# The implementation of drones in the business model of photovoltaic companies

MASTER THESIS


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# ABSTRACT

After discussing for days, we decided to focus our thesis on civilian use of drones for monitoring photovoltaic[1] systems, since we wanted to write something new, which nobody has ever written about. Although data scarcity and limited information availability made sometimes our research difficult, we still wanted to put some effort in a "niche" topic, in the hope that future research could be inspired by this thesis.

At this point, the only decision to make was about the target market. Eventually, we decided to focus on the Italian PV industry, since this was affected by a severe crisis some years ago, and it has not been able to recover ever since. Instead of analyzing the causes that brought about this crisis, we wanted to focus more on the possible solutions for it: one of these is deemed to be the introduction of drones for monitoring activities on PV systems. In fact, the time reduction and productivity benefits that could derive by this use of drones, could let companies in the PV sector to outperform competitors; this could be done especially by the first company that adopts this technology, thanks to the first mover advantage.

All these factors led to the formulation of our research question:

*How can photovoltaic companies successfully implement the use of drones in their business model?*

In order to be able to answer it, we decided to use a qualitative method and conduct a multiple case study research. We did not use a quantitative method for two reasons: the first one is that Yin (2014) states that for "How" types of research questions, a qualitative method is more appropriate. The second reason is that we are not trained to use such a method, and we would have risked making some mistakes while using it. Also time constraints and the scarce willingness of the interviewees to disclose information and to offer us their time was a limitation for our project.

The research question could not have been answered without solid background theories. In light of this, the literature review was used as a tool to broaden our knowledge about topics like innovation, business models and strategy: based on the information picked

[1] From now on referred to as PV

from the literature, we built our own theoretical framework. This talks about change in the business model and the reasons that bring to it, showing that many times profits are the guiding motivation. Furthermore, the framework also shows how sometimes it is difficult for management to see and exploit a new opportunity to change. The term innovation is also defined in this chapter, showing how drones can be considered as such; and how this new innovation is acquiring a more and more central role, so much that it is not possible anymore to talk separately of humans and machines. A last important thing to mention is the need to consider not only the internal activities, but also the external factors within the organizational environment, that can be studied through the PESTLE analysis, in order to create a suitable business model.

In order to have a complete overview of the phenomenon of interest, we decided to gather both primary and secondary data, respectively through interviews and websites. With the former, we could construct the empirical framework, gaining interesting insights in both PV and drones industry. With the latter, instead, we could understand if primary information obtained were influenced by subjectivity of the interviewees or could be considered reliable, and we could gain a deeper understanding of drones and PV history and industry.

We came to know that the drones companies interviewed have a different core business than the thermal drone survey; this is the reason why they do not advertise much about this service. This is proven by the fact that PV companies have a blurry vision about this service, not knowing exactly what it is about. However, the PV companies interviewed not only install the cells, but also make operations and maintenance (O&M) activities; therefore, this new application would be useful in this matter.

Sometimes we have found a match between the theory and the reality, but sometimes this match did not exist. However, we came anyway to a valid conclusion: PV companies must externalize the monitoring service offered by drones, since it is a valuable contribution for company's time reduction and higher productivity. Only after gaining the right know-how, PV companies can decide to internalize the activity.

We think that our thesis could be of interest for possible future researchers. As for now, nobody has written anything about drones for PV monitoring purposes, and our work can be also implemented using a quantitative method. Furthermore, the results of our thesis could be extended to other Countries and to other civilian uses.

# CHAPTER 1: INTRODUCTION

Drones: what are these objects actually able to do? Can they substitute human workers for some activities? These are questions that people have been asking for decades. A drone is an "unmanned aircraft that is guided remotely" (Cambridge University Dictionary). The first drone appeared already before World War II, precisely in 1934, used by the Royal UK Navy for target practice (House Of Lords, 2015). If one has to be loose on the definition of drones, meaning every object that could be guided remotely, then the first appearance of it dates back to the XIX Century, in 1898, in New York: Nikola Tesla, in fact, made a little ship move in a tank of water through a one frequency signal (Assembly website).

This thesis aims at researching something new, a niche topic which authors and researchers have never focused on yet. For this reason, we studied a recent phenomenon, which is involving technology and it is still in its first stages: drones for civilian use. There is no literature as for now regarding this topic: in fact, drones for civilian use are just one of the most recent developments of technology. Drones exist since decades, but their use was circumscribed to the military one. Just in the last years, however, the civilian use of drones has made its appearance, mainly in sectors like agriculture, commerce, monitoring and photogrammetry purposes. We deem, therefore, that a study on this new application could be interesting and lead to possible future research.

Besides the advantages that drones can offer and the peculiarity of this thesis, which could be considered one of the first works about this topic, there are also downsides, mainly because of data scarcity and information availability. We deem, though, that what we have found out can be a solid ground for companies that want to use drones.

Since the meaning of civilian use of drones is vast, we decided to focus on only one of the many possible uses, i.e. the implementation of this technology on Photovoltaic systems. Italy and the PV sector were chosen for various reasons: not only because Italy is our country, but mainly because until the year 2011, Italy was the third producer of solar energy in the world. In the most recent years, though, this market has been witnessing a profound crisis, which led many companies to shut down their activities. In light of this, we wanted to understand what happened, and try to provide a solution to

the companies still in the sector. Giving the maturity of it, only an innovation could have been a key for this change, and this was found to be the introduction of drones in the activity of checking and monitoring PV systems.
Furthermore, what was interesting and brought us to choose this topic was the technology boom that we have been witnessing during the past 20 years. We deemed interesting to study more in detail this drones phenomenon, since it could bring to a revolution in the way companies in the PV sector work and organize their activities. Technology is assuming a more and more central role nowadays in every company, and should not be overlooked when looking for innovation in companies' activities.
There are also many limitations to the use of drones though: for example, just the people authorized and trained to pilot a drone can actually perform the activity of flight. The legislation is also very strict: the areas on which a drone can fly are distinguished between critical and non critical, and for these last ones a special permission is required. Drones are also expensive objects: it is possible that a start-up or a small company can not afford it, thereby making the spread of this technology and functionality more difficult.
Having already a background of subjects in our Master studies that focused on organizational change, business models and strategy, we decided to broaden even more our knowledge of innovation and business models especially, to study the best way drones could be implemented in PV companies' business models.
This led to this thesis' research question:

*How can photovoltaic companies successfully implement the use of drones in their business model?*

After having interviewed employees in three drones companies and in three PV companies, we came to know many new things about these two sectors; not only interviews, but also authors in the literature helped us to build our conclusions and thereby answering the research question.
The structure of our thesis will be now outlined, giving also an explanation of what was written in the 10 different chapters. The structure is as follows:

1) Introduction: A brief introduction to the paper itself, where the main points of the thesis are outlined, to give a general idea of what the paper is about and to raise the interest in the reader.
2) Literature review: in this section, we will write about the literature on business models and innovation, which helped us to have a clearer picture of how the research question could be answered. In order to do this, we chose 10 "inspirational" papers, and many others who contradicted, agreed or implemented the view of these.
3) Method: After having discussed the authors and their papers, showing the links among them and how they relate to one another, the method chapter will explain in more detail what the plan of this thesis was and what we wanted to research. In this chapter, we also outlined the limitations of our work.
4) Context: In the fourth chapter, named context, we will explain both the drones and the photovoltaic industry, with particular attention to the situation of these in Italy. These industries will be analyzed both in terms of legislation and market/growth trends.
5) Case story: In the case story chapter, instead, we will still focus on Italy, but the topic explained will be the history of drones and PV, along with the description of the companies interviewed.
6) Analysis: Once introduced all these concepts, in chapter 6, i.e. the analysis, the concepts will become sharper. An empirical framework will be introduced: this will be basically a detailed explanation of what we have found out from both primary and secondary data. This data will be backed up by quotes from the interviews.
7) Synthesis: In the synthesis chapter, we will link the theoretical and the empirical framework just created, stating what is new compared to the theory and the differences that could be found between reality and our theoretical model.
8) Discussion: In the eighth chapter, the discussion, the causes of the differences and similarities between reality and theory outlined earlier will be explained in a more detailed way.
9) Delimitations: The delimitations chapter will then explain what we focused on, and what, instead, was kept out from our research. This was done in regards of

certain aspects of drones, business models and PV industry. An explanation to all the delimitations outlined will be given.

10) Conclusions: The conclusion chapter will be a summing up of the main findings, and an outline of the implications for the industry and for future research.

To conclude, although the evident limitations and delimitations, we built valid empirical and theoretical frameworks, suggesting our solution to the research question. We deem interesting to study this new phenomenon also under different points of views, for example analyzing another industry within which the use of drones is possible. We therefore hope to have paved the way to prolific future research about this topic.

# CHAPTER 2: LITERATURE REVIEW

In order to have a deeper understanding of theories about innovation, business models and change, we read several papers about these topics. Eventually, we chose 10 papers, which were deemed to be interesting and inspiring for us because of many reasons. We critically debated with the authors in this chapter, meaning that every time we engaged with them and we took a position about what was said in the papers.

Each of the 10 inspiring papers, called "spot reference" (Supervision Meeting 6), will contain three different paragraphs:

1) Description of the key points and the author's position
2) Engagement with the author, basically a discussion of the author's position
3) Take a position following the reasons we gave in the paragraph before and fortify the position with other papers (Ibid).

At the end of the chapter, we created our own theoretical framework: the causality among the papers will be shown in this section, in which the relation will be among each paper and not in relation to the case.

1. Vives and Svejenova (2011)

The paper "Business models: towards an integrative framework" written by Vives and Svejenova (2011) depicts the life cycle of a business model throughout four stages:

1) Origination: the "Why", the purpose of the business model. It can be *profit*, "love of gain", expressed in concerns about performance and competitiveness; *passion*, which is the fulfillment of a vocation; and *people,* as source of motivation, that gives higher priority to social value and development for stakeholders rather than economic value for shareholders.

2) Design: requires choices in regards to "Who", the customer, and "What", the value proposition, activity systems and resources.

3) Operation: focuses on the "How". This involves orchestration of activities and resources, within and across the organizational boundaries.

4) Outcome: is the question of "How much". Not only economic, but also social and cultural values should be taken into account.

Important is also the distinction between innovation *in* the business model, whereby elements of design and functioning are transformed, and innovation *of* the business model, in which the change affects the overall logic of the enterprise by questioning and/or transforming the guiding motivation (Ibid).

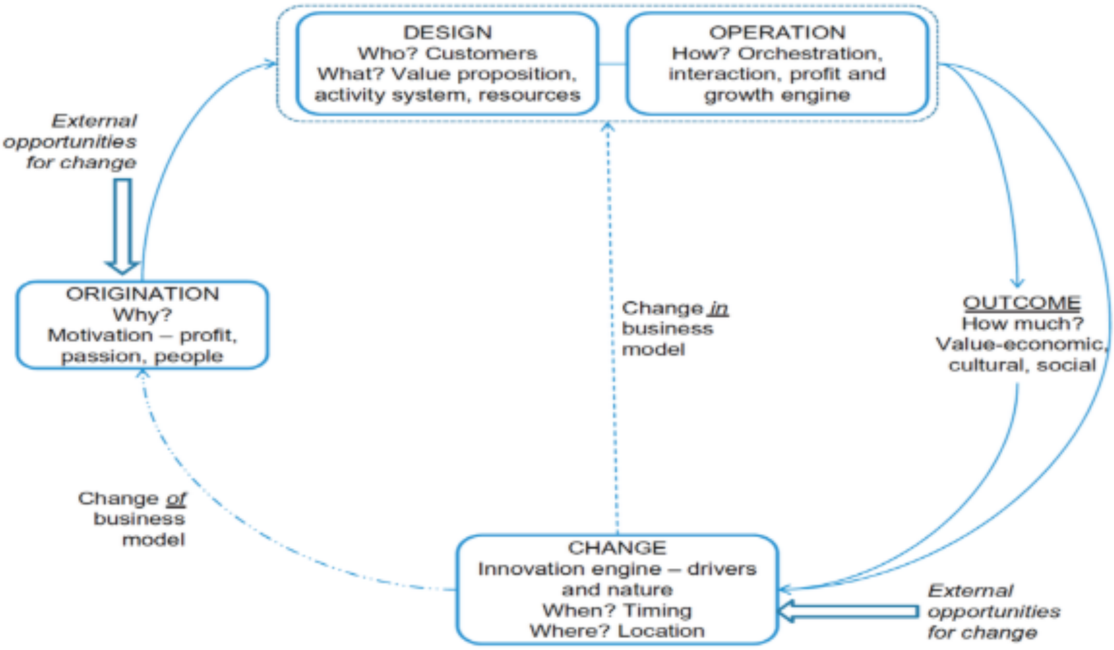



Figure 1: Life cycle of a business model

As the paper says, a motivation to the originations of a business model can be profits. Changes in the business model can be a possible way for the realization of an organizational change. Beer and Nohria, in their paper "Cracking the code of change" (2000) highlight two kinds of organizational changes through theory E, which creates economic value for shareholders, and theory O, which concerns corporate culture.

Furthermore, Vives and Svejenova do not distinguish between episodic and continuous changes, as Poole describes in his paper "Central issues in the study of change and innovation" (2004), but instead, they generalize for every kind of change in the business model. We are of the opinion that this generalization is too wide to describe both kinds of change. In fact, the variation of the business model is slower and smaller with the continuous change than with the episodic one, in which the variation is more radical (Ibid).

Another critique to the model is the fact that Vives and Svejenova (2011) do not take into account the background, the past of the organization, but they only say that a change will happen when the company sees an opportunity to exploit. However, we firmly believe that the business model change will be different depending on the past of the company, given the same opportunity. This is the kind of change described by Ruttan in his paper "Induced innovation, evolutionary theory and path dependence: sources of technical change" (1997): the author, indeed, believes that technical changes are always path dependent, which means that a technical change depends on what the company experienced in the past, in terms of problems and challenges, both within the organization and in the external environment.

2. Kim and Mauborgne (2009)

Kim and Mauborgne, in their paper "Blue ocean strategy" (2009), assert that in existing industries, prospects of profits and growth decline when companies compete for shares in a market with limited demand. Here, the marketplace is called Red Ocean, since the increasing number of competitors, i.e. sharks, turns the water bloody. In a red ocean, industry boundaries are defined and accepted, leaving outperformance as the only option for gains. Red ocean strategy is based on a structuralist view, or environmental determinism, which is a worldview based on the assumption that industry structural conditions are given, and firms are forced to compete within them (Ibid). Blue oceans, i.e. markets with no competitors, are not defined by technology innovation. In industries that are technology intensive, the technology is often already in existence. In blue oceans, demand is created by bending the boundaries in existing red oceans. Prospects of growth and profits in red oceans are shrinking steadily (Ibid).
However, the blue ocean theory is not a totally new concept: also Michael Porter, in fact, in his paper "What is strategy?" (1996), already talked about strategies of differentiation as a means of delivering a unique product to defeat competition, although he has not used the term blue ocean. Furthermore, Kim and Mauborgne (2009) do not talk about the type of innovation: it can be stated from the paper, though, that continuous innovations are part of the competitive strategy, and radical innovations are more seen as blue ocean strategy. This happens because with a radical innovation there is the creation of a totally new market. There is also a weakness in the methodology used by the authors: the companies taken in consideration in the paper are successful

examples of blue ocean strategy, but then Kim and Mauborgne generalize for every company, which cannot be always true.

As previously mentioned, according to us, the red ocean strategy is not a totally new topic: in fact, Porter (1996) states that a real competitive strategy is about being different. It means deliberately choosing a different set of activities than rivals to deliver a unique mix of value: this can give a company a competitive and sustainable advantage (Ibid). Kim and Mauborgne (2009), to a certain extent, just reinvented the wheel, by coining the term blue ocean. Furthermore, the authors, when talking about red oceans, say that in these conditions companies need to outperform the others in order to be competitive. We agree with this last statement, but we think that, for companies to be competitive, a disruptive innovation needs to be introduced, as described by Markides, in his paper "Disruptive Innovation: In Need of Better Theory" (2006): this disruptive innovation can be either a business model innovation or a radical product innovation. This does not necessarily mean that there will be the creation of a blue ocean: we are still in a red one, in which companies have to survive in a market full of sharks.

<u>3. Gould et al. (2013)</u>

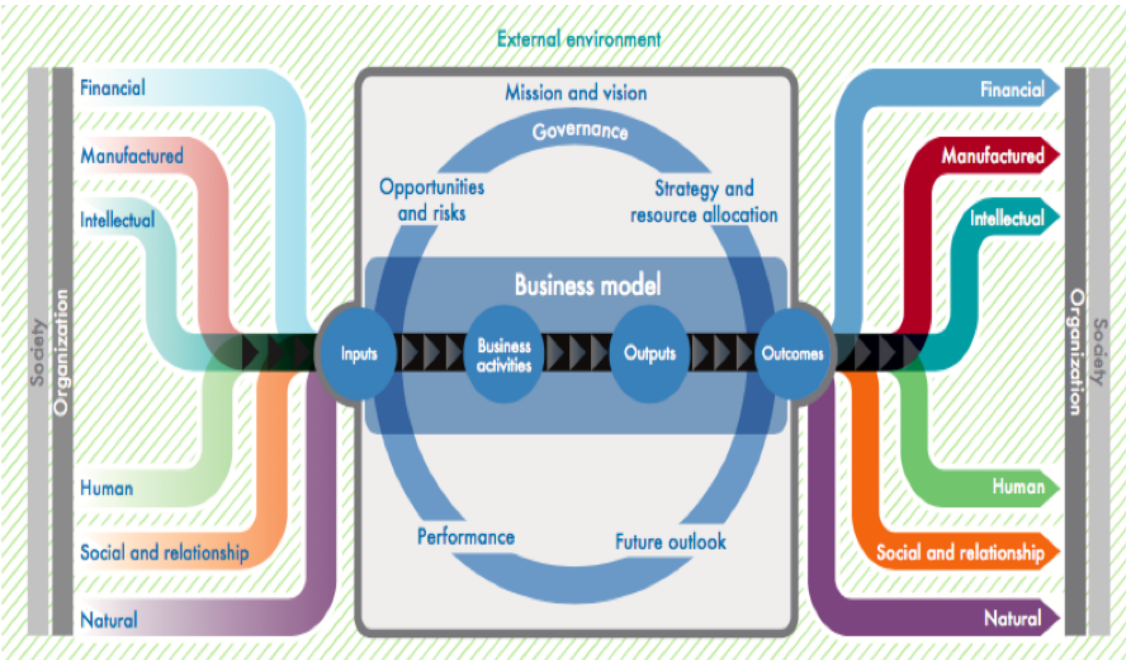



Figure 2: Interdependency between business models and other information

In the paper “Business model – background paper for integrated reporting” (2013) by Gould et al., business models are defined as “the chosen systems of input, business activities, outputs and outcomes that aim to create value over the short, medium and long term”. Following, we are going to better describe each element of the business model:

- Input, the resources and capabilities on which the company relies;
- Business activities, the central gear that transforms inputs into outputs;
- Outputs, key products or services that an organization produces;
- Outcomes, the internal and external consequences for the capitals employed as a result of an organization’s activities (Ibid).

For the process of decision-making, a company needs the right information and measurement system, that must be reviewed periodically to improve all components (Ibid). However, the authors do not take in consideration that the business model is not something static, but it can and must change if a company wants to stay competitive in the market, as stated in the paper “Transformation – an imperative to change” (BCG, 2009). For a business model to be successful, the external conditions that affect company’s choices are also to be taken in consideration, as suggested by the PESTLE analysis (Team FME, 2013). This is also what Gould et al. (2013) tried to emphasize when talking about the “context”, which means the external factors that influence the organization’s operating environment (Ibid).

We are of the opinion that a business model must not be stationary, but it should evolve along the way through the interactions between the current, the past and the future environment. Business models are, in fact, not made only to create value for the company, but also to break out the competition and sustain the competitive advantage (BCG, 2009). This is the reason why business model innovation is especially important in periods of instability: they give rules and path to follow for companies to survive during a crisis. In light of this, we agree with Gould et al.’s definition, but we know that it is important to consider that a business model is something in continuous evolution.

4. Teece (2010)

Teece, in his paper "Business Models, Business Strategy and Innovation" (2010), defines a business model as the organizational and financial architecture of a business. This is the reason why, to be successful, a company needs to excel not only in product innovation, but also at business model design. Matching together the business model and the strategy of the company will lead to protect the competitive advantage from the competitors (Ibid). In particular, there are three factors that can avoid a business model to be copied:

- Business models require systems, processes and assets difficult to replicate;
- Certain level of opacity of the business model can make it difficult for competitors to understand and thereby copy it;
- Incumbents in the industry could be reluctant to replicate it because of the possibility of cannibalization of the existing sales and profits (Ibid).


Figure 3: Elements of business model design

Teece (2010), however, creates only a theoretical definition of business models, which is difficult to apply in the reality for firm analysis. Giving a definition without an explanation for applications to reality is basically useless for companies, since they already have a business model. The model described by Teece seems to be more useful for academic literature than for real case scenarios. A good point in Teece's paper, instead, is that he describes the business model as the organizational and financial architecture of a company: most of the times, in fact, academic literature overlooks the financial aspect of business models, because it is deemed to be irrelevant to explain the interrelations among business model components.

The process of matching the business model with the strategy of a company is the outcome of a sense-making process, as described by Weick in his paper "Sensemaking in Organizations: Small Structures with large consequences" (2001). However, the building blocks of the sense-making process are unknown. In light of this, what is really important in this process is the commitment of all the people that work at the process of sense-making, in order to better analyze company's factors and therefore be successful in the strategy (Ibid).

