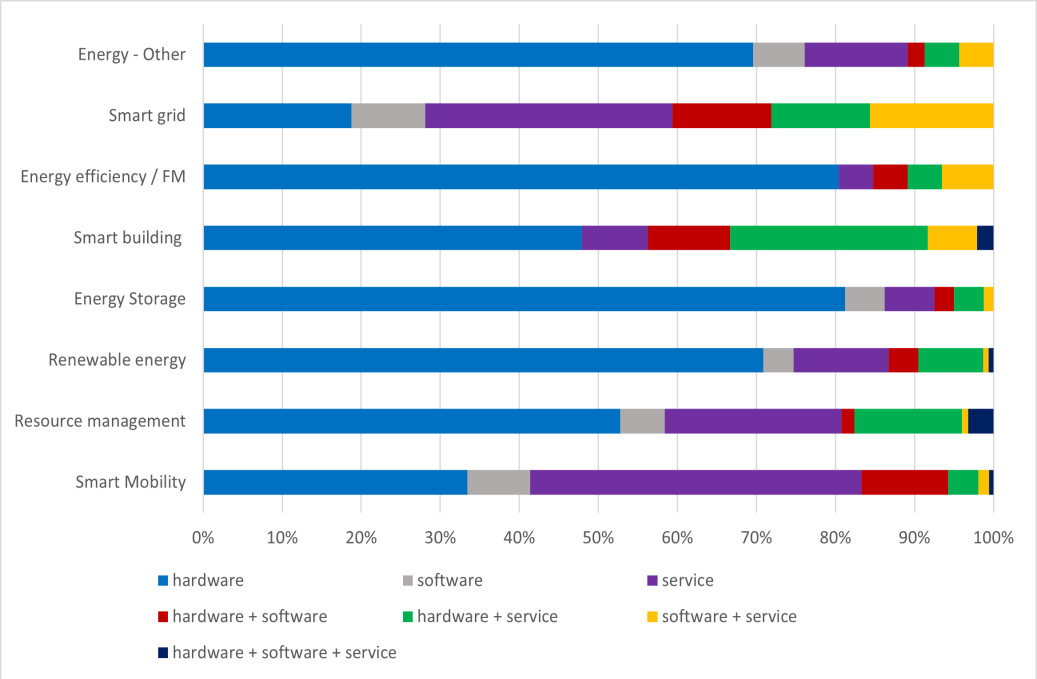


Figure 3.30: Kind of offer - Distribution in the energy technological areas of independent start-ups

Figure 3.30 shows how the kinds of offer are distributed in each technological area. Hardware is the dominant kind of offer for the start-ups active in Resource management (52% of start-ups in this field), Renewable energy (71%), Energy Storage (81%), and Energy efficiency / Facility management (80%). The other technological areas present a diversified portfolio of offers. Services solutions have a big tranche of the start-ups active in Smart mobility (42%) and Smart grid (31%). The "mixed" kinds of offer seem to have little relevance for each technological area. Only Smart building and Smart Grid have more than 20% of their start-ups selling "mixed" kind of offer, respectively hardware+service and software+service.

3.2 Corporations' strategies and structures behind Acquisitions and CVC deals

In this section, we change perspective and focus more on the corporate point of view. We are interested in understanding why corporations are tackling open innovation strategies as Acquisitions and Corporate venture capital investments. Finally, the Literature review has concluded that CVC's activities are deeply influenced by the structure selected to organize the unit. Thus, a brief overview of the structures present in the CVC deals will be shown.

3.2.1 Strategies behind Acquisitions and CVC deals

When analyzing the classification of Investment strategy according to Chesbrough's structure, there are differences in the investment patterns of Acquisitions and Corporate venture capital.