Furthermore, as Nemet asserts in his paper "Demand-pull, technology-push, and government-led incentives for non-incremental technical change" (2009), for a business model to not be copied, it is important that a company invests in scientific knowledge: in this way, it can better exploit the opportunities that arise in the market before the competitors do. In fact, improvement in scientific acknowledgment can determine the rate of innovation - a situation called technology push (Ibid).

5. Demil and Lecocq (2010)

Demil and Lecocq, in their paper "Business model evolution: in a search of dynamic consistency" (2010), talk about the RCOV model, which stays for:

- Resources and Competences (RC), that combined together create value for the company;
- Organization (O), within a value network or the firm boundaries;
- Value proposition (V), that creates the structure of the organization through the whole supply chain (Ibid).

This framework represents a dynamic approach to business models, since managers have to consider the combined effects of resources, organization and valued offered.

Furthermore, the authors emphasize how business models are something dynamic that can always change because of the continuous interactions among all components of the RCOV model (Ibid).

The framework emphasizes how organizations are not formed only by technologies and resources, but also by people. The same is stated by Orlikowski in her paper "Sociomaterial practices: exploring technology at work" (2007), who studies the relationship between organizations and technologies by creating an entangled perspective, in which humans and technologies are considered to be inextricably related to create a successful company.

Furthermore, it is very important to consider that a business model is different from strategy, as Casadesus-Masanell and Ricart also say in their paper "From strategy to business models and to tactics" (2009). In fact, business models refer to the way in which a company operates, while strategy is related to the choice of the business model with which the company competes in the market (Ibid).

We completely agree with Demil and Lecocq's (2010) vision that a business model is something that always changes, and managers must be aware of this. Business models, in fact, need to change as the environment and the marketplace change, if the company wants to survive and stay competitive in the market. It is possible to reach this goal not only by adapting the business model to the new conditions, but also by improving the company's strategy (Ibid). Especially nowadays, it is also important to take new technologies into account, given their continuous development; new ways of dealing with materiality for the definition of the value proposition should be researched, since organizations are increasingly constituted by multiple, emergent and interdependent technologies (Orlikowski, 2007).

6. Zott, Amit and Massa (2011)

Various definitions of business models exist, and not always they overlap: this can lead to confusion. In fact, Zott et al., in their paper "The business model: recent developments and future research" (2011) say that business models can be defined as a statement, a description, a representation, an architecture, a conceptual model, a structural template, a method, a framework and a pattern. In the technology and innovation fields, however, the definition of a business model is clearer: it is the mechanism that matches a firm's technology and the customers needs, connecting the input resources and the market outcomes (Ibid). Furthermore, the paper identifies three kinds of business model innovation:

- Industry models, innovations in industry supply chain;
- Revenue models, innovations in how companies generate value;
- Enterprise models, innovations in the role the structure of an enterprise plays in new or existing value chains (Ibid).

However, the paper just states that these three models are to be found separately in reality, and does not mention that they can also be found together. Furthermore, after reading the paper, it is clear how academic literature has not already found a common definition for business models, shared and accepted by all the researchers who study business models. This different set of business model definitions and approaches to classification has led to the creation of confusion regarding two important aspects: key components of a business model and how innovation occurs within a business model (Ibid).

As Godin states in his paper "Innovation: the history of a category" (2008), innovation derives from creative minds and it is everywhere, and it concerns not only the three aspects described by Zott et al. (2011). In fact, we agree with Godin's perspective about the origins of innovation, which can be imitation or invention. However, it is also true that innovation does not exist as such, but it is constructed through discourses and experiences. Innovations come about only when companies see the opportunity to innovate; this can be in the supply chain, in the value creation processes and in the marketplace in general (Zott et al., 2011).

7. Latour (1992)

In his article "Where are the missing masses? The sociology of a few mundane artifacts" (1992), Latour states that, when analyzing the social structure of society, non-human actors must be taken into consideration. Latour (1992) describes the transformation of a major effort into a minor one through the substitution of humans with reliable, non-human characters as *delegation*. When humans have delegated an action onto technology, a counter-process of technology delegating tasks to humans can

occur. This is called *prescription*. Prescription can sometimes lead to *discrimination*. An example would be the case of a hydraulic door closer ("groom"), where technology has been delegated with the task of closing the door after people enter (Ibid). This leads to technology imposing behavior back onto humans, seeing as it takes a relatively strong person to open such a door. Thus, the technology discriminates people who do not possess the strength to open the door (Ibid).
If we consider Callon's perspective, from his paper "Economic markets and the rise of interactive agencements: from prosthetic agencies to habilitated agencies" (2008), however, in which he states that also technologies possess *agencement*, i.e. the capacity to transform a situation by producing a difference, it is not true that technology discriminates humans, because the former modifies the environment, just like humans do. There is no such differentiation between humans and technologies: they both modify the environment by producing a difference (Ibid). This is the reason why Callon (2008) talks about socio-technical agencement, to describe the collective action distributed among humans and technologies. Latour himself, in a later publication titled "Third Source of Uncertainty: Objects too Have Agency" (2005), affirms that also objects, and not only humans, such as technologies or machines, have agency, which means the capacity to act (Ibid).

We agree with Latour (2005) when he talks about machines and the fact that they are conquering a central role within companies; however, it is also true that they are not substituting humans through a prescription process. Technologies are only becoming more important than before for companies to stay competitive in the market. Furthermore, Latour (1992) describes prescription also as the ethical dimension, stating how humans have to interact with machines and the environment in general, without necessarily physical, financial, intangible, and humans being discriminated by the latter.

8. Chesbrough (2010)

Chesbrough, in his paper "Business model innovation: opportunities and barriers" (2010), suggests two types of barriers to business model innovation in existing firms. The first type of barrier is structural and refers to conflicts with existing assets and business models. The second type of barrier is cognitive, when managers are unable to understand the value potential in technologies and ideas that do not fit with the current business model, since they have been using this for too long time (Ibid). Three tools are suggested that could help to overcome these barriers. The first consists of constructing maps of business models to clarify the processes underlying them, which then become a source of experiments to consider alternative combinations of the processes. The second involves conferring authority for experimentation within the organizational hierarchy. The third is experimentation itself, conceptualized as a process of discovery through trial and error processes, before discovering a viable alternative to the business model (Ibid).

A critique to Chesbrough's paper regards the method: in fact, the author takes into consideration only a specific kind of firms, such as U.S. companies in the high-tech industry, and then he generalizes the concept of the business model innovation barriers. The sample of companies is deemed to be not relevant for generalization. Furthermore, the author focuses more on open innovation rather than on closed innovation; but it is true that the former is more risky, because of lack of protecting regulations, while the latter should be given more importance in the paper, especially now that with the Internet and globalization, information is spreading faster. The last point to take into account is the fact that business model innovation is very important, but it is not enough to succeed in a competitive environment, especially for an already mature company: it is important to also be able to change it.

The first barrier to business model innovation, as said, refers to the conflict that can arise among current business models within the same company. This situation, in which more than one business model is present, is what Markides, in his paper "Business model innovation: what can the ambidexterity literature teach us?" (2013), calls ambidexterity. However, as Markides says, the company must use the two different kinds of business models in a successful way, without falling in the "stuck in the middle" trap (Porter, 1980). Furthermore, O'Reilly and Tushman, in their paper "Organizational ambidexterity in action - how managers explore and exploit" (2011), argue that ambidexterity requires managers to be able to see the change in the environment, and to exploit these opportunities and avoid threats.

9. Malone et al. (2006)

According to what stated by Malone et al. in their paper "Do some business models perform better than others?" (2006), some business models are much more common and perform better than others. Furthermore, they individuate sixteen different kinds of business models, making this classification upon two dimensions:

- The rights that are sold;
- The assets involved, i.e. physical, financial, intangible, and human (Ibid).

For the purpose of our thesis, we deem describing all these 16 different types irrelevant: this is the reason why we will focus just on the one that is needed, i.e. wholesaler/retailer, which buys and then sells physical assets. However, the authors do not consider all the possible cases of business models that are present in the reality. In fact, they do not mention the case in which a company, besides selling its product, also offers other services; these can vary from the assembling of the final product (according to clients' requests) and some maintenance activities. Furthermore, we believe that no business model performs better than others, rather it depends on how a company is able to connect its business model with the strategy, to plan the way to beat its rivals, as also Magretta says in his paper "Why business models matter" (2002). A good business model must answer the following two questions: Who is the customer and what does the customer value (Ibid).
In addition, managers must also consider other issues, like "How do we make money in this business?", "What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?" (Ibid). Compared to Magretta (2002), Malone et al. (2006) have a wider vision of business models, which do not refer only to the financial/economic aspect, but also to physical, intangible and human assets. We are of the opinion that, for a comprehensive definition of business model, it is important to consider all the aspects, not only the economic one. In fact, for a company to survive in the marketplace, it only needs to consider the economic factors of a business model; to be successful, on the other hand, it is also important to consider all the other aspects underlined by Malone et al. (2006).

10. Damanpour (1996)

Damanpour, in his paper "Organizational complexity and innovation: developing and testing multiple contingency models" (1996), provides a detailed definition of innovation: "A process that includes the generation, development, and implementation of new ideas or behaviors. Further, innovation is conceived as a means of changing an organization, either as a response to changes in the external environment or as a pre-emptive action to influence the environment. Hence, innovation is here broadly defined to encompass a range of types, including new product or service, new process technology, new organizational structures or administrative systems, or new plans or programs pertaining to organizational members" (Ibid).

Furthermore, we agree with Damanpour (1996) when he highlights the general lack of clarity on how contextual factors such as firm size and organizational structure affect the ability of organizations to innovate. However, the author does not create a clear-cut differentiation between innovation and invention, even if they are completely different concepts (Ibid). Invention, in fact, is defined as "the discovery of something previously not known" (Clegg et al., 2012). Also the distinction between process innovation -doing things differently- and product innovation -doing new things- is not so clear, but only implicit in the definition the author gives. The only distinction that the author does not take in consideration is the one between radical and incremental innovation. The former fundamentally changes the products, while the latter creates small and continuous improvements to the existing ones and this differentiation is very important, since it changes completely the way in which companies should deal with them (Ibid).

Several authors have talked about innovation, among others also Schumpeter, in his book "The theory of economic development" (1934). Schumpeter defines innovation as "anything that changes the current state, or the doing of new things, or the doing of things that are already been done in a new way". Even if the definitions were ideated 60 years from one another, we deem Schumpeter's definition of innovation being similar to Damanpour's one, although nowadays the rate of technological innovation and the technologies themselves are more evolved than they were in 1934.

In conclusion, we agree with Damanpour (1996) that an innovation depends on external factors that influence organizational behavior and its capacity to act; but on the other hand, his definition is too broad to define in detail the different connotations of innovation mentioned earlier.

## 2.1 Our theoretical framework

Vives and Svejenova (2011) affirm that, every time there is an external opportunity for a change, the company starts to innovate its business model: this can be either a change *of* the business model, meaning all the mechanisms at the basis of the enterprise, or *in* the business model, which means a change in the relations among the parts of the business model or in the process of functioning. However, what the authors do not mention is that, sometimes, managers cannot see this external opportunity and, therefore, they miss a chance to innovate. This problem is also underlined in Chesbrough's paper "Business model innovation: opportunities and barriers" (2010), where Chesbrough calls it *barrier* to business model innovation. In particular, he explains the existence of two kinds of barrier, and the one described above is called cognitive barrier, while the other one is called structural. Chesbrough not only explains different kinds of business model innovation barriers, but also several kinds of business model innovation opportunities, that can be pursued by a company. For example, other researchers such as Zott, Amit and Massa (2011), consider three different kinds of business model innovation, i.e. industry models (innovations in industry supply chain), revenue models (innovations in how companies generate value), and enterprise models (innovations in the role that the structure of an enterprise plays in new or existing value chains). These types are all consistent with the definition of business model given by Gould et al. (2013), according to whom business model is described as a "system of input, business activities, output and outcomes": this system is based on capital as input, which, through business activities, are converted into outputs. We can affirm that with the industry model (Zott et al., 2012), the company is going to modify the inputs described by Gould et al. (2013), that means capital and labor, i.e. all the factors at the top of the supply chain. Secondly, the revenue model refers to changes in the business activities described by Gould et al. (2013). In fact, the way in which a company generates value is determined by how it uses its input in all the activities that are going to produce outputs. Lastly, the enterprise model corresponds to a change in every single part of the business model described by Gould et al., since only in this case it is possible to innovate the whole structure and role of the organization within its value chain (Zott et al., 2012).

Innovation always comes about for a reason, and it is always connected to a purpose. The final goal of innovation is to stay competitive in the market, especially in the one described by Kim and Mauborgne (2009) as Red Ocean. The authors, in fact, say that, in order to stay competitive in a red ocean, a company needs to outperform the competitors. We believe that this is possible only thanks to innovation, since it leads to the creation of better processes, products or services compared to what the competitors offer. In fact, innovation can be defined as a means for changing the organization to respond to the external environment (Damanpour, 1996): this is exactly what a company needs to do to survive in a market full of dangerous competitors.

In the previous paragraph, we mentioned that innovation always comes about for a reason. We noticed that the literature written so far on business models and innovation talks widely about these reasons, mentioning many times the economical aspect behind any innovation. This, in fact, is said by Vives and Svejenova (2011) when they describe the first stage of a business model. They affirm that a purpose for a business model can be represented by profits, people and passion. Profits are related to the "love of gain", and expressed in concerns of performance and competitiveness (Ibid).

These two authors are not the only ones talking about this fact: also Beer and Nohria, in their paper "Cracking the code of change" (2000), distinguish between theories E and O. Theory E takes in consideration the economical reasons that push a company to change, i.e. higher profits, lower costs and higher shareholder value. These purposes are often achieved through a hard approach, which means the use of economic incentives, drastic layoffs, downsizing, and restructuring. Again, one can see the economic reasons standing behind innovation and change.

Also Chesbrough talks about the economic side of a business model, while describing it, in his paper "Business model innovation: opportunities and barriers" (2010). According to him, a business model must fulfill the following functions:

- Articulates the value proposition
- Identifies a market segment and specifies the revenue generation mechanism

- Defines the structure of the value chain required to create and distribute the offering and complementary assets needed to support position in the chain
- Details the revenue mechanisms by which the firm will be paid for the offering
- Estimates the cost structure and profit potential
- Describes the position of the firm within the value network linking suppliers and customers
- Formulates the competitive strategy by which the innovating firm will gain and hold advantage over rivals.

As we can see, also in this definition, the economical part of a business model is there: the author, in fact, mentions profit potential, value proposition and revenue generation mechanism to describe it.

To conclude, we think it is important to take into consideration also the motivation behind the creation of a business model. In this way, a company can choose the best, because nobody cannot tell beforehand which one will perform better than the others.

However, even if the final purpose of business models and business model innovation are often profits, thus the internal part of the organization (such as cost and revenue structure), it is fundamental to take into consideration also the external factors that surround the company. This is well described by Gould et al. (2013) in their paper "Business model - background paper for integrated reporting", which talks about how to define a business model and how to create the most suitable one for a company. While the authors describe in deep detail how to define a business model, on the other hand also Teece (2010) talks about business models and the connection with strategy. The author, in fact, affirms that "coupling competitive strategy analysis to business model design requires segmenting the market, creating a value proposition for each segment, setting up the apparatus to deliver that value, and then figuring out various 'isolating mechanisms' that can be used to prevent the business model/strategy from being undermined through imitation by competitors or disintermediation by customers" (Teece, 2010).

The two papers are, to a certain extent, complementary, since a good business model is not enough to win over a competitor without having a good strategy: Gould's theory (2013) is necessary to create a suitable business model, considering company's activities and context; Teece's is necessary to match the business model with the strategy, in order to protect the company's competitive advantage.

Having a differentiated, hard-to-imitate, effective and efficient business model is therefore of vital importance to the establishment of competitive advantage for a company. However, this is only the first step for a firm to stay competitive. Teece is right when he talks about the way to achieve the competitive advantage, i.e. matching the business model to the strategy. On the other hand, however, to survive in the long run it is important also to maintain and improve this competitive advantage (Porter, 1996). In light of this, it is easy to understand how innovation plays a vital role for the survival and excellence of a company in a given market place.

To better explain this, we will refer to Damanpour (1996), who describes innovation as a process that leads to the creation of new ideas and behaviors, without however making any reference to the fact that people or objects are to kick-start this process; this is precisely the vision that Latour (1992) and Callon (2008) have. According to them, both machines and people have the ability to act; Latour refers to this concept with the term of agency, while Callon with the term agencement. In particular, it is important to consider the socio-technical agencement, which means collective and distributed action, in which the participants can be both human and non-human (Callon, 2008). Here, it is clear the importance given to technologies, and therefore also to innovation (since it is from innovation that new technologies are ideated), to describe actions and activities of modern businesses.

We have been witnessing a technological improvement since the 90's: this means that, for the last 20 years, there has been a technological boom in the businesses that firms conduct. This has brought the technology to have a central role for firms: technology and humans cannot be separated anymore (at least, for most of the activities nowadays, they cannot be thought as separate things). This is the reason why it is important to take new technologies into account, since organizations are increasingly constituted by multiple, emergent and interdependent technologies in continuous development (Orlikowski, 2007).

Technological assets could also be considered as a tool to not allow competitors to copy a company's business model, as Teece says in his paper "Business Models, Business Strategy and Innovation" (2010). In fact, the author considers the factors that allow a business model to not be copied by competitors, such as, for example, opacity and processes difficult to be replicated. In his analysis, Teece considers the rivals outside a given company; Chesbrough, instead, refers to all the factors that allow a business model to be modified within the same company. The two just described are basically symmetrical visions of the same situation, seen from outside (by Teece) and from inside the company (by Chesbrough). Teece (2010) talks about opacity of the business model, which is good against the competitors, because it allows to not be copied; but for Chesbrough, this is considered a negative aspect, because it does not allow the company itself to well understand the business model, and thereby to modify and innovate it.

Malone et al. (2006) and Gould et al. (2013) both speak about business models, but the first one refers more to all the internal company factors (human, financial, physical, intangible); while Gould et al. talk also about the external factors. Linking and putting the two authors together, one can create a more precise and ad hoc business model. With Gould et al., in fact, it is possible to have a general overview of the factors a company needs to take in consideration, which might influence the business model; on the other hand, with Malone et al. (2006), it is possible to have a detailed list of all the different kinds of business models a company can apply, given the conditions the company is facing.

For example, Malone et al. (2006), in their paper "Do some business model perform better than others?" say only that there are 16 types of business models, some of which perform better than others, but we think it is important to take into consideration also the motivation behind the creation of a business model. In this way, a company can choose the best, because nobody cannot tell beforehand which one will perform better than the others.

The external factors considered in the context described by Gould et al. can be better analyzed through a PESTLE analysis. PESTLE analysis, in fact, can be used to consider Political, Economic, Social, Technological, Legal and Environmental issues that may affect an organization (www.free-management-ebooks.com).

- Political factors, such as government attitudes to employees, taxation, trade restriction and societal reform;
- Economic factors, such as inflation rates, exchange rates, trading regulations, duties;

- Social Factors, such as distribution, population growth rate, religious beliefs;
- Technological factors, such as manufacture and infrastructure;
- Legal factors, such as employment, competition, health, safety;
- Environmental factors, such as weather, energy availability and costs, ecological consequences of production processes.

The way in which all the factors are considered to influence the company's activities and therefore its business model depends on the priorities that the management team defines along the way (Ibid). Furthermore, it is also true that some companies can use either all the elements of the analysis or only some of them. The process to implement a PESTLE analysis is simple: from the brainstorming of the key issue outside the control of the organization, the company goes through all the implications and the relative importance of each issue. This is done by rating the likelihood of these factors occurring, so that the firm can adopt the most suitable solution for each of them (Ibid). Only in this way, in fact, we think it is possible to have a whole vision of the environment in which the company operates; therefore, combining this vision with the overview and activities described by Gould et al. (2013), a successful business model is created.

To give a more detailed definition of the business model described by Gould et al., it is possible to take in consideration Demil and Lecocq's paper "Business model evolution: in search of dynamic consistency" (2010). Here, the authors describe their RCOV model (i.e. Resources & Competences, Organization, Value proposition), by saying that, combining efficiently these elements, firms can create a successful business model to thrive in the market place.

The correlation that we have noticed concerns the definition of business model given by Demil and Lecocq (2010) and Gould et al. (2013). In fact, they both define a business model as a combination of resources/input, business activities/value proposition and organization, context and overview; if well correlated among them, these factors lead to the creation of a successful business model. The only differentiation about the two theoretical frameworks concerns the vision that the authors have of a business model, since for Gould et al. (2013) it is something more static, not possible to change so easily; while for Demil and Lecocq (2010) it is something more dynamic: companies must change their business model at the same pace of the evolution of the company's life cycle steps (Ibid). We can affirm that the framework represents a dynamic approach to business models, since managers have to consider the combined effects of resources, organization and valued offered. Furthermore, the authors emphasize how business models are something dynamic that can always change because of the continuous interactions among all the components of the RCOV model.

Summing up, it is clear how all the papers selected were somehow already connected among each other; by drawing upon the weaknesses and strengths of each paper, we were able to create our own framework by considering two broad topics, i.e. business models and innovation. We deem this framework to be more complete and rich than what the past literature already offered about these categories of research.

We began our analysis with the topic of catching external opportunities in order to innovate, quoting Vives and Svejenova (2011); we then stated that this opportunity is sometimes missed by the managers of certain companies, who do not grasp the importance and do not see the opportunity itself. This is basically what Chesbrough calls cognitive barrier to innovation.

We then considered the paper by Zott, Amit and Massa (2011), to explain the different types of business model innovation that exist. Furthermore, we noticed that the definition of business model given by these authors is consistent with the one given by Gould et al. (2013). After having explained the types of business model innovation according to these two authors, we got in detail analyzing and stating that any change in business models comes about for a purpose. Mainly, this goal is to stay competitive in the market place, full of competitors, like the red ocean described by Kim and Mauborgne (2009). A company needs therefore to pay attention to the external environment, fact also underlined by Damanpour (1996), according to whom it is necessary to innovate in order to outperform their competitors. The final reason for innovation is not just the one described above, but more generally the generation of profits (in which, among others, it is included the creation of a competitive advantage). We can quote Vives and Svejenova (2011) and their 3Ps framework, profits passion and people, Beer and Nohria (2000) with their theory E, and Chesbrough (2010) with all the factors that must be fulfilled by a successful business model.

In order to make profits, a company has not only to consider the internal structure and factors, as Malone et al. (2006) described; but it must also pay attention to the external ones, as described by Gould et al. (2013), in what they call context, and more in detail by the PESTLE framework. In conclusion, we also have found useful to compare Gould et al. framework about business models and the one described by Demil and Lecocq (2010) about RCOV model, since we argue that they are complementary to each other: in fact, the former has a more static view of the business model, while the latter offers a more dynamic vision.

# CHAPTER 3: METHOD

In order to answer the research question, we have decided to consider a multiple case study; this means that we have interviewed different companies in the sector, with the purpose of finding a rule or a best behavior, which allows the most efficient use of drones in the photovoltaic industry. However, it is important that, even if the data collection relies heavily on personal interviews, the conclusion of the case study is not based entirely on that (Yin, 2014).

Noor (2008) refers to Yin for explaining what a case is. Yin suggests that the term refers to "an event, an entity, an individual or even a unit of analysis. It is an empirical inquiry that investigates a contemporary phenomenon within its real life context using multiple sources of evidence". He also adds what a case study is not: cases do not study entire organizations, rather they focus on a particular issue, feature or unit of analysis (Ibid).

Baxter and Jack (2008) use Yin in another manner, i.e. to explain when a case study is to be used. They explain that a case study design is suitable in three different situations: the focus of the study is to answer "how" and "why" questions; one cannot manipulate the behavior of those involved in the study; or the boundaries are not clear between the phenomenon and context (Ibid). Baxter and Jack also suggest how to bind a case, and this is done by time and place, time and activity or definition and context: "Binding the case will ensure that your study remains reasonable in scope" (Ibid).

Flyvbjerg (2004) argues that case study research in social sciences is important due to its ability to understand real-life situations, whereas theory would only bring you to a beginner's level.

To be a great case study researcher, it is necessary to have the following characteristics and abilities (Yin, 2014):

- Asking the right questions and give the right interpretation to their answers;
- Being a good listener, without preconceptions;
- Staying adaptive for whatever change can happen along the way;
- Having a good grasp of the issue for which the interview is taken;
- Avoiding being emotionally sensitive to the situation in order to not be biased.

For case study research, also documents are necessary to corroborate the evidences gathered with primary data. Documents, in fact, are helpful to verify the correct spelling of names and titles of the interviewees and organizations (Ibid).

In order to have appropriate and relevant interviews, we have decided to talk with three different companies for each sector studied, which means we took in consideration three companies that offer the service with drones and other three companies in the photovoltaic industry.

The former are respectively called Airvision, Technical Study Mantovano and Nimbus; while for the PV industry we chose MyEnergy, Loccioni and EnerPoint. For each company, we have decided to interview one person.

The purpose of taking into account this exact amount of companies and people was the triangulation of data. The triangulation is a method for validation or verification of the data gathered, generally used to ensure that a report is rich, robust, comprehensive and well developed (Robert Wood Johnson Foundation, 2006).

Yeasmin and Rahman (2012) outline four different types of triangulation: data 'triangulation' (retrieve data from a number of different sources to form one body of data), investigator 'triangulation' (using multiple observers instead of a single observer in the form of gathering and interpreting data), theoretical 'triangulation' (using more than theoretical positions in interpreting data) and methodological 'triangulation' (using more than one research method or data collection technique). On our thesis we used all the methods of triangulation in order to have an even richer set of data, and therefore a more reliable model as outcome.

Mathison (1988) indicates that there are three main outcomes following a triangulation strategy: the first one is *convergence*, happening when data from different sources, methods, and investigators provides "evidence that will result in a single proposition about some social phenomenon". A second outcome is called *inconsistency* among data. The perspectives and data do not confirm a single proposition about a social phenomenon: there are inconsistencies, ambiguities and lack of clarity (ibid). The third and last outcome is *contradiction:* this happens when the "data results in opposing views of the social phenomenon being studied" (Ibid).

There are four main reasons to undertake triangulation (Kennedy, 2009):

- Enriching. The output that comes from different sources is used to explain different aspects of an issue
- Refuting. A set of options can lead to disproves a hypothesis generated from different options
- Confirming. A set of options can lead to confirm a hypothesis generated from different options
- Explaining. A set of options can explain the findings of other options.

Triangulation is fundamental in order to avoid biases of different kinds (Ibid):

- Measurement bias. That happens during the data collection phase. Triangulation techniques in this case will help to reduce biases, such as peer pressures or response biases, for which participants tend to say what the person wants to hear, by combining individual and group research options.
- Sampling bias. When, during the case study, the researcher does not cover the whole population, triangulation can be used to ensure sufficient coverage (for example by using phone interviews or online surveys to include geographically distant participants).
- Procedural bias. Interviewees can be caught unprepared for a particular answer; therefore, using specific triangulation techniques, it is possible to combine short engagements with longer engagements where participants have more time to give considered responses.

## 3.1 Interview structure

The interviews were taken either via Skype or in person, depending on the distance of the interviewees. During the interview, there were always two people. One was asking questions and conducting the interview, more focused on discussion and engagement with the interviewee; the other one was playing the role of the supporter, by dictating the time and suggesting the next question to ask. The role have been interchanged, depending on the gender of the interviewee: if the person was man, the girl conducted the interview and the man was the supporter; the other way around if the interviewee was a woman. This was done because the interviewee is always more willing to talk with a person of the other gender. In fact, as Newton (2010) states, Denscombe (2007) demonstrates how people respond differently depending on how they perceive the interviewer, the so-called *interviewer effect*: "the *sex*, the *age*, and the *ethnic origins* of the interviewer have a bearing on the amount of information people are willing to divulge and their honesty about what they reveal".

The time and the structure of interviews were pretty strict, even if the questions and topics changed, depending on the kind of information the interviewee was giving during the discussion. This means that interviews were semi-structured; the questions were prepared before the interview, but they could change from person to person. Furthermore, the order of questions varied depending on the flow of the conversation (Cohen and Crabtree, 2006).

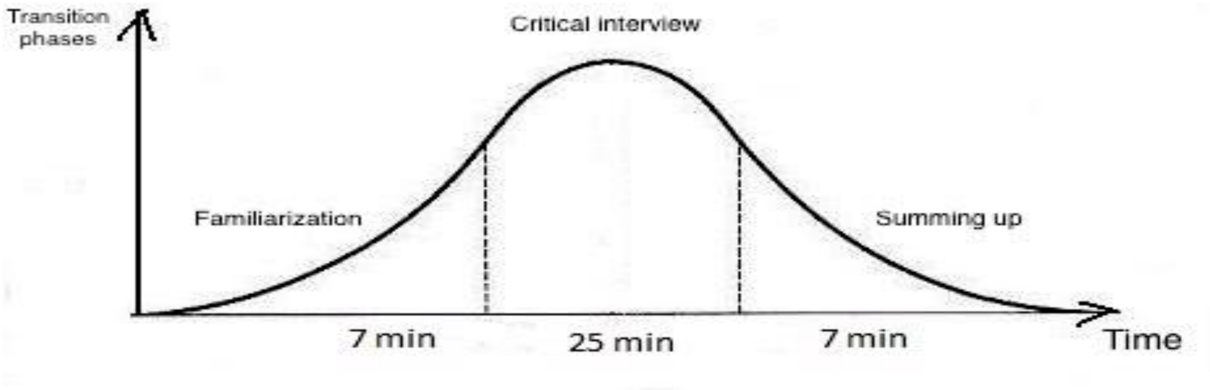
If the interviewee is talking too much, without allowing the interviewers to ask the questions they want, the latter have to interrupt the discussion and the whole interview (Supervision Meeting 5). The success and validity of an interview rests on the extent to which the respondent's opinions and perspective are reflected in the interview and in what they say (Newton, 2010). This means that the interviewers need to ask questions in such a way that interviewees can say concepts in their terms instead of with words rigidly imposed a priori by the interviewer (Ibid). This is the reason why the interviews were qualitative and semi-structured, as this gives *the opportunity to probe answers, where you want your interviewees to explain, or build upon, their responses* (Saunders et al., 2009).

The interviews were thought to last around 40 minutes; during this time, the discussion had to go through three different stages (Supervision Meeting 5):

- Familiarization. From 7 to 10 minutes, in which the interviewee explains her or his role and tasks in the company. This phase helps to make the interviewee feel at her or his ease.
- Critical interview. From 20 to 25 minutes, it is the interview itself, characterized by a continuous flow of information between the interviewee and the interviewer. The latter has to control the direction of the interview by asking specific questions.

- Summing up. From 5 to 7 minutes, just the time to conclude the discussion and greet the interviewee.

Following is the graph that better shows the structure that each interview must have (Ibid):




The interviews were recorded and then transcribed (Appendix). Since we interviewed Italian companies with Italian people, the interviews were performed in Italian. In light of this, in order to avoid to be biased by our memories and impressions of the interviews, we have decided to transcribe word by word in Italian, and asked then to a third person not related to the events to translate the text in English.

Furthermore, we did not ask the same questions to each person within the same company. In fact, we first interviewed three people from drones companies, asking the same questions; then, three people from PV companies, again asking the same questions, but not the same asked to drones companies.

## 3.2 Secondary Data

Before interviewing people from each company, we have done some researches in order to have a wider overview of what the company does and what is the target market and its legislations. For example, we first looked at the norms about drones flights on the official website of ENAC, and then we asked to the interviewees of drones companies how it works, in order to understand if all of them had a clear understanding of all the processes and mechanisms.

Looking for secondary data before the interviews was helpful also to ask more focused questions.

## 3.3 Quantitative Data

Due to the case study nature of the research, the majority of data used was qualitative. However, quantitative data has been of great importance as it makes the report more holistic at the same time as contributing to the mixed methods research. The quantitative data has mostly been in the form of numbers about the companies' market shares, and the industry in general.

## 3.4 Limitations

While writing our thesis, we encountered some difficulties due to various reasons, both because of our knowledge background limits and because of companies' availability, and this brought our work to have some limitations. In this section, we will explain in more detail what these limitations have been, giving an explanation for each of them, and underlying the reasons why our thesis is still deemed to be relevant.

At the beginning, we were thinking to interview three people for each drones and PV company: however, the plan was not respected, due to our lack of time and lack of people willing to be interviewed, since companies asserted they did not have enough time to this kind of activity. In light of this, we decreased the number of interviews compared to what we planned; this can be seen as a limitation, since we could not create a rich and detailed triangulation. However, we deem our research to be still valid, since triangulation was done by interviewing three different companies in the PV sector and three others in the drones industry; therefore, we could say that we matched and triangulated enough data, and enough personal views were triangulated in order to get a fair and true insight of the reality.

Furthermore, it is also true that, if a study is bounded to a delimited span of time, the results of interviews will be "affected by the operations of society during that time period", such as, for example, economy and social trends (PhD Student Website). However, we could not have done otherwise, given the time constraints we have for the thesis process. Our research can still be considered relevant, because from the time drones were first introduced, the legal framework and the economic context in which PV companies are operating have not changed; even by considering a wider period of time, the results would have most probably been the same as the ones described in the thesis.

The third limitation encountered consists in the answers that employees of both PV and drones companies gave us, since the degree of in depth replies to our questions depended on who was being interviewed. This means that all the employees had different insights depending on the position and on how long they have been employed in that sector and in that company. All the interviews were done in a span of time of maximum 30 minutes each, although during the supervision meeting 5 the professor suggested us to interview for about 40 minutes; the reasons can be found in the fact that most of the people explicitly asked us to not use more than half an hour of their time, due to their busy work schedules. However, we argue that the interviews are still rich in contents, since all the interviewees were able to answer all the questions we asked, both the planned ones and all the others that we came up with while the person was speaking; plus, by matching the general topics concerning the whole industry, it turned out that the information given were very similar, if not the same, among all the interviewees.

Another limitation encountered was the fact that we needed to make the interviews in Italian, since we have chosen Italy as the target market, and people in this Country are not willing to speak English, especially since we were Italians. It did not make sense to face potential difficulties in the language, since all of us could understand Italian. However, the limitation came about when we needed to translate the interview in English, the official language of the thesis. During the translation, in fact, it can happen that a person loses the emphasis and the root concept of the sentence, especially if this process is done by the same person who interviewed, because of feelings and personal impressions gathered during the process. In order to solve this problem, during the supervision meeting 5, we have found out it would have been better to find a third person unrelated to the facts, so she or he could have translated all the words without taking in consideration her or his impressions and emotions about the facts that could

have influenced the translation itself. In light of this, we decided to ask a colleague of ours to translate the interviews; therefore, we can still consider our interviews in English respecting the reality of what was said.
In addition, someone can argue that the sample of drones companies, PV companies and interviewees is not representative. Despite all the factors mentioned above, that have occurred during our project, we think that the sample can be still considered significant, since we were able to successfully triangulate the data. In fact, to be considered true and valuable, it is enough for a case study research to be based on triangulation of data sources and data types to support the phenomenon and explore it from numerous perspectives (Baxter and Jack, 2008). The collection and comparison of this data, in fact, enhances data quality based on the principles of idea convergence and the confirmation of findings (Knafl and Breitmayer, 1989).
To sum up, the reliability and validity of the project have to be regarded from the data sources addressed, in addition to the timespan of producing the project report. In fact, the thesis has been made over a limited time of five months, but it is also true that, despite this shortage of time and all the limitations listed above, the study can be seen as valid for its purpose. Also the sources used are seen as reliable: primary data, i.e. interviews, because of the reasons mentioned above, and secondary data, i.e. websites and papers, because they were issued by renowned authors and institutions.

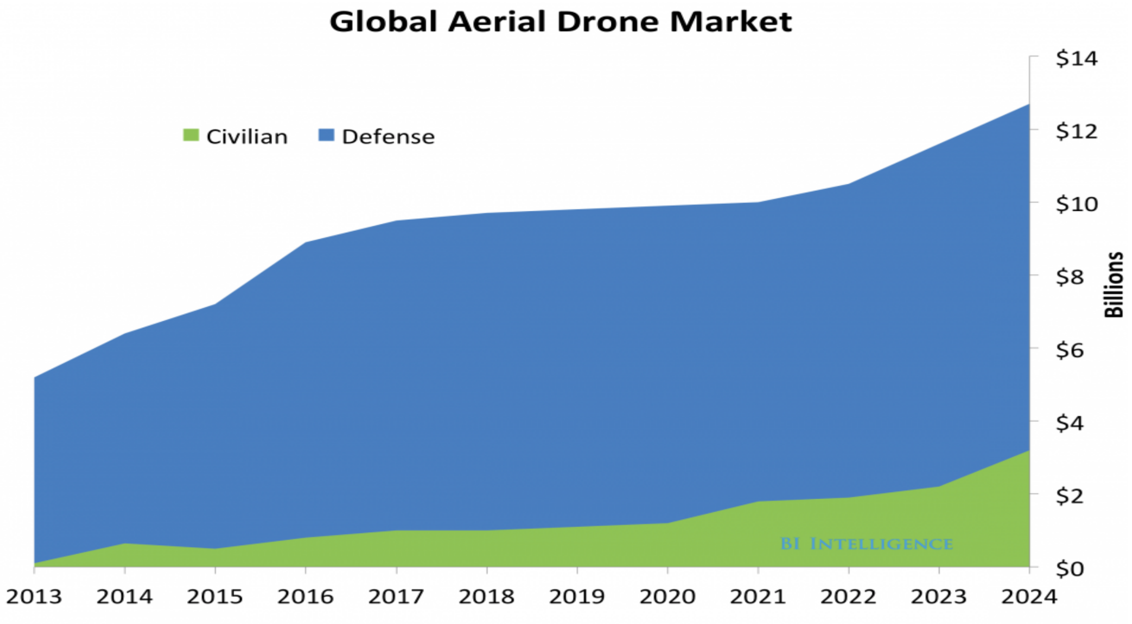
# CHAPTER 4: CONTEXT

## 4.1 The drones industry

During the last years, drones have been progressively shifting from a niche phenomenon for passionate people and experts to a larger public and a huge set of technological applications, so much that businessmen have started to look at this industry for interesting growth opportunities (Dronitaly, 2014).

Even if the civilian use of drones is not known by the majority of the population yet, the industry is growing. Most of the sellers are small private companies and startups; only in the last period, also large defense-focused companies and industrial conglomerates are beginning to invest in drones technology (Business Insider, 2015). In fact, the technology contained in drones is both a bottleneck for investors, since it is difficult to replicate in little aircrafts, and a business opportunity (Ibid). As for now, the commercial drones industry is shaping only around some of the countless worldwide industries, such as agriculture, energy, utilities, mining, construction, real estate, news media, and film production (Ibid).

As shown by the graph below, in 2015 the industry of civilian drones has grown more than the military one (Ibid). A study done by the Business Insider Intelligence found that *the market for civilian drones will grow at a compound annual growth rate (CAGR) of 19% between 2015 and 2020, compared with 5% growth on the military side* (Ibid).

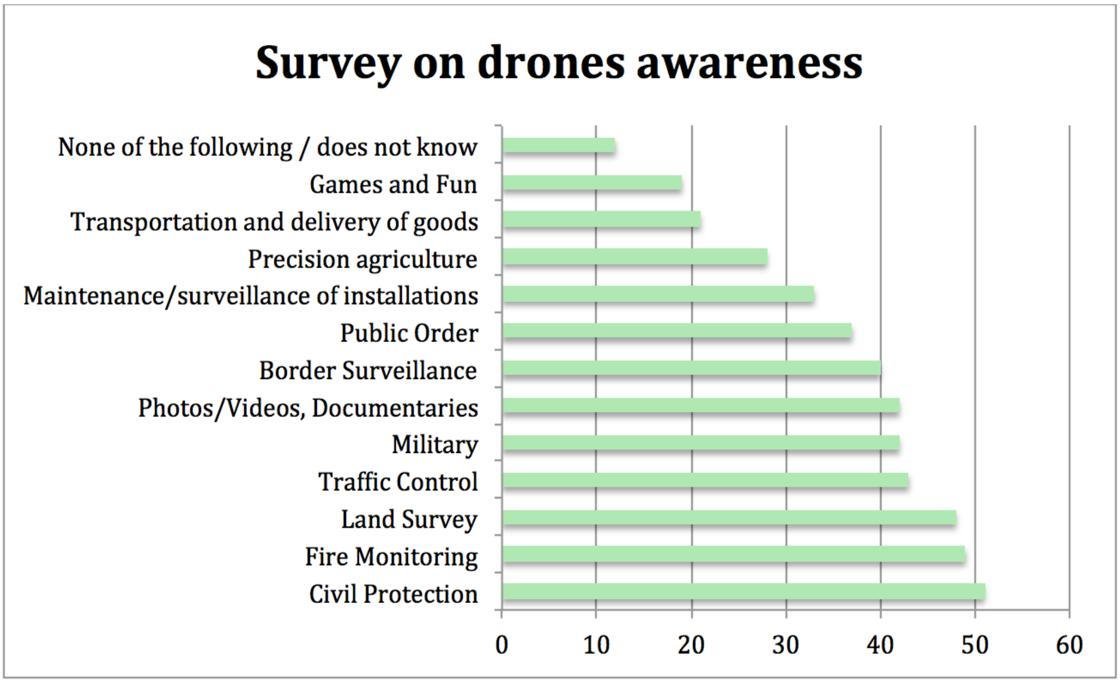



Source: Business Insider (2015)

Italy is one of the first Countries to have created detailed norms for this field, thanks to ENAC (Ente Nazionale Aviazione Civile, the Italian Civilian Aviation Authority). This institution, in fact, designed the regulations for remote controlled aircrafts and set norms also for the behavior of pilots, certifications and equipment needed (Ibid). The regulations are very important for the correct functioning of the industry, that currently counts about 70 drones companies only in Italy (ibid). ENAC, founded on the 25th July 1997, is the Italian institution responsible for the surveillance and control of the civilian use of drones in Italy (ENAC website). It authorized the use of drones for civilian purposes in Italy from April 2014 onwards, and since that date, companies working with drones have started to spread all over the territory of the Country (Ibid). ENAC divides RPAS (Remotely Piloted Aircraft Systems) into two categories, based on the operative mass at the landing, in systems with an operative mass less than 25 kg and systems with an operative mass going from 25 kg to 150 kg (ENAC). They can be used for specialized operations and for research and development activities; they carry different instruments, as well as photo and video cameras (Dronitaly).