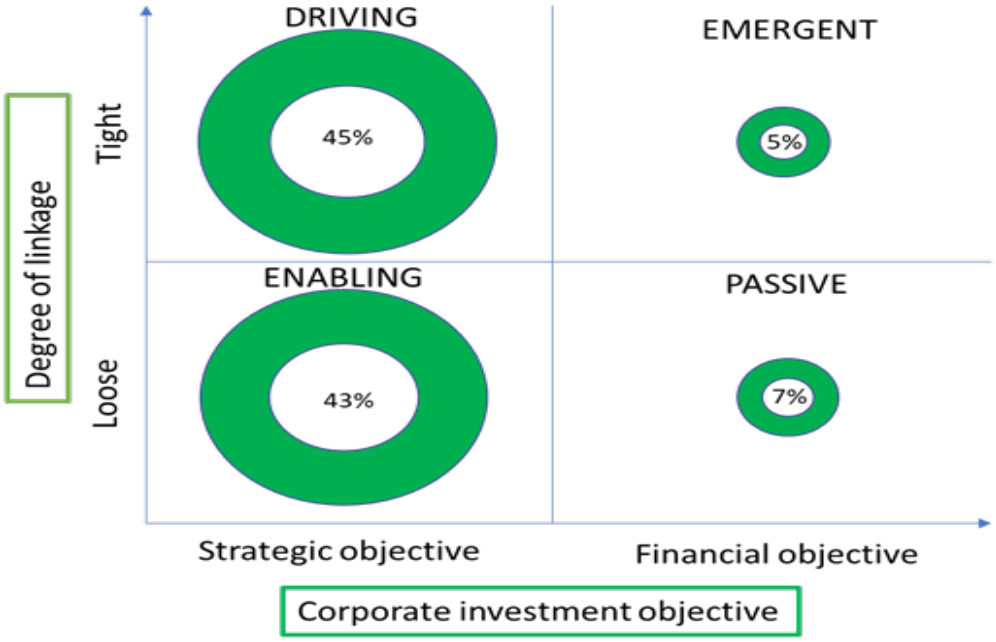


Figure 3.31: Acquirers' strategies behind acquisitions

Acquisitions show a fairly even distribution between "Driving" and "Enabling" strategies, while "Passive" and Emergent" strategies seem not very

relevant. These results confirm that Acquisitions are mainly motivated by strategic investment objectives. Considering the Degree of Linkage between acquirer and target, in these deals we see 50% of the acquisition concerning a tight linkage, and 50% a Loose linkage.

Acquires are investing heavily in "Driving" strategies therefore aimed at supporting the current business model and improving the efficiency of the company's existing operations, as, for instance, a company involved in managing renewable energy plants that purchases a provider of software in forecasting energy feed-in from wind energy and photovoltaic.

However, a big tranche of the acquisitions of energy start-ups (43%) is motivated by "Enabling" strategies. Acquires are going out of their traditional core business to purchase innovations that can be complementary to their offer. In this way, the company stimulates the demand for the company's own offer by creating an ecosystem around it, an example is Business Energy Solutions Ltd, one of the major power utilities in the United Kingdom, that has acquired an operator of Smart Home Solutions, to enlarge its portfolio of application in which energy, its main product, is used.

Corporate venture capital deals show a different investment pattern compared to Acquisitions (figure 3.32 below).

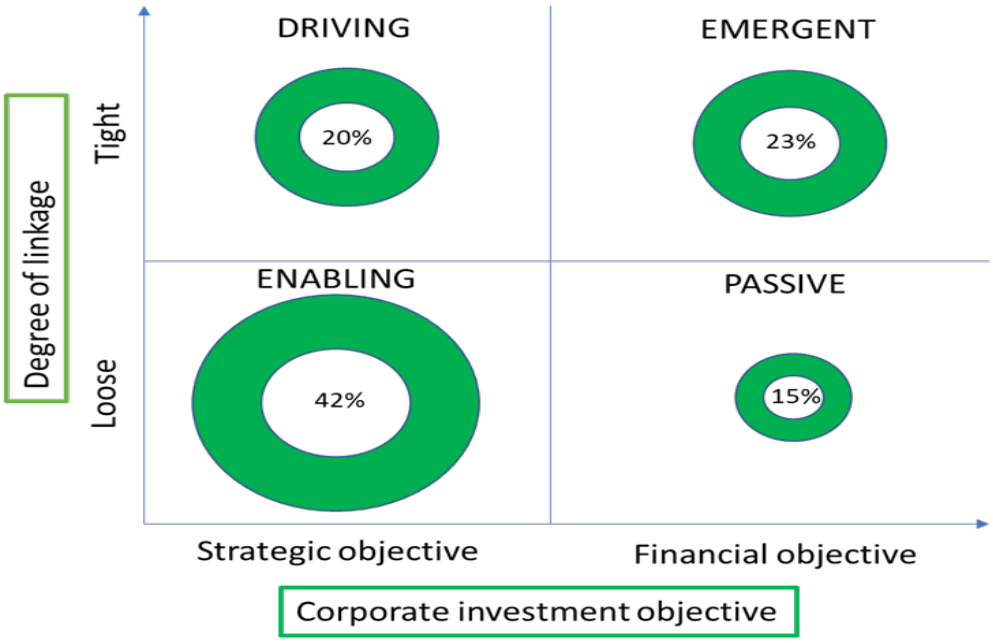


Figure 3.32: Corporations' strategies behind CVC deals

The majority of the CVC deals (57%) are characterized by a Loose Degree of linkage between the target venture and the power utilities that are investing. Utilities are interested in enlarging their competencies and business portfolio to include knowledge and activities that are currently far from their operations but that can prove to be complementary in the near future.

As regards the nature of the corporate objective behind the investment, 62% of the deals are driven by a strategic purpose. Confirming that CVC units differ from traditional VCs for their intrinsic strategic nature.

"Enabling" strategies are the most common in the sample (42% of the total). This category is notably represented by investments of power utilities in ventures active in Data analytics and ICT and Cybersecurity whose resources can be applied to make the operations of the main investor safer and more efficient. Utilities are investing in solutions to improve autonomous and preventive maintenance of their assets.

It is worth highlighting that "Emerging" strategies represent roughly one-fourth of the deals. These investments are mainly driven by explorative reasons. Although they are not part of the utility's current strategy, they could prove to be potential new businesses. In this category are present solutions liked to Intenet of Everything (IoE) or trading platform for Prosumers of electricity.

3.2.2 Structures of CVC unit: Syndication and Governance

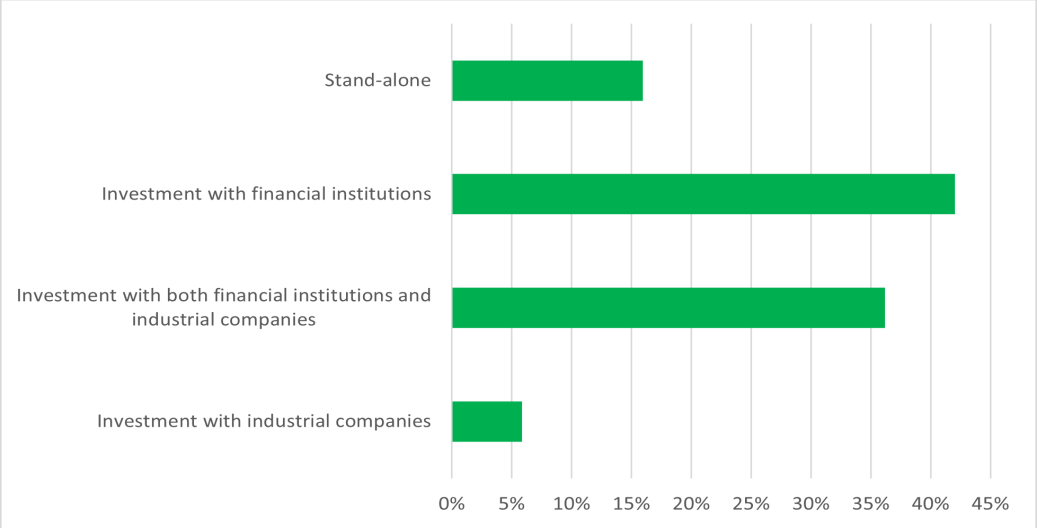
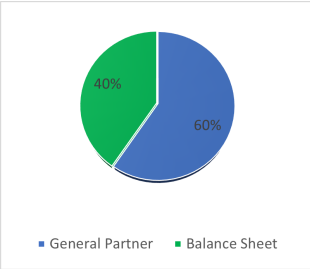


Figure 3.33: Syndication of CVC deals

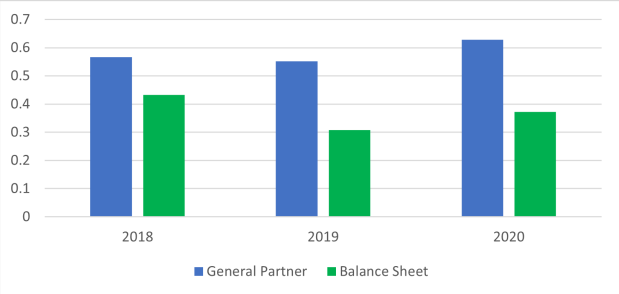
Syndication was presented in Section 1.2.4 of the Literature review. Figure 3.33 suggests that utilities prefer investing in early-stage ventures with partners, in particular financial institutions. This should not surprise because academics as Maula et al. [Maula et al., 2013] have given empirical evidence that partnerships with VC funds allow access to vital complementary knowledge. This knowledge is more finance-related if the partners are financial institutions, while it is more market/business related with corporate partners.

Few deals (6%) are characterized by the partnership with only other industrial companies. This may be due to the fear of utilities, working in a

competitive environment, of not being able to appropriate correctly the inventions of the investee and leave an advantage to other industrial partners that can become shortly a threat.



(a) CVC units governance



(b) CVC units governance for each year from 2018 to 2020

Figure 3.34: Distribution of CVC governance on the whole sample and over the years

Regarding the Governance of the CVC units, from Figure 3.34 it is clear that utilities prefer to invest with General partner modality, thus through a CVC unit with a self-managed and quite independent structure within the parent company, solely dedicated to pursuing CVC activities. This structure is better for explorative purposes. On the other hand, from the literature review it can be assessed that the Balance sheet is better for exploiting the investee to complete rapidly the corporation's offer.

It has been interesting analysing whether there is coherence between the strcture of the CVC unit managing a deal and its purpose. For this analysis we combined the results of Figure 3.34.a and Figure 3.31. We considered the investments with loose degree of linkage with the corporation's core business (Enabling and Passive strategies) as a proxy of investments with explorative purpose. On the other hand, the investments with tight degree of linkage with the corporation's core business (Driving and Emerging strategies) we considered as proxy of exploitative investments. Figure 3.35 is the output of this analysis.