For specialized operations, however, the RPAS operator must sign an agreement with the specific client, in which all the responsibilities of the case and the eventual limitations (ENAC) are clarified.

Unfortunately, people do not know about this new trend; in fact, a statistical research showed how, on a sample of 1,000 respondents, the majority thinks RPAS can be used only for surveillance and evaluation of the territory, even if the latter is only a little part of the purposes for which a drone can be used (Dronitaly).




Source: Doxa Marketing Advice - 05/02/2014

In fact, drones can be used for a potentially infinite number of applications, from military uses to, among others, commercial law enforcements and communication activities (Pauner and Viguri, 2015).

In light of this, it is easy to understand how issues of privacy and data protection can arise with the increasing use of drones (Ibid). According to the lawyer Volovelsky, it is important to find *a balance between the advantages inherent in the civilian use of drones and the possible harm to the right to privacy and data protection* (Ibid). Nowadays, the European Union has to address two questions about drones: the first one concerns the scope drones are used for, while the second one is about privacy (Ibid). There are two big different types of privacy, i.e. physical and informational. With drones, the most threatened one is the informational privacy: the risk arises because of the more and more extended civilian use of private individuals and because of the *lack of adequacy, fairness and transparency in the collection, storage, and even further* *transmission and data processing due to the difficulty of perceiving their presence* (Ibid). In light of this, it is easy to understand why the surveillance of private areas with drones will be forbidden, while for public areas it will be possible only after the consensus of interested people (Ibid).

## **Drones industry in Italy**

In Italy, the market for the civilian use of drones has already created profits for 350 million euros, and growth perspective of about 25% for 2016, thanks to the 500 companies spread all over the territory, especially in the North[2]; each of them, in fact, produces revenues of about 700,000 euros and offers a workplace to an average of seven people (Mosca, 2015). These numbers are understandable, considering that collecting data on an area of 90 hectares with the use of drones can be done in half a day, including the preparation of the data collected, instead of 20 days for a survey carried out by classical means in an inaccessible area (Ibid).

Companies in this sector vary from the ones that take care only of the planning phase or the building stage, to the ones that take care of more phases (Ibid).

In the last five years, there has been a drone industry boom in Italy. Throughout this period, in fact, about 85% of companies in this sector have been founded, giving a significant boost to the whole sector. A drone manufacturer constructs on average 100 drones annually, with prices ranging from 3,000 to 25,000 euros (Ibid).

## **Dronitaly**

Dronitaly is the event dedicated to RPAS in Italy, which unites all producers, distributors, aeronautical operators, service providers, flying schools, universities, institutions, regulatory authorities, associations and the media in the aerial, aquatic or land fields (Dronitaly). It is a *business platform, where companies can showcase*

[2] 60% of all the companies of the industry are in the North, and among them 34%in the North West, while the 26% in the East. 25% of the companies are, instead, in the Center of Italy and the 13% in the South. The remaining 2% are Italian companies with a headquarter abroad (Marketing Advice Doxa).

*products, services, solutions, and meet final users, big customers, investors, representatives from institutions and the public administration* (Ibid).

Last edition of Dronitaly took place on 25-26th September 2015 at the Atahotel Expo Fiera Conference Centre (Ibid). It counted:

- 2,300 professional visitors
- 50 exhibitors
- 23 conferences

*Dronitaly 2015 will be an opportunity to see the trends and evolutions on the horizon and gain a vision of the sector that no other event can provide* (Ibid).

The biggest challenge for drones manufacturers is to create safety conditions for operation in BVLOS and combine them with long time endurance (Drone Industry Insights, 2015).

### 4.1.1 Legal framework for drones

The civilian use of RPAS has the potential to bring aviation into all industries; therefore, it is important to develop a shared regulation that will enable the growth of this new industry and the development of technologies for the future (House of Lords, 2014).

Currently, each European Country has its own regulation concerning the use of RPAS; this is a big disincentive for the opening of a successful RPAS operation in Europe (ibid). On the other hand, however, through a legislation that differs from Country to Country, it is possible to take in consideration the geographical differences that enable day-to-day operations (Ibid). In light of this, it would be better to create a European Union market for RPAS with shared safety rules; while for small RPAS, it would be better to create a flexible system in order to better support the local industry (Ibid).

Of fundamental importance for the use of drones is not only the rules regarding their circulation, but also safety regulation in the aviation industry (Ibid). There are two broad categories of safety regulation: the first one looks at airworthiness, which means safety of the aircraft hardware, and the second one relates to the competences of the drone operator (Ibid). The European Union bases the whole aviation system, both of the real aircrafts and of the RPAS, on the principle that safety must not be compromised, and this is the reason why *RPAS operations should exhibit an equivalent level of safety in comparison to manned aviation* (Ibid). These exact words lead to a certain level of ambiguity and interpretation. The NATS - National Air Transport Service - for example, describes the operational equivalence by referring to the appropriate airspace rules, which means that RPAS should be operated without negatively impact in the activities of other airspace users (Ibid). However, this definition could not be applied to small RPAS, since they fly without any support from the air traffic management; but the Institution suggests that regulators have to evaluate the risk based on the particular circumstances, by analyzing whether the small RPAS can safely fly given the particular task and airspace (Ibid).

With the classic approach, the person certifies the aircraft, the airman and the operator, and only after that the RPAS can fly in the airspace (Ibid). On the other hand, instead, with the proportionate method, since the final purpose is *safety* not only of the machines but also of the operations, regulators need to define the risk and then regulate the situation accordingly *(*Ibid*)*. The latter approach is also called risk-based approach, since the airworthiness and pilot competency requirements are proportionate to the risk of an RPAS flight (Ibid). Also *the Royal Aeronautical Society said that without adopting a risk-based approach,* it would be difficult to develop a comprehensive regulation for such a wide variety of air vehicles and subsystems (Ibid). The fact that a risk-based approach is the most suitable for regulating the use of RPAS is also demonstrated by pilot training and licensing (Ibid). In fact, so far, there is no international system that regulates who can pilot an RPAS, as it is for manned aviation (Ibid). Unfortunately, in absence of EU-wide rules, there is a certain degree of variation about commercial RPAS pilots in terms of competences that they must posses for specific devices or activities, and lastly about obtaining permission from the national aviation authority to carry out aerial work (Ibid). This complexity of different national regimes is slowing down the development of small RPAS services industry (Ibid).

Furthermore, also airworthiness standards are important in order to create a unique EU set of rules for RPAS. These standards, in fact, refer to the quality of the product when manufactured (Ibid). For RPAS below 20 kg of weight - with which the majority of commercial operations are taking place - there are no or few airworthiness standards;

the same goes for RPAS with a mass of more than 150 kg. The task to coordinate research and development of all the technologies required to make an RPAS fly in non-segregated airspace is done by SESARJU - Single European Sky Air Traffic Management Research Joint Undertaking, a public-private partnership founded in 2004 (Ibid). However, some of the technologies needed to allow the safe use of RPAS into non-segregated airspace is not available yet. If these new technologies are not improved in a relative short period of time, there will be the risk that the European Union will be overwhelmed by the current leaders in RPAS manufacturing, such as the U.S.A. and Israel, and also by new competitors like Brazil, Russia, India and China (Ibid).
Another problem that is worrying RPAS operators are the high costs and the difficulties to buy insurance for third party liability (Ibid). It was estimated that the price of insuring an RPAS is almost double compared to the one of a family car insurance, due to the lack of information that insurance companies have of drones; furthermore, the EU insurance market is currently restricted to few providers (Ibid).

After framing the European scenario, it is important to know how regulations regarding drones are currently working in Italy, since we are focusing our study on this territory. In the Country, the Institution who is in charge of the civilian use of drones is called ENAC (Ente Nazionale Aviazione Civile), and since April 2014, when it first authorized the use of drones for civilian purposes, the Institution has been creating ad hoc regulations in order to establish the basis for improving civilian drones industry.
In particular, according to the Regulation number 216/2008, written by the European Parliament and Council, ENAC must take care of all the RPAS with operative mass at the landing of no more than 150 kg and all the drones projected and modified for scientific research purposes (ENAC Website).
ENAC establishes that all RPAS must be identified with a tag to be put on the drone itself and on the ground station, with both the data of the operator and of the system, as well as a flight manual (Ibid). From the 1st July 2016, the RPAS must be equipped with an electronic identification system that both allows the real time transmission and registration of RPAS and operator data as well as flight data, such as altitude and the airspace used (Ibid). It is responsibility of the operator to update all the information and documentations regarding the drone (Ibid).

It is possible to distinguish three kinds of operation:

- VLOS, Visual Line of Sight, are operations conducted from a distance, both horizontal and vertical, for which the pilot can maintain a continuative visual control of the drone, without needing tools to increase the sight. If the RPAS flies in this condition, ENAC can request the installation of lights and other tools on the drone, to facilitate the vision of it. Not only the drone, but also the pilot must be recognizable by wearing a jacket with high visibility. VLOS operations can be done only during morning hours at a maximum altitude of 150 meters and a maximum horizontal distance of 500 meters in completely safe conditions. Bigger distances can be authorized by ENAC after providing a documentation of risk evaluation. In this kind of conditions, if the pilot loses control of the drone, she or he has to terminate the flight as soon as possible, and always before losing the visual contact. Operations in VLOS cannot be conducted within 5 km from an airport if the pilot does not ask for a special permission; also in active regulated or prohibited areas they are not allowed. The VLOS operations in controlled traffic areas are allowed only with RPAS with an operative mass at the landing inferior to 25 kg and at a maximum altitude and distance respectively of 70 meters and 200 meters. However, in trajectory of landing and take off and until 15 km from the airport, the altitude limit is 30 meters (Ibid).
- EVLOS, Extended Visual Line of Sight, are operations conducted in areas, which go beyond VLOS conditions and for which special conditions must be applied to fulfill VLOS standards, like a supplementary ground station from which it is possible to observe the drone. EVLOS operations can be conducted only after a special authorization issued by ENAC (Ibid).
- BVLOS, Beyond Visual Line of Sight, are operations conducted from a distance for which it is not possible to have a continuative sight of the drone. For this reason, this type of operations requires specific procedures to avoid collisions; it also requires segregated areas, may they be temporary or permanent, in which the drone can freely fly based on risk evaluation done by the RPAS operator and then approved by ENAC (Ibid).

Norms for the civilian use of RPAS differ depending on the area pilots have to operate in. In critical areas, since the risk of damages is higher, there are more precautions to follow; for non-critical areas, rules are less rigid.

## Non-critical operations

Non critical operations means all the operations conducted in VLOS for which it is not planned to fly, even in cases of damage and malfunction of the drone; these are areas with no people, sensible infrastructure and urban conglomerates (ENAC).

Before starting a non-critical operation, the operator must send through the official website to ENAC all the declarations of the case, and specify all the conditions and limits applicable to the specific flight. The operator is the only responsible for the evaluation of the risk of the flight (Ibid).

## Critical operations

Critical operations are all those, which do not belong to the definition of non-critical ones. For critical operations, a specific authorization from ENAC is required (ENAC website). These operations can be conducted only in areas where a fair level of risk exposition can be guaranteed; the level of security is defined by the characteristics of the RPAS, the operator, flight activities procedures, environmental conditions and maintenance programs (Ibid).

In order to proceed with critical operations, the RPAS must be equipped with a termination flight tool, independent from the primary system of command and control and the minimum flight altitude must be determined in accordance to that system, in order to create the safe conditions for terminating the flight, if the pilot loses control of the drone (Ibid).

According to the law, flying over urban areas in VLOS is safe only when the following conditions are fulfilled:

- There must be a primary system of command and control, in compliance with the specific of EUROCAE ED-12 at projection reliability of, at least, level D; even if alternative standards would be acceptable for ENAC if they fulfill the same reliability objectives (Ibid);

- There must be an adequate system to maintain the control or limit the effects of the operations in case of data link loss (Ibid);
- There must be a termination system with independent control that allows a fair exposition to potential risks of impact (Ibid).

However, flying over people for procession, sportive and entertainment events or in areas with unusual concentration of people is always prohibited. The same rules apply also for indoor operations (Ibid).

## Authorizations and declarations

For critical operations, the operator must fly only if authorized by ENAC for the specific situation based on his or her skills; while for not critical operations, it is the operator who self declares to posses the right skills to do the specific operation (Ibid).
This authorization or declaration covers all the aspects of operational safety and can be sent to ENAC only after the operator has positively completed an experimental flight as propaedeutic activity for verifying the conditions for the real flight (Ibid). The operator must possess a technical and operative organization and an operational manual that has to define all the procedures to manage the flight and maintenance activities (Ibid). The manual must contain all the modalities with which the operator can analyze the risks and all the mitigation activities (Ibid). The propaedeutic activity before the flight needed to create the right control conditions of the drone given the environment and the weather, must be done by the pilot. This activity must be done in uninhabited areas by pilots with a special certificate, without prior communication to ENAC (Ibid). It is compulsory for the operator to record and preserve data and risk evaluation of the activities, and to annually provide this information to ENAC (Ibid).
In order to obtain the authorization from ENAC, the operator must provide to this Institution a specific documentation, in which he/she declares that the RPAS is in compliance with all the conditions given by ENAC and all the limits applicable to the flight. The documentation can be prepared either by the operator or by an organization

recognized by ENAC. Along with this documentation, the operator must attach the following documents:

- Data on the tag of the RPAS, the description and the configuration of the system, the characteristics and the features that guarantee a safe use of the drone, which means the declaration of conformity of the builder company in the case of RPAS with Certification of Project (Ibid);
- Results of initial experimentations trials (Ibid);
- Type of specialized operation planned (Ibid);
- Results of risks analysis concerning the planned operations (Ibid);
- Flight manual of the RPAS or equivalent document (Ibid);
- Maintenance program of the RPAS (Ibid);
- Operations manual with the description of the processes of evaluation and management of risks (Ibid).

Only after providing all these documents, ENAC can give the authorization to proceed with the flight; however, in specific cases, it can ask for additional analysis and inspections (Ibid). The authorization is valid for all the operations conducted in the same conditions, and falls whenever the operator makes changes on the RPAS. In the last case, for non-critical operations, the operator has to ask for a new authorization by declaring the new characteristics of the drone (Ibid).

## RPAS operations with an operative mass at landing inferior or equal to 2 kg

All operations conducted with RPAS with an operative mass at the landing inferior or equal to 2 kg are always considered non-critical operations, if the drone is in line with all the projection and technical aspects described by ENAC or by an Institution authorized by the latter, regardless the areas the drone is flying on (Ibid). It is in any case prohibited to fly over people for procession, sportive and entertainment events or in areas with unusual concentration of people. For this kind of operations, the requirements described before are not needed, but the pilot has to guarantee the right conduction of the activities and do the required maintenance (Ibid).

The specialized operations conducted with drones with an operative mass at the landing inferior or equal to 0.3 kg and rotating parts protected from accidental impacts and with a maximum speed of 60 km/h are considered non-critical operations in every kind of scenario (Ibid).

## Project certificate

Constructor companies that want to build standardized RPAS can ask ENAC for a certificate valid for every drone of the same species (ENAC).

The project certificate is issued by ENAC only after all the inspections needed and if the constructor company has followed the following steps:

- The company has been recognized as an adequate organization for the emission of conformity certificate by ENAC;
- Definition of RPAS configuration to report on the certificate itself;
- Conduction of analysis and trials necessary to establish conditions and limitations to demonstrate the level of security in the specified scenario;
- Arrange the flight and maintenance manual or equivalent documentations (Ibid).

Then, the project certificate must contain the following information:

- The name of the constructor company;
- RPAS identification and configuration;
- Operations scenario;
- Conditions and limitation;
- Technical documentation;
- Other kinds of information, if required by ENAC (Ibid).

In order to conduct a critical operation, every RPAS must be accompanied with the project certificate and a conformity certificate issued by the constructor company, in which the company attests the correspondence to the project certificate (Ibid).

## RPAS operations with an operative mass at landing equal or superior to 25 kg

RPAS with an operative mass at landing equal or superior to 25 kg that are active under Italian jurisdiction, must be registered at ENAC database called Register of Remote

Control Aircraft, and must have a special tag both on the drone and on the ground controller (ENAC).

## Flight permission

The flight permission specifies conditions and limitations for flying, and can be issued for mainly two reasons:

- Experimental reasons such as research and development purposes (ENAC);
- Specialized operations if the RPAS is not a standard one (Ibid).

In order to obtain the flight permission, the owner of the RPAS has to apply at ENAC through documentation that proves that the drone is able to do that particular experimental activity (Ibid). Furthermore, if necessary, the area in which the operator is going to fly can be closed during the period of the operation (Ibid).

ENAC gives the permission only after checking the validity of the documentation and for a period of time necessary to do the specified activity (Ibid). The maximum validity of that permission is three years, but if the necessary conditions exist and the operations can be done at a fair level of security, ENAC can extend or renew the permission, depending on the purpose of the operations (Ibid). However, the permission is not valid anymore when the conditions and limitations are not respected (Ibid).

For standardized RPAS, instead, the constructor company has to ask for a restricted certificate, in which there are all drone details, limitations and conditions at which the RPAS can fly. The latter term is referred to the operations that the drone can do and in which types of area it can fly (Ibid).

## The operator

In order to obtain the authorization to fly, the operator must prove the following:

- She or he must possess a technical and operative organization, able to manage all the RPAS owned by the operator;
- She or he must nominate a technical responsible for operations, navigation and training;

- Her or his RPAS must have all the documentation and authorization, and must be equipped for the required specialized operations;
- She or he must arrange the recruitment of pilots with the right license to control the specific RPAS;
- She or he must prepare a manual of the operations, which must contain instructions and procedures needed to manage the operations both in normal and emergency conditions; this manual must also be available to all the people involved in the activities;
- She or he must be able to conduct operations in accordance to the limitations and conditions required for the authorization (Ibid).

## RPAS maintenance

The RPAS operator has to establish, in accordance to the constructor's instructions, a maintenance program in order to ensure an adequate conservation of the system (ENAC). Furthermore, the operator must have a recording system of the hours of flight and the events related to the security, maintenance and substitution of drone components (Ibid). The ordinary maintenance of the RPAS could be done by the operator after attending a maintenance course at the constructor company or other authorized organizations (Ibid).

## The pilot

A valid certificate is required to pilot an RPAS, since the pilot has the responsibility of the flight security (ENAC). All the people who are more than 18 year old and have an adequate psychophysical attitude can obtain the certificate or the license to pilot, only if they prove to possess an aeronautic knowledge and the skills to pilot an RPAS (Ibid).
The license and the certificate of pilot are issued by ENAC or other authorized organizations, and it expires after five years (Ibid).
In order to do specialized operations, the pilot needs to ask the permission to ENAC at least 90 days before the activity, and she/he has to do at least three different flights with the RPAS (Ibid).

The certificate and the license of pilot are something different. The differentiation is based on the RPAS that the pilot can drive with one or the other. In fact, with the certificate of pilot, a person can operate with RPAS with an operative mass at the landing inferior to 25 kg in VLOS conditions. On the other hand, with the license of pilot, a person can operate in BVLOS conditions and also with RPAS with an operative mass at landing superior or equal to 25 kg (Ibid). The certificate is issued by a training center approved by ENAC, while it is ENAC itself that takes care of the licenses; they are released following the same procedure of flight attendances (Ibid).

## Certificate of pilot

In order to obtain the psychophysics adequacy for the certificate, the pilot has to obtain a medical certificate from an AME - Aero Medical Examiner, which follows the European Regulation n. 1178/2011. A medical certificate of level II is also fine in order to obtain the certificate (ENAC).

Before obtaining the certificate, an operator must follow this procedure:

- Gaining the knowledge of all air rules, basic aeronautic cognitions and operative and safety risks through the attendance of a training course with a positive final exam result at a RPAS training center approved by ENAC;
- Attending with a positive result a training program with an RPAS of the same class of the one the operator wants to take the certificate;
- Passing a practical exam with an examiner from the RPAS approved training center (Ibid).

RPAS approved training centers are also the providers of the renewal of the certificates, through a practical exam and a valid medical certificate (Ibid).

## License of pilot

In order to obtain the psychophysics adequacy for the license, the pilot has to obtain a valid medical certificate of class III, released in accordance to ENAC regulations (ENAC website).

In order to renew the license, the pilot must take a practice examination with an examiner recognized by ENAC, and possess a valid medical certificate. All the licenses and renewal procedures are issued by ENAC (Ibid).
Furthermore, ENAC establishes all the requirements for licenses for RPAS in BVLOS conditions or with an operative mass at the landing superior or equal to 25 kg (Ibid).

## RPAS training center

RPAS training centers approved by ENAC offer both a theoretical and a practical training (ENAC). In order to be recognized as such, ENAC has to verify if the center possesses adequate procedures, materials and training tools. The instructor for the practical training and the examiner must be authorized by ENAC as well (Ibid). After the practical exam, the training center has the duty to issue the license within 3 days. The notification is published only on ENAC website and it is possible to see it by clicking on the website the required data. The same procedure is done in order to renew the license (Ibid).

## Specific procedures and supply of air navigation area serviced

If there are some interferences with another aircraft, the RPAS operator in VLOS and EVLOS conditions does not have any priority right, and the remote pilot, through the function "see and avoid", has to put the drone on the ground immediately or at a maximum altitude of 25 meters, in order to not interfere with the aircraft anymore (ENAC website).
For non-critical operations in VLOS and EVLOS, all the RPAS flights with an operative mass at the landing inferior to 25 kg, must be conducted at a horizontal distance of 50 meters from people, who are not under the operator's control (Ibid).