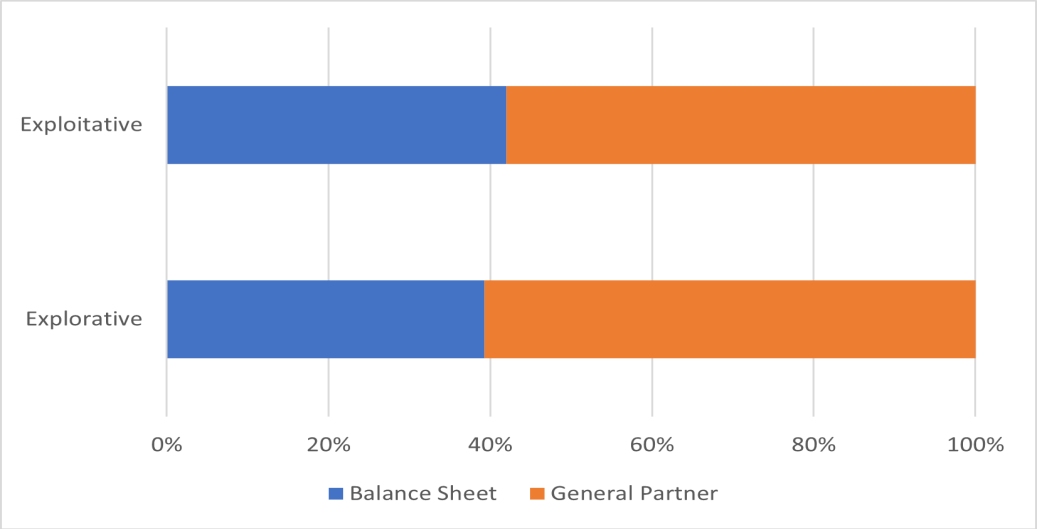


Figure 3.35: Relationship between strategy and structure of CVC deals

It can be seen that 38% of the exploratory investments (Enabling and Passive) are managed by a unit with Balance sheet structure and the exploitative investments (Driving and Emerging) are conducted by units with General Partner structure in the 42% of cases. This misalignment between strategy and structure could bring the CVC program to fail as we explained deeply in the Literature review (Section 1.2.5). Corrective measures will be discussed in the next chapter.

Chapter 4

Conclusions

4.1 Discussion on the results

The purpose of the present thesis was the combination of two goals: (1) highlighting the trends of innovation that are likely to influence the energy sector with a threefold temporal perspective and their geographical distribution; (2) detecting the reasons why and the structures with which established corporations engage in Inbound open innovation. The focus of this second topic was on the strategies of the corporations involved in Acquisitions and CVC programs and the main structures of the latter.

This work started with a review of the existing literature on the topic of Open innovation. Among the several mechanisms that corporations can use to innovate openly, we focused on Acquisitions and CVC. This investigation allowed us to measure the existing knowledge about these practices, to place them in the global innovation strategy of companies, and to understand the need for them to renew their internal resources and capabilities. This need revealed itself to be particularly pressing for the main players of the energy sector.

The literature review revealed some gaps in the academic research on the subject and highlighted the need to provide additional empirical insight. The analysis of the datasets collected was done especially for this purpose. We hope this work has been able to participate, at least slightly, to fill in this gap in the literature and academic knowledge.

42 Acquisitions, 188 CVC deals, and 1027 independent start-ups were presented in this work. The variables of interest varied according to the research question we wanted to answer. As regards the trends and their geographical distribution we used the variables Technological areas, technological subareas, geographical position of the start-ups' headquarter, and type of offer. As regards the strategies behind Acquisitions and CVC we leveraged the variable Strategy, developed according to the Chesbrough framework. Finally, the structures of CVC were analyzed through the variables syndication and governance. In chapter 3 we have shown the results of the analysis. Here we synthetize the main findings answering our research questions.

4.1.1 Discussion about the start-ups' technological trends and their geographical distribution

The first part of the scope of our analysis (Section 3.1) was focused on the trends in innovation in terms of technology and typology of offer developed by start-ups and where these latter are geographically distributed. In other words, we intended to answer the following research questions:

What are the most relevant technological trends and the most popular types of offers among innovative start-ups in the energy sector, distinguishing short, medium, and long term impact?

Where are the innovative startups interesting for the energy sector most concentrated? How are they geographically distributed?

Our quantitative analysis revealed interesting answers. It is worthy to notice that some trends are commonly shared by all three samples studied, while, in other occasions, we can detect some differences between CVC deals, acquisitions, and independent start-ups.

Generally speaking, 2020 has represented a tough year for all businesses, Covid-19 has represented that "black swan" that no one was able to predict and that stopped for months the traditional way of working. This can be seen also in open innovation. Acquisitions, CVC deals, and the foundations of start-ups all declined in 2020. This is due to the operational difficulties in

concluding deals and the fear of the evolution of the pandemic.