## Documents preservation

The operator, the constructor, the project organizer and the pilot are requested to maintain and make available to ENAC all the documentations produced, in order to prove the conformity of the operations to the regulations (ENAC).

## Events communication

The operator, the constructor, the project organizer and the pilot of RPAS with an operative mass at the landing equal or superior to 25 kg are requested to communicate to ENAC, in compliance to EU regulations number 376/2014, all the events happened with the drone (ENAC). In case of accident or serious inconvenience, in accordance to EU regulations number 996/2010, there is the duty to inform the ANSV - National Agency for Safety of Flight - within 60 minutes (Ibid).

On the other hand, for RPAS with an operative mass at the landing inferior to 25 kg, the operator, the constructor, the project organizer and the pilot are requested to communicate, on the basis of their responsibilities, the accident or the serious case within 72 hours, through the procedure indicated by ENAC (Ibid).

## Penalty for not following the regulations

As written in the Law number 241/1990, ENAC can adopt measures for the total or partial suspension of authorizations and certifications for not more than six months in cases of non-fulfillment of regulations requirements, or when the operator shows her or his inability to ensure the correspondence with them or refuses that ENAC makes checks on the documentations (ENAC website). ENAC will then notify the suspension to the operator, along with the reasons and the timing for the reinstatement of the requirements. However, if the operator will not fix the correspondence required within the time indicated by ENAC, she or he will lose the authorization, certification and privileges (Ibid).

The realization of specialized operations with RPAS without a previous authorization from ENAC for critical operations or the operator's declaration for non-critical operations, is punished following the navigation norms and fines (Ibid).
If the pilot does not follow the rules, her or his certificate or license will be suspended for a period of time that goes from 1 to 12 months, depending on the seriousness of the non-fulfillment (Ibid).

## Data link

The data link is necessary to ensure the function of command and control of the RPAS, in order to make the drone reliable and safe, wherever the operations will be held (Ibid).
The data link uses only authorized frequencies, chosen for minimizing the possibility of involuntary interferences, that can compromise operational security (Ibid).

## Insurance

It is not allowed to conduct operations with an RPAS without a valid insurance that covers third parties responsibilities and that has a minimum requirement in terms of maximum coverage as wanted by EC Regulation number 785/2004 (ENAC). The regulation, in fact, establishes the minimum insurance cover per accident, depending on the aircraft used (Official Journal of the European Union; 2004).

## Security

RPAS operators must adopt protection measures adequate to prevent illicit actions during the operations and also prevent volunteer interferences with the radio link (ENAC). In order to do so, the operator has to establish reasonable procedures to impede the access to the non-authorized personnel into operational areas, such as ground station and system stowage (Ibid). RPAS operators are also responsible to check if there are new dispositions issued by Public Security for the areas involved in their activities (Ibid).

## Privacy and data protection

Personal data treatment, if necessary, should be mentioned in the documentation needed for the procedure required. In any case, the treatment is done following the legislative decree number 196 of 30th June 2003 and subsequent modifications (ENAC).

## Aircrafts

The pilot of the drone has the responsibility to use it without causing risks to people and things, and collisions with potential obstacles, by giving the precedence to every object in the air (ENAC).
The pilot is also responsible for obtaining all the permissions from ENAC regarding authorization and electromagnetic frequencies for radio commands (Ibid).
Reservation of air space is not required in the following conditions:

- Aircrafts have the following characteristics (Ibid):
  - Operative mass at the landing inferior to 25 kg;
  - Maximum wing surface of 500 dm2;
  - Maximum wing load of 250 g/dm2;
  - Maximum displacement of pistons engine of 250 cm3 or maximum total power of electric engine of 15 kW or maximum push of turbine motor of 25 kg (250 N) or maximum total power of turboelectric engine of 15kW;
  - Free or circular bound flight;
  - Aerostat of cold air of a total weight of the gas container carried for burners not superior to 5 kg;
- The activity respects the following requirements (Ibid):
  - The activity is done during morning hours and the pilot maintains a continuative visual control with the drone, without the use of optic and electronic devices;
  - The activity is done in areas selected for this specific activity at a maximum altitude of 70 meters and at a maximum range of 200 meters in inhabited areas, sufficiently distant from buildings and infrastructures;

- The activity is done outside the aerodrome traffic zone of an airport or at a distance not superior to 5 km from the airport, where there is no aerodrome traffic zone for the protection of air traffic;

- The activity is done outside controlled traffic regions;

- The activity is done outside active regulated areas or prohibited ones.

If all the requirements are not satisfied, the activity can only be done inside specific areas selected by ENAC or in segregated areas (Ibid). The pilots must have in any case a certification issued by Aero Club for flight at altitudes superior to 70 meters (Ibid). Furthermore, if the weight and the power of the drone do not respect the requirements, the operator must be at least 18 years old and must be the owner of the certificate of aero modelism issued by Aero Club (Ibid).

The flight must always respect eventual dispositions issued by the local authority (Ibid). However, all the aircrafts at free flight class FAI F1 with a mass inferior to 1.5 kg, the ones at circular bounded flight, and the aircraft used indoor, are not requested to respect the dispositions described above (Ibid).

## 4.2 The Photovoltaic Industry

The photovoltaic is one of the renewable technologies available in the world (Paula Mints, 2010). Although it was deemed to be too expensive, the PV industry has continued, nonetheless, to grow at a compound annual rate of 34% over the past 30 years. "Growth at this rate would be envied by any industry, and certainly deserves recognition, particularly as it has come with significant problems and has been extremely difficult to achieve. Now, with worldwide consensus on global warming along with sufficient evidence that fossil fuels are rapidly depleting, solar electricity is finally earning some respect - but the industry still has perception problems to solve" (Ibid). Problems such as the conception that is a not so reliable source of energy due to the variable weather conditions, for example.

In the same article, Paula Mints underlines the pros and cons of solar energy. On one hand, the technology behind it, which means basically photovoltaic systems and plants, is very expensive and there is no doubt about that. However, on the other side, the cost of energy is rising fast just like the cost of environmental damage, so some investments in PV systems should not harm the companies and the entire world eventually. Solar energy is also a clean and renewable energy, whereas producing energy from carbon and fossils is polluting and sometimes more costly (Ibid).

Besides the pros and cons, also some obstacles have to be overcome; these obstacles are mostly related again to the cost problems and expensive solar systems. "To make systems more affordable, the PV industry continues to require incentives (direct subsidies, capacity and production rebates, feed-in tariffs and tax incentives)" (Ibid).

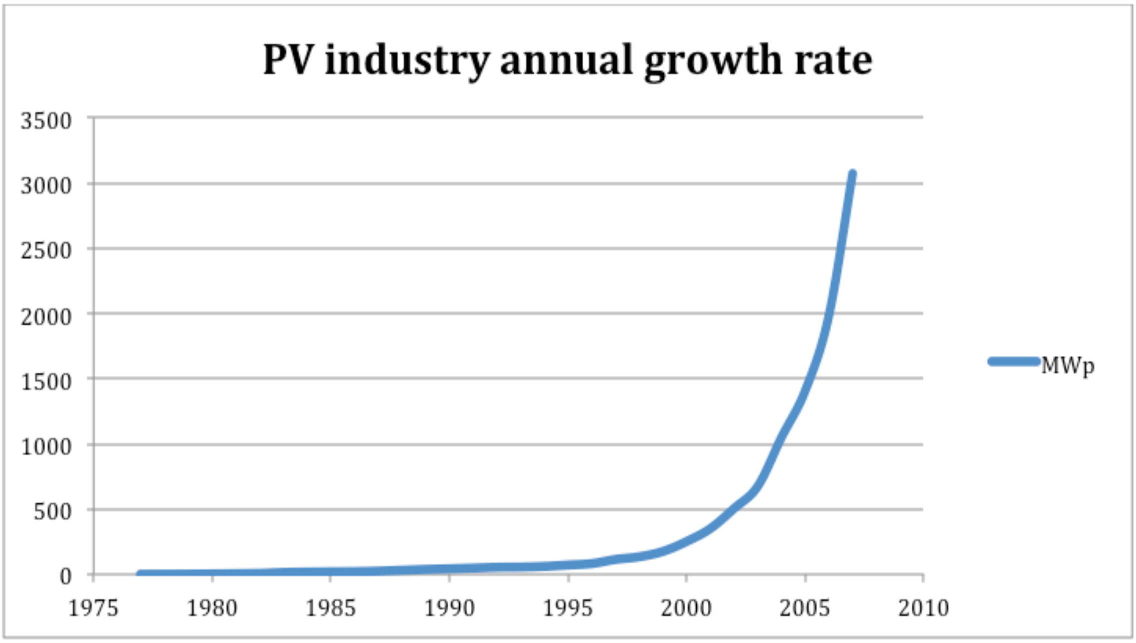
The same article by Mints also provides an overview of what were the percentages of growth in the PV industry for the last 30 years. Following is the table of the CAGR (compounded average growth rate) along the years.

| 30 YEAR CAGR | 20 YEAR CAGR | 10 YEAR CAGR | 5 YEAR CAGR |
|---|---|---|---|
| 1977-2007 | 1987-2007 | 1997-2007 | 2002-2007 |
| 34% | 27% | 39% | 44% |

PV industry compound annual growth rates (Source: Solarserver.com (2010)

While this table denotes a growth of the PV industry over the last 30 years, yearly changes are not taken into account. This is the reason why Mints shows other tables in the same article, which show the annual growth, year by year beginning from 1977 to 2007. The industry doubled the Kw from 1977 to 1978, going from 500kW to 1MW. The growth slowed down in 1984, when it was just 21% compared to the previous year. A strong growth was witnessed in 1997, with a percentage of 38 over year 1996. One more thing that can be noticed from the tables is that since 2000, annual industry growth has consistently been >30% (at least until 2007, which is the last date available for this table) (Ibid).

The following graph clearly shows the boom of the PV sector in the new century.



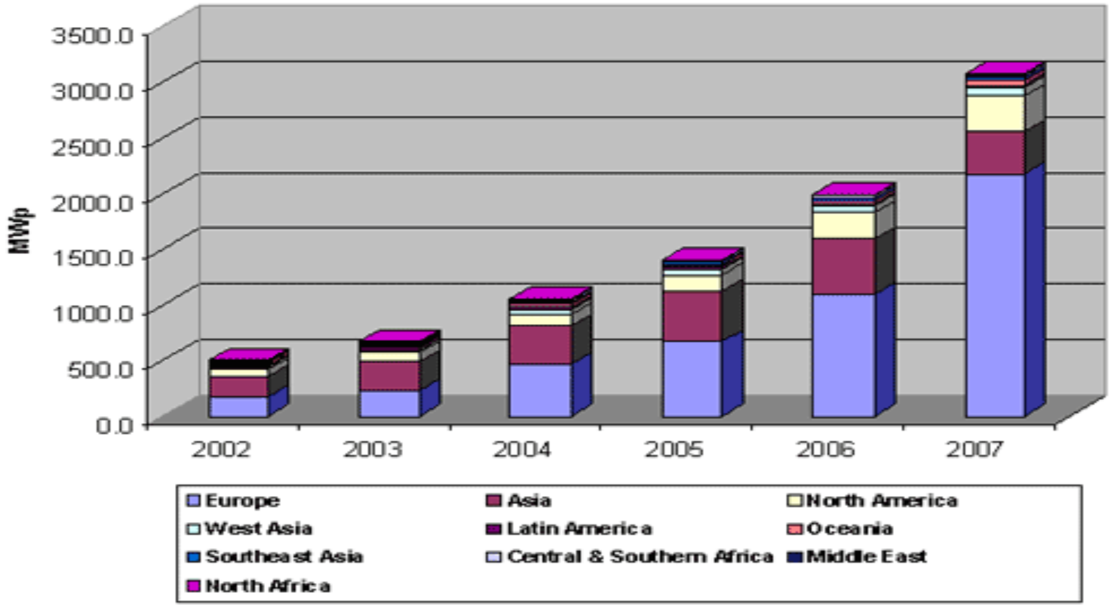

Source: Solarserver.com (2010)

During the last couple of years, the growth in the PV industry has attracted lots of investments and media attention. This brings to a virtuous cycle, since the money coming from the investments can be allocated to R&D purposes, and this industry really needs continuing technology and manufacturing developments. "The growth also invites professionals from other industries, such as softwares and semiconductors, to join the solar industry" (Ibid).

***The role of incentives and the future of solar electricity***

"The feed-in tariff model, which provides a pure economic incentive to buy a solar system, has proven to be the most successful market stimulus for the PV industry (…) The feed-in tariff incentive model allows the system owner (or system investors) to profit from ownership in what amount to a two-year annuity payment" (Ibid).

In the past, incentive programs helped the PV industry gaining ground in Japan (a capacity-based incentive led to a growth of PV systems until its cessation) and in Europe as well, for example in Germany, where the feed-in tariff had huge success and resulted in industry demand skyrocketing. As the graph shows, in 2007 Europe represented more than the 70% of the global industry demand (Ibid).




Regional PV industry growth (Source: Solarserver.com, 2010)

Spain is an example of how feed-in tariff programs can go wrong. Spain was the strongest global market in the year 2008, but its program was revised in September 2007, and the government decided to implement an annual cap. This led to a decrease in demand and also a rapid decline for Spain in growth for the PV sector. Also Japan had some issues, because the government decided to stop the country's subsidy program, which led to a stagnation of the market; the government therefore initiated a new incentive scheme to restart demand. South Korea is also a growing market, but the problem here is the bureaucracy that slows sales of PV systems to this country (Ibid).
If one takes a look at the emerging markets, “China and India have strong potential to emerge as significant markets, but have yet to exercise this potential because solar electric technologies remain expensive to implement, coal is cheap, and both countries have affordability problems” (Ibid). Other problems in these countries are represented by unstable economies, poverty, theft and lack of credit: all of these hinder the need for PV technologies to provide electricity to remote houses and villages. Maybe one of the biggest problem faced by suppliers of PV to the developing world is trying to work with the government departments and the bureaucracy present in these countries. In developing countries there is the need also to provide electricity for urban areas: the

problem is that "conventional electricity is often priced below the cost of production, providing an effective barrier to grid-connected PV technologies" (Ibid).

In the U.S.A., instead, several programs were put in place to make the PV market survive, and make the manufacturing sector efficient through cost-cutting techniques and governmental incentives (Ibid).

"Overall, the international solar industry continues to celebrate its strong success and extraordinary growth, while at the same time anxiously looking for the next strong market. The industry must continue to lower costs, while convincing all participants along the value chain to lower margins and profits so that a sustainable (long-term) market can emerge" (Ibid).

The current trend in the PV industry is towards large-field or utility-scale applications: this means that an investor group installs >1 MWp of PV, and sells electricity to end-users. This trend is expected to continue to dominate application sales (Ibid).

The remote applications (habitation, industrial, consumer power) are cost effective without subsidies – and they have been like this for years. For remote applications, though, affordability is still an issue, the cost - or simply the possibility - of extending the grid to remote populations far outweighs the cost of the PV system. Actually, for many years, the PV industry was dominated by remote applications. The following table provides data on application trends from 1992 to 2007 (Ibid).

| YEAR | TOTAL MWp WORLDWIDE | OFF-GRID % TOTAL | GRID-CONNECTED % TOTAL | CONSUMER INDOOR % TOTAL |
|---|---|---|---|---|
| 1992 | 54.1 | 88 | 7 | 5 |
| 1993 | 55.7 | 88 | 7 | 5 |
| 1994 | 61.1 | 76 | 19 | 5 |
| 1995 | 71.5 | 82 | 13 | 5 |
| 1996 | 82.6 | 81 | 14 | 5 |
| 1997 | 114.1 | 62 | 34 | 4 |
| 1998 | 134.8 | 65 | 31 | 4 |
| 1999 | 175.5 | 58 | 39 | 3 |
| 2000 | 252.0 | 47 | 51 | 2 |
| 2001 | 352.9 | 40 | 58 | 2 |
| 2002 | 505.0 | 30 | 67 | 2 |
| 2003 | 675.4 | 27 | 27 | 1 |
| 2004 | 1049.8 | 19 | 19 | 1 |
| 2005 | 1407.7 | 17 | 17 | 1 |
| 2006 | 1984.6 | 14 | 14 | < 1 |
| 2007 | 3073 | 10 | 10 | < 1 |

Source: Solarserver (2010)

To sum up, the PV industry still has many obstacles to overcome: the continuing expensive need to invest in R&D, the need to reduce manufacturing costs and increase efficiency, downward price pressure forced upon the industry by its need for incentives. Some other obstacles are the constant anxiety that incentives will end before sustainable demand is obtained and competition from other energy sources; to be mentioned is also the capacity, which can be too little to meet demand, or too much. In this last case, as a result, this leads to underutilization (Ibid).

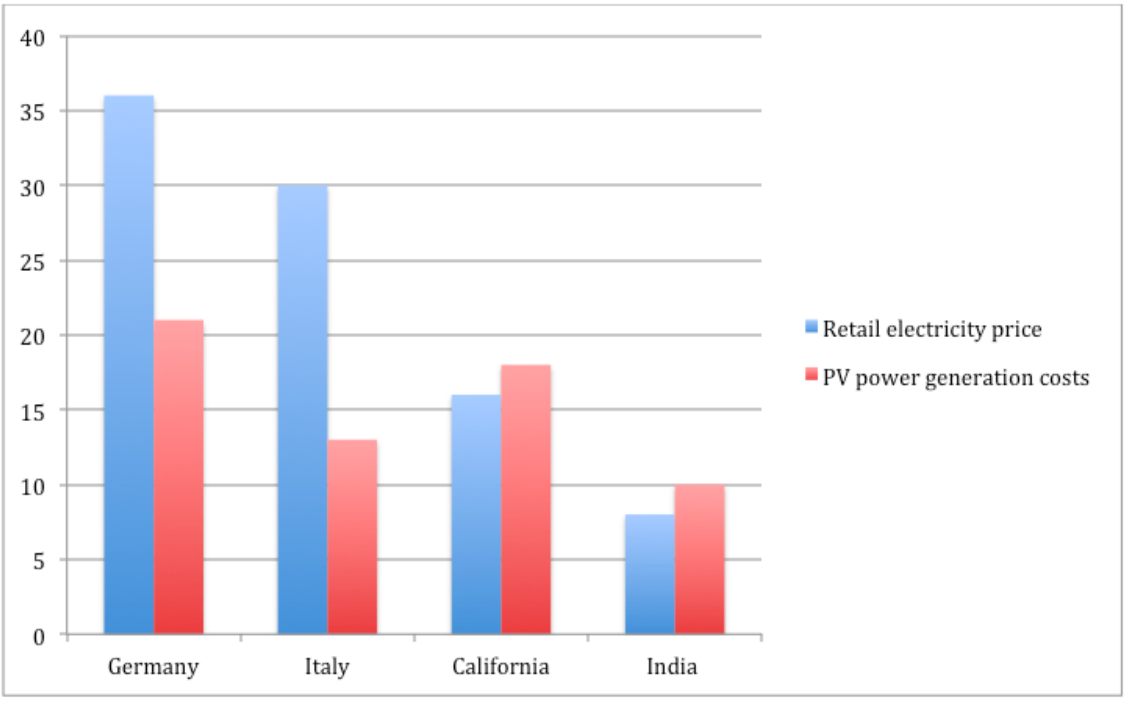
After the last few years of overcapacity and savage price competition, the PV industry gained ground again: the globalization and diversification had an important role in this, making the companies across the PV value chain becoming profitable again (Dobrott, 2014). In the last 12 months, there has been a double-digit growth rate for the PV market, and this is mainly due to three factors:

- The cost of PV, that has declined a lot in recent years, and is expected to decline further in future "making solar competitive with almost every other source of power generation";
- The diversification of PV demand, so that the market is no longer dependent on just a few markets;
- The profitability of the industry, since the supply and demand situation have improved recently (Ibid).

The following section will divide these three factors and explain them more thoroughly.

**1. PV power is competitive without subsidies:** PV-generated power is economical in many markets today, because of the significant reduction in PV costs in the last few years: as a matter of fact, "PV prices are expected to decline continuously with further technological improvement, thereby strengthening PV's competitive advantage in the coming years" (Ibid). In some markets, where the power prices are high for end consumers (for example Germany, Italy, Hawaii, Brazil), PV can generate power at a substantially lower cost than usual electricity prices (Ibid).