Let's focus on the first research question. From all three samples it can be concluded that Smart Mobility is the main field of these last 3 years. However, the main focus of the start-ups active in Smart mobility changes if we consider Acquisitions, CVC, or independent startups. This shows the different degrees of development reached by the distinct technological sub-areas linked to Smart mobility. The most acquired start-ups involved in Smart mobility are developing Sharing services, while the investee in CVC deals are working on charging infrastructure. Finally, electric vehicles and components are the main subject of independent start-ups. Sharing services are less capital intensive to implement and they require less switching costs for the customers, thus they have shown quickly high traction, and consequently, it makes sense that many startups reached the point of exit through an acquisition. Then it can be hypothesized, from the results of the analysis, that CVC deals focused mainly on charging infrastructure because many power utilities see these solutions as a possible way to enlarge their portfolio of activities by positioning themselves as the main provider of energy for the vehicles to which the world is likely to switch in the future. Moreover, these infrastructures are crucial for triggering the scalability of electric vehicles. Indeed these latter are under the development of many independent startups, however, an operating network of charging stations is needed to push customers to change in mass their vehicle. Governments should put their maximum effort to keep legislation up to date with innovation, so as not to hold back the growth of start-ups and possible new markets. Smart mobility has another peculiar feature, among the energy technological fields, it is characterized by a majority of services among the kinds of offer of its solutions. The fact that the most important field of innovation is mainly offering services is coherent with the mega-trend of servitization [Vandermerwe and Rada, 1988].

The Renewable Energy field, although not a new area, shows that it has still a lot of space for innovation and it reveals to be the second field in terms of acquired and independent start-ups and the second energy field also among the targets of CVC deals (Actually, in the sample of CVC, Renewable Energy counts one start-ups more compared to Smart Mobility, however, the cumulated money raised in the latter area is more than double compared to the former, thus we decided to consider Renewable Energy as second energy field for targets of CVC deals). The main segment is Solar power for each of the

three samples. It is interesting noticing that the main kind of offer is different between the sample of acquired start-ups and the group of independent ventures. Service is the main offer of the former, while the latter is characterized by a majority of hardware solutions. If we consider acquisitions a proxy of success indicator for a venture, we can conclude that start-ups should develop business models based on services rather than hardware. The product-as-a-service model allows indeed both financial advantages for the company, e.g. continue cash in-flows through subscription models and ease the selling process, and operational advantages (e.g. maximized used through multiple users [PaaS,];[ser, 2007]). It is coherent with this reasoning the fact that the most common kind of offer among the targets of CVC deals active in this field is Hardware+Service.

Resource management is the third field for both acquisitions and independent start-ups but not for CVCs. This should not surprise if we consider the nature of the sample of CVC we have defined. We have only considered CVC deals with a power utility as the main investor, thus the sample of CVC deal analysed had some limitations. Even though corporate venture capital is used to enlarge the portfolio of activities of power utilities, it is logical that they are less interested in a solution related to water and waste management rather than a solution more directly linked to the management and consumption of energy like a Smart grid, Smart Buildings, etc... In addition, power utilities have highlighted the lack of strong appropriability capacity [Energy Strategy, Politecnico di Milano, 2021], thus for many of them it can be difficult imagining to enter a business that has different knowledge required, thus a deal in this technological area, can be perceived as too risky. Anyhow, the high level of activity of acquisitions and independent start-ups in this field shows a rowing interest towards water and waste, two resources that for decades have been managed with low efficiency and now open many growth opportunities.

Analysing the targets of CVC deals, we have considered also the ones active in technological areas not strictly related to energy. It is significant the great importance of Data Analytics, and ICT and cybersecurity. They represent, in the sample of CVC, the first and second fields as regards cumulated money raised. This confirms the trend explained in the Literature review. Power utilities need digitalization to increase efficiency, safety, and productivity. The fact that power utilities are investing more in these two

fields than in the other energy fields underscores that it is likely that many applications like Smart gird, Smart building, Energy efficiency/ facility management, which involves the management of complex and interconnected systems, require that utilities have a strong digital development in order to make these solutions affordable and reliable for the market.

We have considered the variable "kind of offer" as a measure of the trends in term of business model in the three samples analyzed. The "pure" offers represent the majority of the start-ups, this can be explained by the fact that young ventures must focus on a clear and simple offer in order to succeed, reach milestones and convince investors. A mixed "offer" can create difficulties in explaining clearly the solution while pitching and consequently in raising money. When a founder has only two minutes to pitch his whole project, clarity and simplicity are the keys to success in winning competitions and the interest of investors. Among the "pure" offers we can see that Service is generally the most important. Only in the sample of Independent start-ups Hardware is most frequent in terms of deals compared to Service. The fact that CVC deals and acquisitions focused more on services may highlight that (1) a service model is considered more secure by investors (2) start-ups that have business models based on service, even if the solution developed is, in practice, hardware, are more likely to successfully conclude investments or acquisitions. Assuming that CVC deals and acquisitions are proofs of success for star-ups, the Product as a service represents a good model with which doing business.
The conclusions about Smart mobility and the analysis of the kind of offer underline heavily the importance of the mega-trend of servitization. The "as-a-Service" model is becoming the main custom when selling both hardware or software. This trend is enhanced by digitalization. Digital services, offered as complements or substitutes of the pure hardware or software offer, allow companies to increase their turn-over ratio [Springer, 2019].