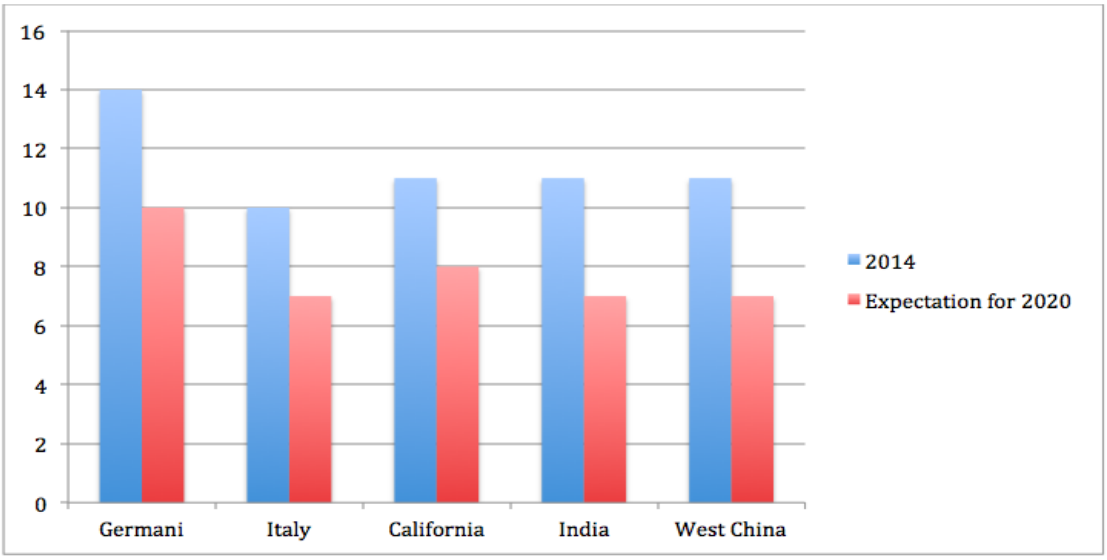
In the following graph, the LCOE/cost (levelized cost of energy[3]) is calculated for a typical region in the country at 6% discount rate




Levelized cost of energy by country (Source: Apricum market model)

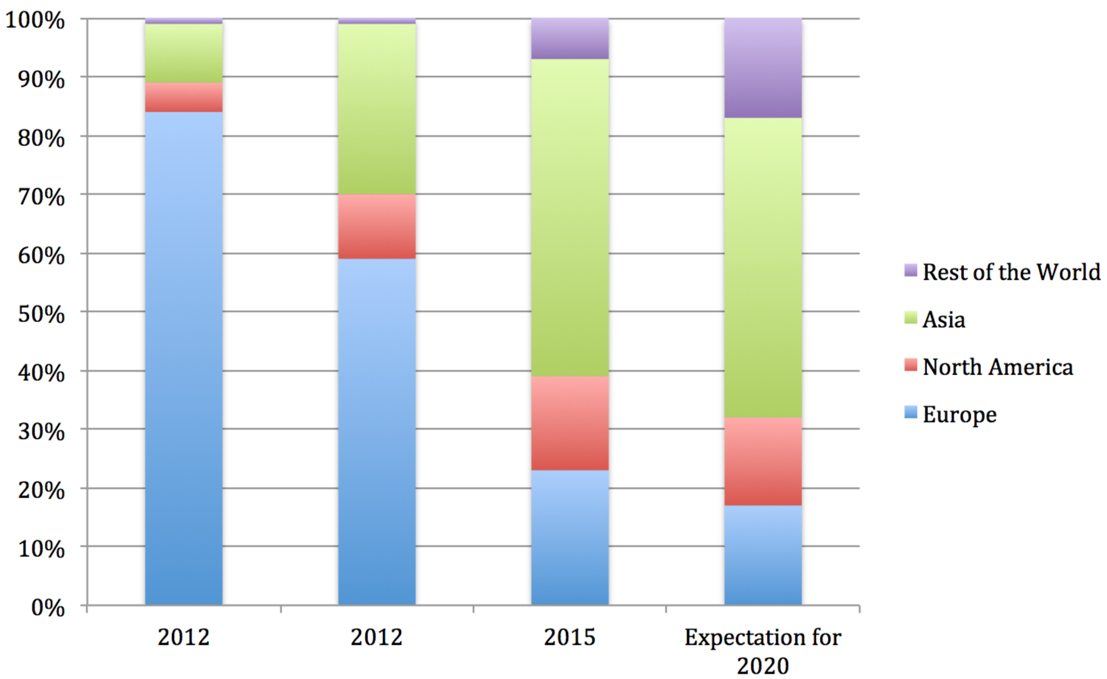
The generation cost of PV power will be competitive by 2020 also in many other regions, as PV power generation costs will be declining to 5–10 USD cent/kWh. The next graph, instead, will analyze the potential and expected utility scale PV power-generating cost, with a comparison between 2014 and 2020 [USD cent/kWh].

[3] The LCOE is the total cost of installing and operating a project expressed in dollars per kilowatt-hour of electricity generated by the system over its life (source: NREL Website)




Graph: Generation cost of PV power (Source: Apricum market model)

**2. Diversification of global PV demand:** It can be observed that now, global PV demand is more regionally diversified than ever before. This means that the global market is much less affected by demand shocks arising from policy changes in single markets. European countries, that have been PV leaders for the last 10 years, have now been replaced by countries such as China, USA and Japan (Ibid).




Graph: Global distribution of PV demand across continents (Source: Apricum market model)

In recent years, new markets of global significance have emerged. In 2010, five markets in the world represented 80% of global PV market volume. In 2015, instead 14 markets made up the same 80% of global PV market volume – an increase of almost threefold (Ibid).
“Besides China, USA and Japan, emerging economies in the MENA region (Middle East and North Africa) and Central / South America are gaining a larger global market share and will drive significant global PV growth in the future” (Ibid).

**3. Profits are returning to the PV industry:** “Thanks to rising capacity utilization and stabilizing prices along the value chain, PV manufacturing companies are beginning to be profitable again” (Ibid). The prices of PV components have been stable since 2013, after witnessing a price drop in 2012. PV production costs will continue to decline due to improvements in technology, and will result in lower prices in the long term (Ibid).
Several investors lost most of the money invested in PV companies in the past; after some time of non-investments, in the recent months we have witnessed a growth in investments with solar companies all along the value chain. The trend of investors has been to choose companies with innovative concepts, differentiated products or simply better cost structures: these are the kind of firms that are likely to provide sustainable returns to investors. It is understandable that no investment is safe a priori: they need to be carefully selected. “For example, the trend of local production in emerging solar markets to increase market presence presents several opportunities, such as acquiring a struggling module manufacturer or forming a joint venture for new manufacturing facilities to serve the local market” (Ibid).
In an interview with Frauke Thies (2014), Policy director of the European photovoltaic industry association (EPIA), she first explains the reasons why the market has declined in Europe in recent years (PV power plants, 2014). There has been “sometimes unexpected support reductions, retrospective measures, and unplanned changes to regulatory frameworks that severely affect investors’ confidence and the viability of PV investments”. The only PV market still profitable in 2013 was Germany, even if Europe in general witnessed a reduction of almost 50% in two years (10.3 GW in 2013 from 22.4 GW in 2011). Still, Europe as a whole ranked number 2 on the global market in 2013 and doubled the U.S. for PV production. Italy and Germany were the countries

that suffered in 2013, but other markets exploded like UK, Romania and Greece. The problem in Europe is that the trending of production is downward: this is a market that needs both political support and the removal of existing market barriers, Thies says (2014). She also underlines as the local demand is a critical factor for a PV industries, as well as local financing conditions (Ibid).

This also confirms the reduction of costs and prices witnessed by the PV market in recent years, due to economies of scale, increased competition and overcapacity. Prices are not expected to be higher in the future, and future decreases in prices "are likely to come from technological innovations, as well as from reduced installation margins and operation and maintenance costs" (Ibid).

Some Stanford researchers found that since 2000, when the boom of PV started, this industry has required a huge amount of energy coming mostly from fossil fuels from the production of PV cells themselves (Golden, 2013). However, in 2014, the electricity generated by PV panels installed all over the World has surpassed the amount of energy going into fabricating more modules, according to Michael Dale, a postdoctoral fellow at Stanford's Global Climate & Energy Project (GCEP)" (Ibid). Basically, the so-called energy deficit is going to be paid off between 2015 and 2020, thanks to "declining energy inputs, more durable panels and more efficient conversion of sunlight into electricity" (Ibid).

Using less materials or switching to producing panels that have lower energy costs than technologies based on silicon are two of the ways through which a reduction of costs in producing PV panels can be obtained (Ibid).

"The energy payback time can also be reduced by installing PV panels in locations with high quality solar resources, like the desert Southwest in the United States and the Middle East" (Ibid).

### 4.2.1 The PV industry in Italy

In 2009, the photovoltaic industry was one of the "Italian industrial sectors which has maintained a growth rate during the recent economic crisis", said the GIFI - Gruppo Imprese Fotovoltaiche Italiane, "Italian photovoltaic enterprises Group". According to the GIFI, the generation plants were more than doubled from 2008 and their production of electricity tripled. If about 78% of the share of photovoltaic power installed in 2009 in the world came from the European Union, Italy played a leading role with 1,142 MW of cumulative installed capacity in 2009 and ranked fifth in the world at that time (source: Acea website).

This Italian power during the crisis is demonstrated also in 2010, when SunEdison - one of the then leaders in solar power globally - constructed the largest photovoltaic system in Europe (70 MW), in Rovigo. 850.000 square meters, 840 km of cables, 280.000 solar panels, 58 steel poles. Local authorities expressed enthusiasm for the work, noting the economic impact it had on the area: the entire construction process in fact has offered employment for about 500 people (SunEdison, 2010).

Also for 2011 we can speak of photovoltaic boom in Italy (Rossi and Cipriari, 2012). The report published in January 2012 by EPIA (European Photovoltaic Industry Association), states that Italy was the World's leading manufacturer of new plants in 2011, thus undermining the primacy of Germany. This happened mainly because of the decree "Salva Alcoa", which extended the tax benefits for PV introduced in 2010 also to the first months of 2011 (Ibid). The strong growth was also attributable to the incentives that the State provided to create new facilities thanks to the "Conto Energia". This fund drew on the bills of all consumers and was used to finance the construction of new plants: in proportion to clean energy produced, the State would pay a certain contribution for 20 years. The market reacted positively to these incentives, installing almost 9 GW of power in a year (Ibid).

A characteristic of the photovoltaic phenomenon in Italy has always been its size: much of the energy power of the Italian plant (about 90%) is produced by small size structures, capable of producing a power level in the range between 1-20 kW. This category includes domestic photovoltaic systems up to 6 kW (Ibid).

The choice of families to install PV systems in their homes is driven not only by economic reasons, but also by the knowledge that PV is free of pollutants and greenhouse gas emissions, that strengthen the idea of a not polluted source of energy for a better World (Ibid).

For the 80% of the Italians, solar is the source on which to focus, as shown in the annual survey data commissioned by GIFI ISPO polling institute. The survey shows that Italians are fully aware of the potential for efficiency and renewable sources but they are quite critical about what so far has been Italy's commitment with respect to this type of investment (Casaeclima, 2013). In particular, over 80% of the respondents believes that solar energy is the cleanest renewable source on which to bet and 94% of them say it is definitely not harmful to health, 92% of which is respectful to the environment and 81% of respondents does not disfigure the landscape. (Ibid).

"Photovoltaic is a booming business and will grow again" says Vincenzo Scimeca, PV technician and author of the book “PV Systems: from the inspection to the realization”, who believed in the potential of the sector as an employment area. But there have been also difficulties, especially linked to the relationship with the banks. Because of the international financial crisis there was a credit crunch, which caused the demand for more stringent conditions on loans not only for small business investors, but also for families. In addition, it was sometimes difficult to dialogue with the Superintendence of Cultural Heritage and with the municipalities, the latter in particular did not always incorporate the legislative simplification (Rossi and Cipriari, 2012).

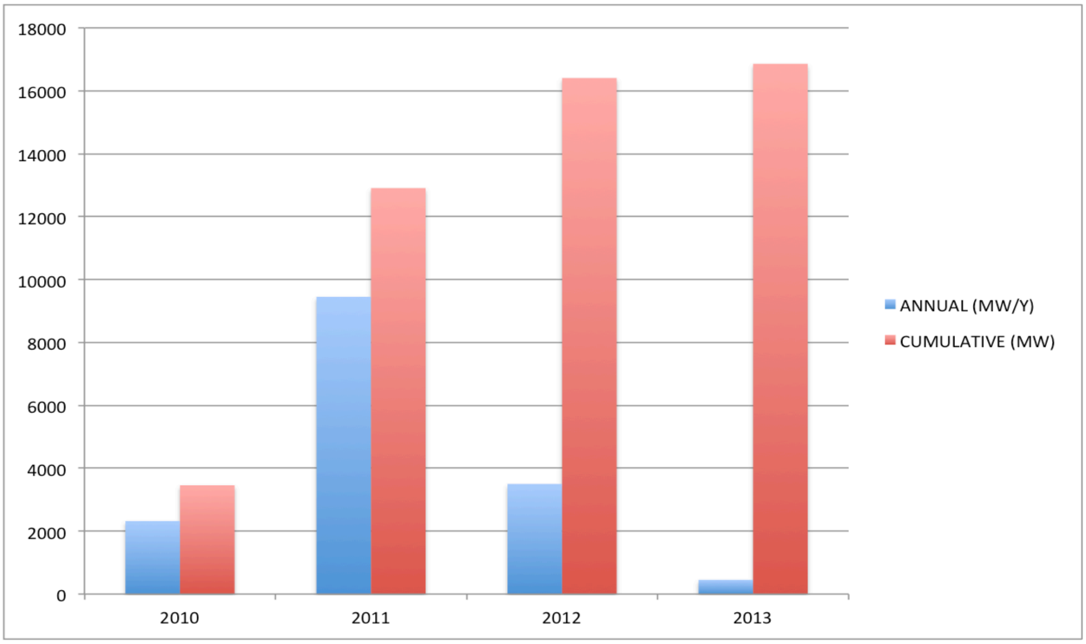
While on one hand the years immediately after the crisis showed a growth in the PV industry, the same cannot be said for 2013 (Qualenergia, 2013). In fact, in the meeting with the Consortium of Italian Popular Banks, GIFI presented the results of a survey conducted among the member companies, which shows a 50% loss of jobs and almost 50% of turnover of PV companies in 2013 compared to 2011 (Ibid).

"The sector's survival is at risk - said Emilio Cremona, President of GIFI - over 8.000 solar workers have lost their jobs in 2011”. The reduction regarding orders of PV modules, investments by end users and increased layoffs are also considerable damage to State revenues, and consequently for the whole national economy. "I am sorry to see that - continues Cremona - in Italy, where the economic recovery should be the first point of the political agenda, there is no industrial project promoting renewable energy" (Ibid).

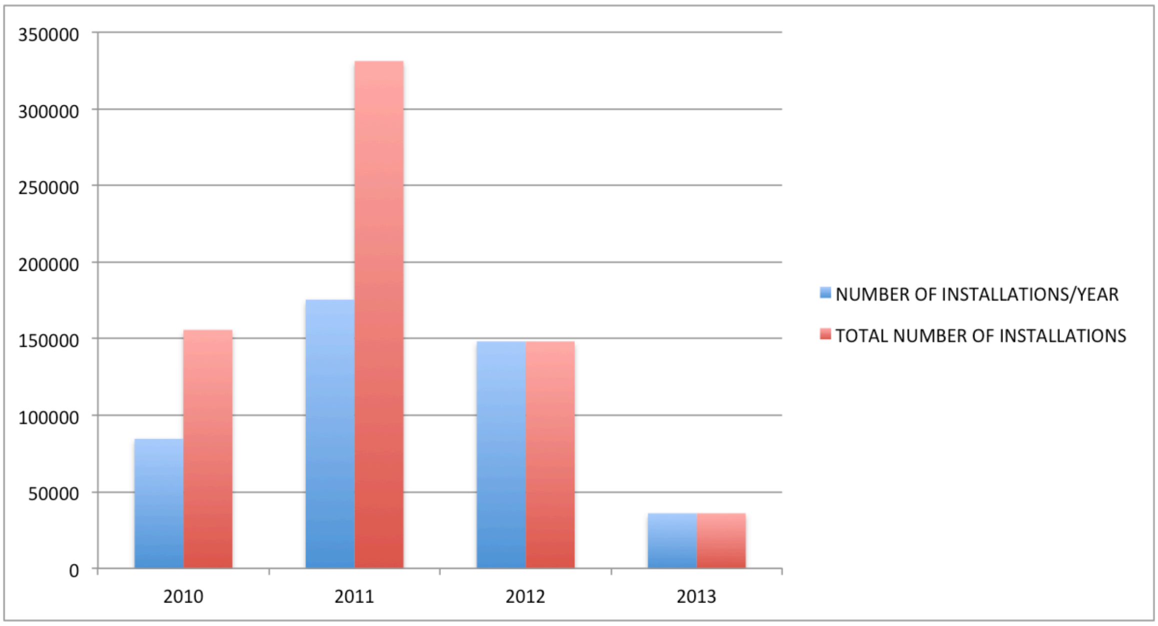
GIFI also said that the Italian photovoltaic industry is in crisis mainly because of regulatory instability and non-sighted policies. In 2012, the total turnover amounted to 6.2 billion euro, with a 58% reduction compared to 2011 and the number of total employed personnel in the field at the end of 2012 amounted to about 14,000 units, down 22% compared to 2011 (Casaeclima, 2013).

This is not to say that there are no PV installments in Italy, because the benefits that PV technology produces for Italy are anyway significant: in 2013, about 7% of the Italian energy needs were met through photovoltaic energy, and in 2012 it was avoided to import 2 billion euro gas. The price of energy peak hours was reduced up to 26% (Ibid).

The President of GIFI Emilio Cremona said that the photovoltaic industry in Italy produces many benefits, but this industry is currently in crisis, as one can see from the both the reduction in employment and GWh produced in the sector.



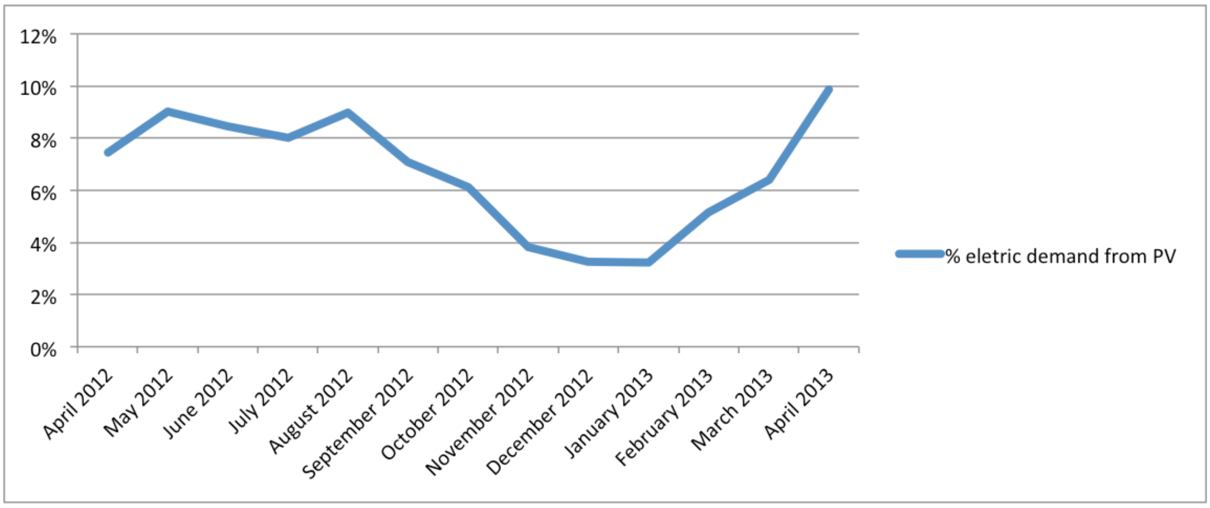

Historical trend for PV energy installer every year (Source: GSE, 2013)



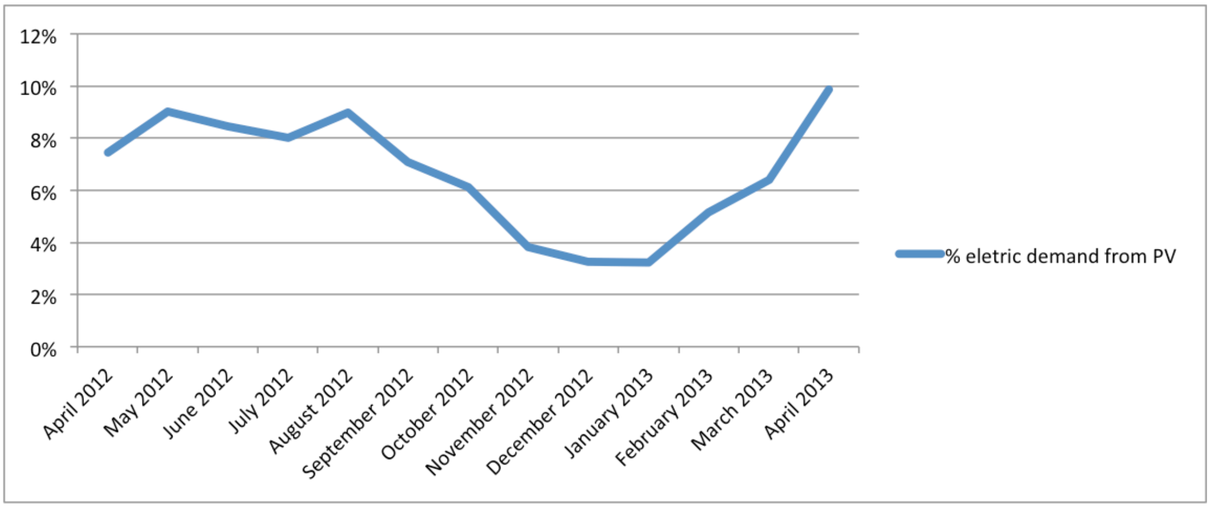

Trend on the number of installations every year (Source: GSE, 2013)

As of April 30, 2013, there are 16,859 MW of photovoltaic power connected to the national grid, of which approximately 3,500 MW connected in 2012 and just 451 in 2013. From the graph it can clearly be seen that the amount of MW per year and number of system installed in 2013 is much less than the years before (Ibid).