As regards the geographical distribution of the start-ups' headquarters, the US represents a more fertile land than Europe if we consider the ventures acquired or subject to CVC investments. This difference is not due to the features of the start-ups, which are on average similar between the two geographical areas. The causes of this disparity should be searched outside the organizations, in the context within which they work. The analysis demonstrates that the Unites states have more acquisitions and CVC deals

compared to Europe and this is coherent with what has been said in the Literature review. Europe has more costly regulations, such as severe personal bankruptcy measures or the market for early-stage investment and higher costs for patenting compared to the United States. Thus it is evident that the latter hosts more start-ups that reach important financial milestones like an acquisition or a CVC deal. Other influencing factors are the lower liquidity of the European capital market, a smaller and less developed VC funds market [Da Rin et al., 2006], and a culture that is less risk-taker and less inclined to accept failures [Freytag and Thurik, 2007]. However our analysis shows that Europe is experiencing a change, not only this disparity is getting smaller over the years, but in the case of the independent start-ups, we see that Europe is becoming more fertile than the US. There is hope that the governments across all Europe, and not only in Germany and UK, will build a friendly environment for startups so that they cannot be forces to move their headquarter somewhere else or even worse, be not able to reach CVC investments or acquisitions. A first step could be making lower and more equal across Europe the price to open a business. Now the disparities are very significant [Statista, 2019]. Moreover, the "Next-generation EU" recovery plan, accepted to push growth after the pandemic is a once-in-a-lifetime occasion to invest in innovation and accept new agile ventures as drivers of the change thanks to their higher speed and flexibility [nex, 2020].

Interesting reflections can be drafted by studying how the different technological areas are distributed on the geographical areas of interest. Both in the sample of acquisitions and independent startups, it can be concluded that there is a similar concentration of venture focused on smart mobility in Europe and the United States. This represents another proof that this field is an international priority at the moment. Moreover, it can be perceived how in the US a big effort has been devoted to developing innovation in Resource management. This may be explained by the fact that the US feels more of an urgency the disruption in water and waste management. For what concerns businesses related to water, Europe, and in particular the EU, is more developed. Higher investments have been made, the maintenance of water distribution is higher [TUDelft,] and the EU water policy is much less fragmented than in the US [Ziolkowska and Peterson, 2016]. As regards waste instead, the EU has developed a culture more prone to recycling than the US. If on average in the EU 40% of the waste is recycled/composted and 38% is landfilled, in the US only 24% is recycled/composted and 69% is landfilled

[Greentechmedia, 2013]. Consequently it is logical to conclude that the US fells more the urgency to increase its recycling rates compared to the EU.

In terms of CVC deals instead, Europe is leading the Smart mobility and energy storage field while the US in Energy-other, the consist of solutions targeting, for instance, to clean fusion-energy. Renewable energy instead is a field that is more and more interesting for young ventures spread also in Africa and Asia, where off-grid solutions are under development.

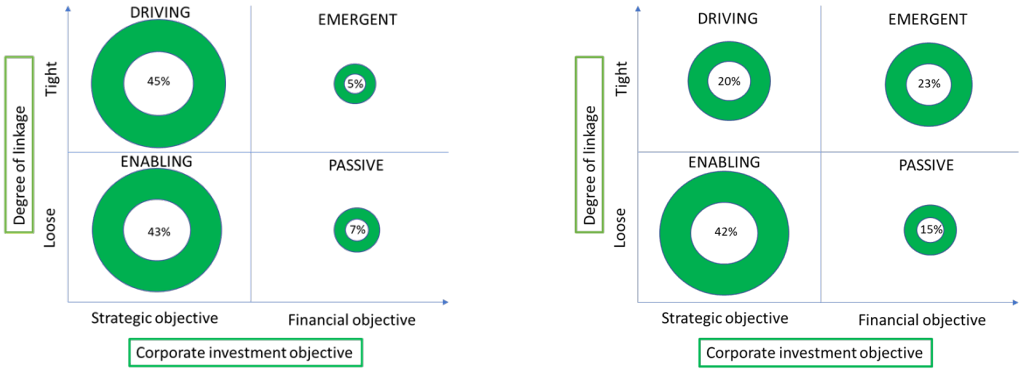
4.1.2 Discussion about the corporations' strategies and structures behind acquisitions and CVC deals

Here we intend to draft the conclusions about the corporations in the field of open innovation. Our focus is on their intentions behind the application of open innovation techniques as acquisitions and CVC, and the structures of the CVC units. In other words we answer the following questions:

What are the strategies behind the acquisitions and the corporate investment in venture capital of energy star-ups?