Photovoltaic power installed in Italy has contributed in 2012 to 5.65% in demand and to 6.46% of national electricity production. For the first four months of 2013, according to Terna data, photovoltaic technology has contributed to 5.27% of the demand and the 6,10% of the national production of electricity; in the first four months of 2012 these values were respectively 4.78% and 5.52% (Ibid).




Trend PV contribution compared to the national electric demand (Source Terna, 2013)




Trend PV contribution compared to the net national electric production (Source: Terna, 2013)

Germany and Italy, between 2009 and 2011, have hosted the vast majority of solar systems installed worldwide (Torchiani, 2013). This happened because of the high level of incentives granted to the owners of the panels in these two countries. In Italy, in particular, thanks to the incentive system known as “Conto Energia”, between 2008 and 2013 over half a million plants were connected to the grid, about 17 GW of total capacity (Ibid).

But the heyday of the national PV should be over, because the Conto Energia has ended in July 2013. In support of the National Solar, in fact, there are only tax deductions of 50%, good for small domestic plants but certainly not enough to attract major international investments (Ibid).

The situation of the Italian photovoltaic, in short, is dramatically serious, but in reality, what has changed is the whole geography of the global market. Even Germany, after years of domination, lost in 2013 its second place of photovoltaic and slipping to fourth. The primacy in the field of new installations it will be up to China that has decided to bet on the development of its internal market (Ibid).

In the second place there is Japan: in this case, the installation of the panels race is the direct consequence of the Fukushima catastrophe of 2011, which involved the blocking of all nuclear facilities in the country (Ibid).

In the third place, with about 4.5 GW, are the United States, which in recent months are racing the most. And Italy closed 2013 in fifth position with 2 GW: the decisive year, according to analysts, had to be 2014, when the real value of the national solar without the support of the Conto Energia would be unveiled (Ibid).

In Italy in 2014 just under 1.4 GW of new PV capacity were installed: a very encouraging number for the post Conto Energia incentives, where the only incentive for photovoltaic are the tax deductions 50%. These deductions, however, apply only to the residential PV. The data comes from GB Zorzoli, one of the leading Italian energy experts (Qualenergia, 2015).

The article by Expoclima, 2014, shows some statistics about the PV industry in Italy.

The average size of the installed plants amounts to 30.5 kW, while new installations are mainly small in size and connected to the low voltage network.

The number and distribution of power among the Italian regions is not homogeneous. The highest number of plants can be traced in the North (54% of the plants is there), where Lombardia and Veneto have the most, while the Centre has installed approximately 17% of the same and in the South the remaining 29%. Similarly, the installed power is concentrated in the North, with about 44% of the total plants, with Lombardia to give the greatest contribution, in the South (38%), where he leads the Apulia, and the Centre (18%), with a record of Lazio (Ibid).

In 2013 the production of photovoltaic plants in Italy increased by 14.4% compared to 2012, reaching 21,589 GWh.

Also in 2013, the highest production of photovoltaic nationwide was conducted by Puglia (17%), followed by Emilia Romagna and Lombardy (Ibid).

Nationally, 41% of the power is installed on the ground (mainly South Centre), 49% of buildings (especially in the North), 6% of greenhouses and shelters and the remaining 4% otherwise, e.g. for noise barriers motorway (Sardinia, Calabria and Liguria). 54% of the PV capacity installed in industry, 13% in agriculture, 20% in the service sector and 13% in the domestic (Ibid).

In 2013 in Italy own consumption amounted to 3,590 GWh (17% of total production of photovoltaic systems), of which 38% in the industrial sector, 26% in the service sector and 24% in the domestic sector (Ibid).

The IHS[4] report in 2014 on major photovoltaic manufacturers in the world shows a curious fact: in the first 15 positions, there are no German, Italian and Spanish companies (Codegoni, 2014). This means that no company in the countries that paid most of the incentives during the solar boom in the early years of this technology, has managed to create a large industry sector. This confirms the trend of 2013 for Italy, and stretches it also for 2014 (ibid).

Pietro Pacchione, chief operating officer of the company “Green Utility SpA” and member of the “Assorinnovabili” Governing Council, tries to explain what happened. Basically, behind some PV companies in other parts of Europe and Asia moved huge financial and industrial giants, which believed in the new business, giving the necessary capital to let those companies grow immediately also on the international markets; in Italy, on the other hand, the biggest PV system was just hundreds of MW, and it was deemed to be purely national (ibid).

Many Asian companies, then, are vertically integrated: from silicon to modules. It is clear that they get unbeatable scale economies. In Italy, Spain and Germany, however, behind the PV companies are enlightened individual entrepreneurs, almost never a big corporation. So companies remained small, exposed to negative situations and unable to compete in international markets (Ibid).

Until the '90s, Eni was producing photovoltaic cells and modules for Italy, while Enel invested in the very first large-scale solar plants. As for now, in Italy there are some PV

[4] IHS provides information and analysis to support the decision-making process of businesses and governments in industries, such as aerospace, defense and security; automotive; chemical; energy; maritime and trade; and technology. (wikipedia)

companies, and the main ones are: the Sicilian joint venture 3-Sun, Enel Green Power and Sharp-STMicroelectronics (ibid).
Enel Green Power has recently become one of the largest producer of energy from renewable sources in the world. It is much criticized in Italy, because it does not install almost anything in the country, but just outside the border: in Italy, in fact, the environment is becoming increasingly unfavorable due to strict regulations for the PV business (ibid).

If we have a look at the 2015 outlook, we find out that Italy is third in the World for installed systems: 15% of the global total behind Germany and China and before the United States and Japan (TGCom 24, 2015).
"Families and small and medium enterprises really believe in photovoltaic - says the president of the Renewable Anie, Emilio Cremona - and the data prove this." The "merit" goes to a combination of factors, from the extension of the tax deduction of 50% until 31 December 2015. "Not to mention the fact - continues Cremona - that the costs decreased by about 75% compared to a few years ago" (Ibid).
2015 will be the year of reorganization after the insecurity and instability post incentives, as emerged from Solarexpo.This expectation is also confirmed for the beginning of the second quarter of 2015 (Sandrin, 2015). According to Anie Rinnovabili, Italy has installed 78.1 megawatts since the beginning of 2015 (until May 26, date of the article). The target was then moved to small-medium range, especially due to regulatory uncertainty for the profitability of large parks. The geographical spread of the regions of northern Italy remain at the top for new installations, in particular Lombardy, Veneto and Emilia Romagna contributing with 42% of the MW installed in 2015 (Ibid).
In comparison with the previous year, with 2,674 GW products schedules in April 2015, the national energy demand increased by 20.8%. After hydropower (3.653GWh), photovoltaic stands as the second largest source of renewable energy in front of a wind sector still well distant (1,464 GWh). According to Legambiente in the report "Comuni Rinnovabili 2015” (Renewable Municipalities 2015), we have achieved full coverage of PV in every Italian town (Ibid).

# CHAPTER 5: CASE STORY

## 5.1 The history of drones

The simplest definition of drone is the one it is possible to find in the vocabulary. In the Cambridge University Dictionary, for example, a drone is defined as *an unmanned aircraft or ship that can navigate autonomously, without human control or beyond line of sight; the aircraft or ship is* in fact *guided remotely.* By these few words, it is possible to understand how the use of drones during the years has had a lot of applications, firstly in the military field and then, in a second moment, in the civilian field.

Drones can also be called RPAS - Remotely Piloted Air System - described as remote controlled air, ground or naval means of transport, which do not require personnel on board, and can be used in potentially dangerous situations for humans (Dronitaly).

To completely understand this particular type of product, it is also important to know how a drone is built. It is possible to distinguish between the aircraft itself, *the pilot station and the command and control link, connecting the two* through radio waves *(*Ibid*)*.

Drones can be categorized into four different types, depending on their characteristics and functions (Telecom.com):

- Rotating wing, which are similar to helicopters, even if they reach the stability in flight through counter-rotating rotors instead of having a tail one. The most common type of this drone has four rotors, but it is also possible to find drones with six or even eight rotors. Thanks to their characteristics, these drones are able to fly in every direction and to take off and land in a vertical way (Ibid).
- Stationary wing, which are the drones that are the most similar to model airplanes; however, the control station is created by an app instead of a manual control. These drones can carry heavier weight and have more autonomy than other kinds of drones of the same weight; on the other hand, stationary wings drones need a wider space in order to land compared to other kinds (Ibid).

- Airships, that have the same characteristics of aircrafts; but since they are way lighter than the real ones, they can be used in enclosed and crowded spaces (Ibid).
- Flap wing, which are inspired from the ornithopters, since they can exploit air current and fly and land independently from the direction of the wind (Ibid).

Military drones, also called UCAV - Unmanned Combat Aerial Vehicles - brought back their origins to the invention of aircrafts (Nesta Website). Military Armies from every Nation have always dreamt to individuate and destroy their enemies without involving any person from their side. This is the reason why, in this field, drones have witnessed a huge improvement over the years (Ibid).

*The first recorded use of a remotely piloted aircraft was in 1935, when the Royal UK Navy used the DH82 Queen Bee for target practice (House of Lords, 2015).*

However, the father of the idea of remotely controlled vehicles was Nikola Tesla (Nesta Website). The inventor, who lived in the XIX Century, was in fact t*he first to patent a remote-control for unmanned vehicles* on 8th November 1898 (Assembly Website). *The patent covered any type of vessel or vehicle, which is capable of being propelled and directed, such as a boat, a balloon or a carriage* (Ibid). The first public demonstration took place in New York, at the Madison Square Garden, where Tesla made a little ship move in a tank of water through a one frequency signal (Ibid). The "sensitive device", as called by its inventor, consisted of a metal oxide powder subjected to a magnetic field and an antenna who received the radio waves arranged on the boat (Ibid). Unfortunately, at that time, Tesla was unable to sell the technology: the U.S. Navy thought that the boat was too fragile for a real battle and private investors and banks did not see the usefulness of it (Ibid).

The use of drones as currently defined by the dictionary was introduced for military uses only after World War II, in particular during the Vietnam War, when an unmanned aircraft called Ryan Ferebee was flown over the Vietnamese Territory (Nesta Website).

Even if it is true that remote piloted aircrafts had been around for decades, the early 21st century will be remembered as the period of drones for military use (The Economist, 2014). It is sufficient to remember that when the U.S. invaded Iraq in 2003, the nation had only about 200 drones, but by the time the army left, the U.S. possessed almost 10,000 drones (Ibid). Drones had been known for decades but what is new is the Global

Positioning System (GPS) and the better satellite systems that can send back copious data (Ibid). Throughout the entire period, a huge amount of drones was used in various stages of Army operations; for example, some of them were sent on the ground to deal with bombs (Ibid). However, before being used for whatever kind of military actions, drones are put through the full qualification process required for any kind of weapons, even if it is true that only a few drones were used to launch attacks, and most of them was used to individuate enemies and not to kill people. A considerable amount was also used for logistics and communication purposes (Ibid).
The increasing number of drones used in the military field has led throughout the years to raise the pressure for autonomy for two main reasons. First of all for costs, since a drone needs minimal supervision; and secondly for safety reasons: the greater the reliance on drones is, the more enemies want to attack them and their ground station and pilot. More autonomous drones means a less vulnerable army to these attacks (Ibid).

Drones for civilian use, instead, were first introduced in the U.S. in 2015, thanks to a law approved the year before (U.S. National Security). In Europe, the introduction happened in 2014; this is the reason why 2014 was nominated "the year of drones" (House of Lords, 2014).

In light of this, it is clear why there was a rising in lawmakers concern, both for safety and privacy reasons, not only in the U.S., but also in Europe (U.S. National Security). Before starting effectively to use drones in various markets, in fact, it is important to establish a set of rules which must be followed all over Europe, in order to create an accepted framework in which people can work (House of Lords, 2014). The European Commission thinks that now is the right time to introduce drones for civilian use, given the current conditions among European Countries, in which trades and people are free to move and work without any particular constrictions (Ibid). Drones, in fact, by definition, crossed international borders since from the early foundation of the industry (Ibid).

## 5.2 The history of photovoltaic

A photovoltaic cell is “a type of photocell that changes light from the sun into electricity, used in solar panels, pocket calculators, etc.” (Cambridge dictionary online). This process was discovered for the first time in 1839 by Edmund Becquerel, a French experimental physicist, while experimenting with an electrolytic cell made up of two metal electrodes (Bellis, 2014). Following, in 1873, Willoughby Smith discovered the photoconductivity of selenium, but the idea of exploiting the PV effect as a source for producing energy could not be properly developed because scientists had to operate with materials with scarce efficiency (Solaridea, 2014). After many experiments with different materials and findings about this new field, in 1954 the first commercial solar cell in selenium was invented by Person, Fuller and Chapin. The initial costs of this new technology were huge; this is the reason why it was used just in specific cases, such as for the supply of artificial satellites. All the experiments made after 1954, until around the mid 70s, had the aim of reducing costs for satellites supply. Beginning from the 80s, the attention was brought also to “terrestrial” uses (Ibid). As of today, research is aimed at reducing costs of production and improving the efficiency of PV systems.

### 5.2.1 The PV in Italy

In August 1961, at the first International Conference of the United Nations on New and Renewable Sources of Energy, held in Rome, numerous works were presented on the state of, and prospects for, photovoltaic. After the oil crisis of 1973, since oil prices went up and other sources of energy needed to be found, the “Consiglio Nazionale delle Ricerche” (National Research Council) began to manufacture solar cells; in the meantime, Solar SpA and Helios Technology were founded (Solaridea, 2014).
In 1979, at Passo della Mandriola, near Cesena, the first Italian photovoltaic of 1kW[5] was installed, through a collaboration among the Institute LAMEL, ENEL, the Riva Calzoni and Helios Technology (Ibid).

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5 The **watt** (symbol: **W**) is a derived unit of power in the International System of Units (SI), named after the Scottish engineer James Watt (1736–1819). The unit is defined as joule per second and can be used to express the rate of energy conversion or transfer with respect to time (Wikipedia)

In the late 80s and early 90s, Italy was one of the forerunners and one of the main actors in the world of photovoltaic; a boost was represented by the investments that followed the "Piano Energetico Nazionale" (National Energy Plan) of 1988, which, in order to diversify the sources of production, had defined different actions for PV development and set an ambitious target of 25 MW of installed capacity by 1995. In the following years, investments in the PV industry led to several Photovoltaic power stations, including the one in Serre (Salerno), 3.3 MW, one of the largest in the world until the end of the century (Ibid).

In 1993, the "Piano Fotovoltaico Nazionale" (National Photovoltaic Plan) began; despite the goal of 25 MW was not reached, still as many as 14 MW were installed on the Italian territory, which allowed Italy to be first among the European countries in installed power PV systems in the 90s (Ibid).

After a few years of neglect by politics on this sector, in 1999 the "Libro Bianco Italiano per la valorizzazione energetica delle Fonti Rinnovabili" (Italian White Paper for the development of Renewable Energy) identified targets to be achieved in order to obtain reductions of greenhouse gas emissions (as ratified by Kyoto Protocol of 1997) and fixed a target for Photovoltaic of 300-500 MW by 2010 (Ibid).

### ***The "Programma tetti fotovoltaici" ("Photovoltaic roofs program", 2001)***

The "Programma tetti fotovoltaici", launched in 2001, provided capital funding for PV systems up to 75% of the total cost, excluding VAT (Value Added Tax). The program was divided into four separate measures: a National Invitation and three sub-programs co-financed by the regions (in 2001, 2002, 2003) (Solaridea, 2014).

A total of 66 million euro was allocated by the Ministry of the Environment, Land and Sea. Albeit many points of improvement emerged, the result was still encouraging, as the 100% of the funds made available was used allowing to switch from 1MW / year installed in 2000 to 5 MW / year installed in 2005, bringing Italy to produce 30-40 MW in total in 2005 (Ibid).

## ***Conto Energia ("Energy Bill", 28 July 2005)***

On the 28th of July 2005, the then Ministry of Industry, together with the then Ministry for Environment, Land and the Conference of Regions, defined the criteria to encourage the production of electricity from photovoltaic systems in what was called "Conto Energia" (Solaridea, 2014).

The results of the program were astonishing: in December 2006, in fact, 4.330 plants for a total of more than 62 MW were being built; 1.400 plants of approximately 10 MW of power were terminated; 900 plants with a total capacity of over 6 MW were projected.

The regions with the greatest number of installations and of power installed were:

• Lombardia (444 plants for 2.7 MW)

• Emilia Romagna (340 plants for 2.5 MW)

• Veneto (302 plants of 2.1 MW).

Trentino Alto Adige, with only 137 operating plants, had an installed power of 2.9 MW. The first among the southern regions was Puglia with 1.9 MW and 164 installations (Ibid).

Albeit with many positive aspects and results, as demonstrated by the boom of applications in March 2006, in the formulation of the "Conto Energia" in 2005 many critical aspects emerged, especially bureaucratic and administrative. These issues have been addressed and resolved by importing many points of the German law: this importation proved to be very successful and resulted in the "Nuovo Conto Energia" (New Energy Bill) of February 2007 (Ibid).

## ***The "Nuovo Conto Energia" (February 2007)***

The new Ministerial Decree amending the rules of the system of incentives for the production of electricity from solar sources, commonly called "Nuovo Conto Energia", was signed on 19th February 2007, published on the Official Gazette no. 45 of 23th February 2007 and entered into force on 24th February 2007 (Solaridea, 2014).

The new mechanism has drastically improved the procedures of the old incentives system and eliminated most of the weaknesses which had encouraged the speculative bubble. It also made it easier to recognize the solar rate, as there is no longer need to go through an application and admission in a special ranking, abolish the annual ceilings and tends to be very favorable for integrated solutions in building products. The "Nuovo Conto Energia", valid for 20 years, has a feed-in tariff[6] differentiated on the basis of the rated power of the system and the level of architectural integration (Ibid).

***Goals for Italy***

In 2007, the goals for Italy were to reach 3000 MW installed by 2016. What was not clear at that time, was the fact that the incentives for the future were not established, so this might have created problems for the future; after Germany and Spain finished their first energy bills, they have renewed them only reducing some incentives, to push manufacturers to optimize production processes in order to bring down costs. But the goal of 3000 MW installed capacity was already reached in late 2010: GSE, the State energy services agency, confirmed that by the end of 2010, Italy's total installed PV capacity was nearly 3000 MW (Reuters, 2010).

## 5.3 Companies overview

### 5.3.1 Drones companies

In order to frame our analysis about the drones industry, we have decided to take in consideration three companies authorized by ENAC all over the Italian territory. In the official web page managed by ENAC, it is possible to find only five drones companies that can work in the photovoltaic system, due to the types of drones they have. In fact, in the PV industry a thermal camera must be used, i.e. a camera able to reveal the differences in the superficial temperature of objects (in this case PV cells). However,

[6] A **feed-in tariff** model is a policy mechanism designed to accelerate investment in renewable energy technologies. It achieves this by offering long-term contracts to renewable energy producers, typically based on the cost of generation of each technology. Rather than pay an equal amount for energy, technologies such as solar PV and tidal power are offered a higher price, reflecting costs that are higher at the moment. The goal of feed-in tariffs is to offer cost-based compensation to renewable energy producers, providing price certainty and long-term contracts that help finance renewable energy investments (Wikipedia)

the camera is not so light, so only few kinds of drones are able to fly with it, the others cannot support such a huge weight while flying.
The companies we have decided to interview have different business models, core competencies and different typologies of service with drones.

**AIRVISION**

AirVision is a company formed by five people (Interview A), founded in 2011, which both produces drones and offers services with them all over the Italian territory. It is a division of a bigger company called Neutech (Airvision Website), which produces personalized technological solutions to support cameras and video cameras (Neutech Website).
However, the company does not possess any camera: it is the client who provides it to AirVision, or it is the latter who rents it. The department is also specialized in the construction and sale of drones to the final customer, only after providing a little training on how to control the drone while flying. The third department instead, named StarFly, is specialized in the creation of components for hobby modeling, by using the synergies and the competences of the other departments.
Fundamental values for the company are engineering, experience, passion and problem solving, which led it to the expansion in Italy with two headquarters, one in Trieste and one in Imperia, both in Northern Italy (Ibid).

Picture 1: Drone AirVision (source: AirVision website)


Picture 2: Drone with camera (Source: Airvision website)

**TECHNICAL STUDY VINCENZO MANTOVANO**

Technical Study Vincenzo Mantovano is a company formed by four people, founded in 1995, which bought two drones in 2014. The drones were sold by an Italian company called FlyTop, whose activity is authorized by ENAC. The company also invested on several kinds of cameras, but not on thermal ones. The owner, in fact, believes that the investment was not necessary, due to the high cost of the camera and the low demand of the service. If needed, the company lends it from a specialized reseller. It offers its services in all Italian Regions, even if the owner, during the interview (Interview B), assessed that the greater portion of his income comes from the North-East.
The company does not have a website, since the owner prefers to publicize his company through both participations to specialized conventions and partnerships with prestigious Italian universities. With the former modality, the owner can meet companies who are looking for information in this field, hoping they can use the new technology for their business affairs; with the latter, the owner tries to increase the reputation of his business (Interview B).
The core business of the company consists basically in offering a service of videos or pictures taken by the drones; the analysis of the images is not included, since the employees do not have the right skills to also offer this service. It is either the client

who asked for the service, or a specialized company, that will analyze the images and will create a conclusion (Interview B).

Picture 1: First drone at Technical Study Vincenzo Mantovano

Picture 2: Second drone at Technical Study Vincenzo Mantovano

**NIMBUS**

Nimbus is a company founded in 2006 as a spin-off of a private company, specialized in the creation of specific vehicles for the Defense. Currently, the company is producing several models of drones, all of which already obtained the permissions to flight by ENAC (Nimbus website).