What are the structures of corporate venture capital units, belonging to power utilities, in the investments of star-ups?

As regards the first research question above, it can be noted in Figure 4.1 that for both the majority of the deals have a strategic investment objective. This confirms the contents of the literature review that consider these programs as means for strategic innovation. However, it is interesting to underline that CVC has a more explorative purpose on average compared to acquisitions. This can be easily explained by the difference in nature of the two mechanisms. CVC implies a much lower financial commitment compared to acquisitions, thus the accepted inclination to risk in the former is higher. Moreover, with CVC deals, a corporation gets a minority equity shareholding and consequently a lower responsibility on the future of the venture, and the corporation is less negatively impacted by its failure compared to the case of an acquisition.



(a) Acquisitions' strategies

(b) CVC strategies

Figure 4.1: Corporations' strategies behind acquisitions and CVC deals

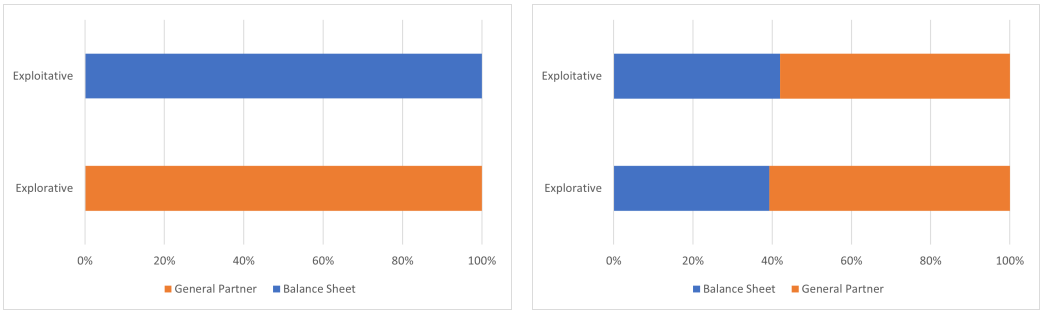
Finally, our analysis has highlighted some important aspects of the syndication and structures of the CVC.

As regards syndication we can conclude that corporations still prefer investing with some financial or industrial partners rather than staying alone. Thus, they renounce the exclusivity in the appropriation of the target's value in exchange for support in the investee's valuation and scouting capabilities. This may bring to a simple conclusion. Most corporations feel not ready to apply open innovation practices by themselves. Both because they have still little VC experience and they have low appropriability capabilities.

As regards the CVC unit's structure we notice that corporations prefer the General Partner modality that implies a unit that is detached by the parent company and more autonomous. This structure is better for explorative purposes(Section 1.2.5). However, from the literature review it can be assessed that the Balance sheet is better for exploiting the investee to complete rapidly the corporation's offer. In an optimal scenario, comparing the structure of the CVC units with the strategies behind the CVC deals we would expect a situation in which:

- Deals with explorative purposes are managed by a unit with General Partner structure. We can proxy these explorative deals, following Chesbrough's framework, to investments with loose degree of linkage with the corporation's core business (Enabling and Passive strategies);

- Deals with exploitative purposes, that we can proxy to investments with tight degree of linkage with the corporation's core business (Driving and Emerging strategies), are conducted by a unit with Balance Sheet structure.



(a) Theoretical best practice (b) Reality

Figure 4.2: Relationship between strategy and structure of CVC deals

From the results of the analysis (Figure 4.2), it can be seen that this expectations are not met. We can conclude that 38% of the exploratory investments (Enabling and Passive) are managed by a unit with Balance sheet structure and the exploitative investments (Driving and Emerging) are conducted by units with General Partner structure in the 42% of cases. This incoherence with the literature may be explained by understanding that (1) many corporations are not experts yet in the venture capital business; (2) a corporate could be willing to conduct both exploratory and exploitative investments but they define only one unit to keep management simple. This misalignment between strategy and structure could bring the CVC program to fail as we explained deeply in the Literature review (Section 1.2.5). Consequently an Ambidextrous approach could be the solution that many CVC units are looking for to avoid the failure of several investments.

4.2 Managerial implications

This study brings interesting managerial implications on many fronts, to those who today or in the foreseeable future will have to interface with the

energy innovation environment and want to have a clear and systematic vision of it.

Firstly, this study is particularly useful for entrepreneurs who are interested in entering the energy context. Knowing in-depth the industry in which you want to access, the trends and challenges that characterize it, the technologies, and the most popular business models, is essential to get off to a good start.

Secondly, this work can set interesting guidelines for established companies. Managers should exploit this work to understand the threats and opportunities for their firms, the direction that competitors are pursuing, which young ventures can disrupt the industry, and which businesses can be explored or exploited to look for innovation and growth. Managers should define very clearly in advance the strategy they want to pursue to make a coherent open innovation program. Moreover, they should understand the level of their absorptive capacity of external knowledge in order to decide the modality and the structure with which applying Acquisition and CVC's programs. In particular, while studying CVC deals, we have seen that there is not a positive correlation between explorative strategies for open innovation and a structure of the CVC units with a level of autonomy coherent with it, the same for exploitative programs. The lack of correlation between strategies and the theoretical correct unit's structure may prevent some corporations from successfully pursuing their innovation goals with CVC. Thus few managerial implications that may be drafted from this analysis are: (1) the corporation should have a unit coherent with the nature of their strategies; (2) if a company has both exploitative and explorative goals they should think about setting up two CVC units, one with General Partner structure for explorative investments, and one Balance Sheet unit for exploitative activities. Ambidextry in CVC may be a modality that assures more successful deals.

Managers should also ensure a diversified portfolio of investments in open innovation. Both in terms of typology of deal and strategy. On one hand, companies should invest both in acquisitions and CVC deals. The former to appropriate exclusively with a majority equity shareholding the value created by the most interesting companies, while, with the latter, buying a minority shareholding as a real option in companies whose value should be defined better and consequently whose related risk is high. On the other hand, in

terms of strategies, a company should have in its portfolio "Driving" deals to easily integrate the output of the targets in the parent company's offering thanks to the closeness of the start-up's activity to the company's core business. However, an 'Emerging' type of investment might be more suitable when faced with massive disruption.

Finally, corporations must maintain a sufficient level of internal core know-how. Otherwise, they could be unable to interiorize the external competencies and inventions, and consequently, all attempts to innovate openly would be wasted.

The third category affected by this work is one of the investors. By reading this thesis, they would understand the current trends in the energy sector and decide whether to follow them or make riskier bets on fields and models that yet are not the subject of many investments.

Policymakers are the last category that may find this work as a source of reflection. They can read this analysis and find the reasons to make mechanisms for open innovation easier and less problematic when failing happens. The natural development of innovation that can be assessed through this study may define the priority of technological fields to which it makes sense to focus first.

There is a la lack of a clear and standardized quantification and measurement system of the strategic impact of open innovation mechanisms on the parent firms and start-ups' performance. This framework would help all the actors involved in these processes to better plan and monitor their open programs. Everyone would benefit from an econometric analysis using a regression model measuring the strategic impact of the open innovation activities in terms of new products launched on the market, number of patents, investments in internal R&D or technology transfer, etc...

To conclude the main theoretical implication of this study is therefore to highlight the importance for future research to pay attention to the study of the characteristics of a particular sector. Analyzing the historical trajectory of this sector would allow for a better understanding of the place of acquisitions and CVC in the panoply of innovation tools of firms in these sectors and the reasons for using them. Consequently, we invite scholars to extend

this kind of analysis to different sectors and periodically making these reports to draw a clear historical development that can highlight best practices and common errors that the business world should avoid the keep innovating and solve the big challenges we have ahead.

4.3 Limitations

The quantitative analysis is highly dependent on the database definition procedure on which it is based. Indeed, it was composed based on deals coming essentially from Pitchbook, CrunchBase, or Zephyr. Although these platforms contain a large number of deals and independent start-ups, they may not be able to include all the deals and ventures that theoretically satisfied the selection criteria of our methodology. Cross-referencing with other databases or accessing the premium version of the ones used could have increased the number of subjects available for the analysis. Another limitation is the time frame considered in the analysis. This one is voluntarily based on the period 2018-2020 for Acquisitions and CVC deals and from 2016 to 2020 for independent startups but leaves out the previous deals and start-ups founded earlier.

Moreover, some variables such as Technological Area, Technological subarea, Strategy of the investment, or Type of offer are nominal variables that we have manually attributed according to our understanding of the invested start-ups. Some subjectivity may therefore have influenced this attribution.

Finally, this work focused on CVC and Acquisitions, but, to have a more complete overview of Open innovation in this sector, the other mechanisms briefly introduced in the literature review, such as alliances, corporate accelerators, etc... are worth to be analyzed. To conclude, many aspects of this research could be optimized to better analyze Inbound open innovation.

As seen in the introduction, the importance of Inbound open innovation and its mechanisms are going to increase in the future and this paper, therefore, leaves the door open for future research to better understand and take advantage of this now-ubiquitous tool.

4.4 Last remarks

The next decade will be crucial to decide how strong the climate crisis will strike our society. The energy sector is the main industry that must drive this change because the most part of Co2 emissions depends on how energy is generated, distributed and consumed. Open innovation is the key to save the society for the a crisis that will not spare anyone anywhere.

"Business cannot solve every problem, but no big problem can be solved without the participation of business." [Ross, 2021]

List of Figures

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