The company has four employees, and two of them have the certification as drone pilots. The activity of the company is divided in two segments (Interview C):

- The production of drones, that goes from the projection phase until the deliver of the product to the final customer;
- Services, that include both the monitoring and the maintenance activities.

Monitoring is the service for which the company makes the drone fly over a specific area to check the status of buildings and activities. Maintenance, instead, means that the company takes care of the reparation of the drone.

Clients of this company are various: from public administration to private companies in different industries such as photovoltaic, safety and railway (Ibid).


Picture 1: Hexacopter PPL 612 (Source: Nimbus Website)

### 5.3.2 Photovoltaic companies

To create a rule for the best implementation of drones in the business model of photovoltaic companies, it was important to study and understand how photovoltaic companies work: in particular, how big their installations are and their maintenance activities in terms of costs.

**MYENERGY**

MyEnergy is a company founded in 2006, that went public only in 2012. It is a company that started to work with the PV systems, but currently it is working also in biomass gasses and eolic fields (MyEnergy website).

The company counts 100 installations in Italy (for the 90%), Chile and Mexico (for the 10% of all the installations).

MyEnergy gains its profits mainly from two activities:

- Maintenance, that counts for the 10% of the total profits; maintenance includes all the activities of cleaning, electric verification and building of the installations (Interview D)
- Installation of new PV cells, that counts for the 90% of the profits and that are possible thanks to 20 different suppliers that produce the cells. These suppliers are spread all over the World and chosen depending on the project MyEnergy needs to deliver.

The cells that the company needs to monitor and maintain are installed both on the roofs of buildings and on the ground.

Picture 1: Example of PV system on a roof (Source: Myenergy website)

Picture 2: PV system on the ground (source: MyEnergy website)

**LOCCIONI**

Loccioni is a family company, founded in 1968 with the purpose of spreading all over the World an entrepreneurial model to improve knowledge and work environment, thanks to people and technologies, by creating customized solutions and long term relationships with clients (Loccioni Website). As for now, the company possesses 40 PV installations around the globe and 40 are also the researchers dedicated to the development of new solutions (Ibid). The company works within five areas such as human care, energy, environment, security and mobility. The one that is important for our study is energy.

Loccioni possesses two kinds of PV installations. One is dedicated to the auto consumption, which results in a decrease of energy costs for the whole company; the installation produces 1,5 MW and is located for the majority (1 MW) on the ground and for the rest on building roofs (Interview E). The other one, instead, counts 12 MW spread among different business clients; they are located for the 90% in the nearby (Marche Region), while the remaining in Northern Italy (Ibid). The company is in charge not only of the installation, but also of all the maintenance activities, both the daily and extraordinary ones (Ibid). However, for the daily activities, Loccioni subcontracts the service to electricians located near the area of the PV systems, in order to faster respond to customers' needs.

**ENERPOINT**

Enerpoint is a company founded in 2001, with more than 50 employees, that possesses a huge number of agents, installers and professionals all over the Italian territory. This allows the creation of reliable PV systems of every dimension, which so far count for more than 70 MW (EnerPoint Website). Enerpoint distinguishes itself from the other competitors thanks to the following characteristics (Ibid):

- Accurate research, selection and sale on large scale of high quality components for PV systems;
- Realization and installation of PV systems;
- Training courses for operators interested in the PV industry;

- Promotional activities for solar power through national and international conventions and events;
- Developments of online communication tools to make private and public consumers aware of solar power.

For our study, however, we take in consideration only the Operations & Maintenance Department of Enerpoint, founded in 2014, in which only 10 employees work. The department does not have any PV cells, the company only sells and then takes care of the cells of their clients (Interview F). The customers are mainly banks and investments funds; therefore, only clients interested in making highest profits without investing too much effort and energy in it. This is the reason why the department takes care of everything, from the administrative part to the more technical one (Ibid). Sometimes, however, the maintenance activities, especially the ordinary ones, are subcontracted to other small companies, represented in the majority of times by electricians; this is done because these people are located in the same area which hosts EnerPoint's clients PV systems, so that Enerpoint can better and quicker answer to their customers' needs (Ibid).

# CHAPTER 6: ANALYSIS

In this section, we are going to explain in more detail what we have found out from primary and secondary data, by sharpening the general overview given in the previous paragraphs about the companies object of our study.

Before gathering primary data from the PV companies, we did not expect that their business models were as described by the interviewees. In fact, we thought to find companies that both produce and install the PV cells, by providing also the service of maintenance and controlling of the energy production. Surprisingly, we have found out that all of them outsource the production of the PV cells, by having a selected list of manufacturer companies from which to choose, depending on the client and on the request (Interviews D, E and F). After buying the product from an external manufacturer, these companies offer to their final clients the service of installation, and then a long term plan for all the maintenance activities, being in charge of the cleaning and reparation of the cells. The companies earn thanks to the markup paid by their clients as the difference between the costs of the service and the price of the same (Ibid).

*The 10% is made from PV systems maintenance, the remaining 90% is given by the construction of new plants. We work both in Italy and abroad, like China, Mexico, Uzbekistan, Switzerland and Ghana (10-15% of total sales). The most important system is the one of Ferrari in Maranello, and also the one of the State railways.* (Interview D)
*We are integrators of solutions: in practice, we go to the customers to suggest different solutions and one of them is precisely the installation of PV systems. First you do the technical design, which should be the installation of the PV system, then the customer gets an economic proposal: if he accepts it, we buy the material and organize ourselves with the manpower to do the installation. So then the system is mounted, started, and then from there we make a maintenance contract, which in most cases is for twenty years.* (Interview E)
*We do maintenance activities and we also assemble installations. The Italian market for residential PV is still going strong.* (Interview F)

In the Context section, we explained that the PV sector has been experiencing a crisis in Italy, especially after the end of the State's incentives program. This means that many companies have already shut down because they were not profitable anymore, as proved by the decrease in the GigaWatts produced, which has halved (Torchiani, 2013). The sector has, therefore, become highly concentrated: all these factors led to a creation of a market full of fierce competitors, that try to gain market shares outperforming the other companies in the sector.

Drones are new technologies produced only by authorized companies; they can cost up to thousands of euros, depending on the model you choose. The cost of this new application concerns not only the drone itself, but also the license issued by ENAC, through which you can make the aircraft fly. This license is given only after passing a physical test based on the eyesight, and on a theoretical exam about all the mechanisms and security norms regarding drones (ENAC website).

All the people interviewed for the PV industry mentioned the fact that, if they ever will make a big investment for the service offered by drones companies, the time spent on inspections would be much less, therefore also the costs of the whole operation would be reduced. In fact, by using the drone, it is possible to know the exact point of the malfunction, which is impossible with the current software, since this would have just identified the damaged string and not the precise point of the malfunction. In this way, less people are needed to fix what is wrong, and a team constituted by many employees is unnecessary to locate the problem (Interview D, E and F). However, the interviewees have never taken into account these employees that would not be necessary anymore, the ones whose job is replaced by the drones. We deem this finding to be especially true, since during the interviews we did not ask a specific question about employees' layoffs; by doing this, we would have channeled the topic too much. This would have created a bias in the responses given to us; the interview would have been too structured and the answers too piloted.

*The idea has never been deeply examined, given the high costs of the service. The operator, which identifies the fault manually, takes a little longer but costs much less. In itself, the drone service is very useful.* (Interview D)
*On ground facilities it could be convenient, because they are systems that take up a lot of surface. A drone speeds up the analysis by giving an overview from above, instead of having one or more persons to analyze every single panel.* (Interview E)
*The drone is a great way to monitor a PV system from above through thermography: if done by hand, this activity has a high hourly cost. With drones, instead, it allows me to instantly locate hot spots, where the modules have problems.* (Interview F)

During the interviews, we also came to know that sometimes the activities of Operations and Maintenance (O&M) are outsourced to local companies (Interview D, E and F). In particular, when the PV systems are located in the nearby of the PV company, the operations are done by internal employees; on the other hand, the operations are taken care of by external professionals, if the installation is far from the company headquarters (Ibid). The former phenomenon described is the case of internalization, meaning that it is the PV company itself that does the whole work; otherwise, we would talk about externalization or outsourcing. Another factor that can influence the choice between the two options is the complexity of the activities: for the ones that have a high degree of complexity, like the extraordinary maintenance activities, the PV company would rather internalize the process, otherwise an externalization is possible for ordinary activities, such as the cleaning of the cells and the simple changing of a fuse, inverter etc. (Ibid).

*We both outsource and let our employees do the job, it depends on the type of operation and the place of intervention. Sometimes we call electricians or companies specialized in the cleaning of the facilities. Generally, for extraordinary administration activities, we prefer sending our employees on-site, while for most of the routine activities commonly we call external companies.* (Interview D)
*We have both employees and outside contractors. To be closer to customers' needs: especially for trips to distant cities, if you just have to replace a fuse, which is a trivial operation, it is inconvenient to send a person from our town to get to the destination.*

*For this kind of operations, we rely on third parties who are located in the same city of the PV system to be repaired.* (Interview E)
*The electrical maintenance is carried out by employees, with the exception of installations away from headquarters: in this case we use subcontracted labor. The control is always under us. Other activities such as monitoring or cleaning modules is subcontracted, apart from the case of a large facility where a dedicated employee also cuts the grass.* (Interview F)

If the company starts to use drones for monitoring activities, there will be two possible scenarios. In the internalization case, drones are going to replace the job done by internal workers, thereby leading to potential layoffs within the company. In the outsourcing scenario, instead, drones companies are considered to be competitors of the external worker manually checking the PV system. In fact, drones map the whole installation, identifying potential issues in just one glance, while the external company does the same job, only with longer timings, since humans are not able to create a complete mapping of the system with just a single check. However, the human workers will not be replaced completely by the drones, since the actual reparation or maintenance activities should still be done manually.
The match between drones and PV systems can be considered an innovation: this is a relatively new application and it totally changed the way in which the screening and the monitoring of PV systems is done. In fact, both with drones and with workers, there is the need of at least two people; with a drone, one is the pilot and the other is the one who controls the operation with a monitor at the ground station (ENAC website); with humans, two workers are necessary mainly because of safety reasons. However, the timing is very different between the two types of the same operation: the drone requires much less time in order to complete the whole mapping. By the way, both timings depend on the PV system size and the number of malfunctions (Interview E). This happens because every time a malfunction is identified, the drone must halt and take a picture, and the same happens with the manual workers who have to diagnose the problems (Ibid).

*If you have the cameras and there are problems, you have to stop at every cell and take a picture. The comfort you get with drones is having a wider overview, because photos are taken from above, and sometimes it is also able to identify the problem. With hand camera, instead, it definitely takes much more time.* (Interview E)

Summing up, the technology has advanced during these years, and it resulted in programming drones, together with thermal cameras, to do the job that once was only done by hand. It is true, though, that most of the companies possess a software that locates the presence of a problem by checking the energy production; however, the problem is not precisely identified both in seriousness and position of the cell/fuse/inverter. In fact, the software identifies the difference between optimal energy production and the energy actually produced (Interviews D, E and F). If this difference is about 20% of the optimal energy production, this is still tolerated and needs no checking activity, because it does not necessarily denote a malfunction of the system (Interview D). It can simply be a leaf on the cells or a cloud that impedes the expected production (Ibid).

*The service for customers is divided into two types: the first is the monitoring (for few customers), the second is maintenance, according to which the PV plant performance should not fall in the first year below 80%. Basically we put on the system some arrangement environmental sensors, which show us how much the facility could potentially produce: from this data, we "allow" to have a 20% loss (often environmental factors, temperature too high, incidents of short circuit etc. etc.). At each higher grade centigrade after 25, the photovoltaic module loses 0.4% of such production efficiency. With the camera and the drones you can identify performance and possible problems of the PV modules. We then give the guarantee to the customer that the PV system produces a total of at least 80% of its maximum potential capacity, offering routine maintenance and repairs.* (Interview D)

*We have a daily monitoring for PV systems via a remote connection. So, either by the ADSL of the customer or through the installed SIM card of the modem, we have the ability to connect at any time on PV systems, and see if there are active alarms or whether the plant is producing energy properly. Obviously, this thing has been*

*automated through a dedicated software, and therefore we are not we going physically to see if there are problems, but there are some sensors that run and send automatically emails or SMS if something is not working properly.* (Interview E)
*Our monitoring system allows you to identify the faulty strings, in blocks of about 24 panels. From this data, the maintainer can understand where the problem lies. The process is fairly straightforward once you get the email of the malfunction: it identifies the area and action is taken immediately.* (Interview F)

In light of this, it is clear how drones can be an effective innovation that can help PV companies in increasing hourly productivity in monitoring the PV systems. However, the awareness of this new application of drones for civilian use is low (Doxa Marketing Advice, 2014). This is the reason why, often PV companies do not make any investment for this service, since they do not even know well how the service works. Three out of three of the PV companies interviewed, in fact, told us that they knew about this application; however, they never formally contacted a drones company to ask for prices and estimates (Interview D, E and F). On the other hand, not only the drones are not well know from the companies, but also they have a perception that the costs are too high compared to the service offered (Ibid). They do not deny the usefulness of it, stating that the reduction of activities time can lead to an increasing productivity (Ibid).

*The idea has never been deeply examined, given the high costs of the service. The operator, which identifies the fault manually, takes a little longer but costs much less. In itself, the drone service is very useful. For a 1 MW facility approximately (10000 MQ around the implant) it takes about 2-3 days and about 800-900 euro to locate the fault manually: in my opinion, even though I never asked for a quote, with a drone the cost could skyrocket to at least 3000-4000 euro. (Interview D)*
*As I understand it, it is not that simple: the costs are quite high, and particular knowledge is required for piloting them. As for now, we only have had a preliminary and cognitive meeting, nothing important.* (Interview E)
*The doubt stays more on the economical side, and not on the advantages of time that a drone offers. Also, you must have a person able to read the report that the drone produces, and a person who knows how to fly it.* (Interview F)

However, the interviewees explained how there are also downsides with the use of drones for monitoring purposes (Interviews E and F): in particular, there is the need of a pilot, who must have a certain set of skills to fly the aircraft. One of them mentioned also particular skills in order to be able to read the results of the report, which the drone produces (Interview F).

*Another problem could be represented by the inverters, in which case the drones are unable to give their support, because it is an electrical problem.* (Interview E)
*Also, you must have a person able to read the report that the drone produces, and a person who knows how to fly it. The downside is that, while the operator works and finds something, he can solve the problem right away; with the drone, this process becomes more laborious.* (Interview F)

Summing up, the companies interviewed were very skeptical about the use of drones, because the employees could not grasp the opportunity of profits.
From the interviews, we understood that all the PV companies have a similar business model, that differs only for the numbers and the entity of clients (they can be private companies, public owned firms and investment banks etc.) and the territory in which they operate. In light of this, it is possible to state how the introduction of drones in the business models of PV companies would change it in the same manner for all the companies. This means that, from the use of the specific software to monitor the functioning of the cells and the use of manual worker to find the particular place and entity of the malfunction, the changed part of the business model would consist of making a drone fly all over the installation area to find the problem and understand the seriousness of it. This would be done by outsourcing the service, and not by buying a drone, because of the too high bearing costs, both for the drone itself and for its license.

Most of the PV systems are positioned on rooftops and hills; the former are considered critical areas, since they are located in zones where people and houses are present, the latter are considered to be non-critical. Therefore, the drone must follow different rules and regulations, depending on the area it flies on; not only the drones, but also the pilots

need to have different authorizations, and they need to ask for one to ENAC for both critical and non-critical operations.
We can now see how technology is gaining such a central role during the past years; in the case under analysis, this happened first with the software that can control and check the energetic production (Interview E), then with the drone that can check if there are any problems on the PV cells and make a mapping of the whole system.

The drone is becoming very important in this kind of operations, not only because of time saving issues, but also because it is inextricably linked with the pilot. In fact, drones and humans are becoming intertwined in just one thing: the one cannot work unless also the other is there.

# CHAPTER 7: SYNTHESIS

In this chapter, we are going to link the theoretical framework we have built with the empirical one we have described in the analysis chapter. We will then underline what is new compared to the theory, by describing what we have found out from the two frameworks, and the differences between the model we set up and the reality.

What we have found differing from the literature is that companies in the PV field would actuate change just because of Profits (Interview D, E and F). But profits are just one of the three reasons for changing a business model, outlined in the paper by Vives and Svejenova "Business models: towards an integrative framework" (2011), i.e. People, Passion and Profits. People are considered by the authors as a social value to follow; however, all the companies interviewed do not take into account neither this source of motivation, nor Passion, described by the authors as a vocation or a calling (Ibid). Furthermore, since all interviewees have the same vision about the reasons to change, we deem this fact to be valid because of triangulation principles.

Moreover, Beer and Nohria, in their paper "Cracking the code of change" (2000), affirm that taking the initiative of changing a company's structure and organization is nowadays vital if the company wants to compete with its rivals. Managers, therefore, need to deeply understand both the nature and processes of change (Ibid). It is for this reason that the authors coin the terms theories E and O, to help companies to act in the best way during a change process. Beer and Nohria (2000) affirm that usually changes based on economic values, described by theory E, and changes based on organizational capabilities, explained by theory O, happen in tandem. Only by successfully combining both of them, the result of the change process will be positive. However, the interviewees in our case, while talking about a potential change with the introduction of drones, only mentioned profits and costs advantages (therefore theory E), instead of changes in organizational skills and employees' capabilities (theory O).

In order to create a competitive advantage, it is not always enough to change in the business model and/or in the organization, but it is also important to formulate a business model, which is coherent with the company's strategy. This is what Teece suggests in his paper "Business models, business strategy and innovation" (2010). The

author, in fact, states that “coupling strategy and business model analysis is needed to protect competitive advantage resulting from new business model design” (Ibid). It is also true, though, that the application of drones on PV systems is easy to copy, because the drone is not something born inside the company. In light of this, it is easy to understand how, by coupling competitive analysis strategy with business models, it is not always possible to protect a company's competitive advantage, although Teece (2010) says otherwise; in the case of outsourcing the service of drones, we deem that the business model of a company can be copied more easily, making the company lose its competitive advantage, owned thanks to the first mover tactic.
Teece (2010) also explains the so-called *opacity* of business models, “that makes it difficult for outsiders to understand in sufficient detail how a business model is implemented, or which of its elements constitute the source of customer acceptability”. In the case under analysis, we are of the opinion that this opacity does not exist: PV companies would just acquire the service of drones from external firms, which makes the business model more likely to be copied.

Since the drones service would be externalized, all the companies in the market could use the same application, leading to an annulment of opacity of business model, and therefore also of the competitive advantage. In this scenario, the competition will become very fierce, since all the competitors would possess the same know-how and characteristics. This is the reason why, we are of the opinion that the PV industry can be described as a *red ocean,* by using Kim and Mauborgne’s words (2009). A red ocean, in fact, is a very competitive market, where competitors, called sharks, are fierce and the possibility of being bitten by them, therefore turning the water bloody, is high (Ibid). This is exactly the situation the PV industry is witnessing, especially in Italy, after the crisis in this sector.

Furthermore, if the activity of maintenance is outsourced, meaning that a PV company buys the service from a third party, there is a change in the supply chain of the PV company itself. This is exactly what Zott, Amit and Massa say in their paper “The business model: recent developments and future research” (2011). The situation we are studying is what they describe as an industry model, i.e. an innovation in industry supply chain, since with externalization, the suppliers are going to change: from people in charge of checking manually the panels, to drones companies.

If, on the other hand, the process is internalized in the business model of PV companies, meaning that a PV company uses its employees for checking and maintenance activities, then employees layoffs would be necessary, since the job could be done faster by the machine, thereby substituting human workforce. Beer and Nohria (2000), when talking about theory E, describe properly this scenario, which consists of economic incentives, drastic layoffs, downsizing, and restructuring as a possible scheme for business change.

Out of the three employees interviewed for PV companies, all of them told us that they are not well informed about the use of drones for PV panels monitoring purposes, and also skeptical about this application (Interview D, E and F). They basically do not know or they are not able to see the chance of profits that could derive using such technology, compared to the relatively high costs of the service (Ibid). The situation just explained is what Chesbrough in his paper "Business model innovation: opportunities and barriers" (2010) calls a *cognitive barrier*, meaning that the management is not able to see the opportunity of profits within the environment in which the company operates.

Another issue that we came to know through the interviews was that drones are too expensive, and in order to be flown by the pilots, these need a specific driving license, issued for the Italian territory by ENAC (ENAC website). The fact of having a specific license leads to discrimination towards the people who do not possess it: this is well described by Orlikowski in her paper "Sociomaterial Practices: Exploring Technology at Work" (2007). The phenomenon of discrimination is a relatively new one, which started only with the advent of technology and broadened with the increasing role of it. In light of this, it is easy to understand how important it is to take new technologies into account when talking about companies, since organizations are increasingly constituted by multiple, emergent and interdependent technologies in continuous development (Ibid).

Also Callon, in his paper "Economic markets and the rise of interactive agencements: From prosthetic agencies to habilitated agencies" (2008), takes into account the increasing central role of technologies, by introducing the concept of *socio-technical agencement*. He states that every action is distributed and "all the entities contribute in their own way to the collective action that consequently consists of a series of ordered acts" (Ibid). This is what happens in the case in which the drone is flown by the pilot during the monitoring activity, since none of them can operate without the counterpart.

Also Damanpour, in his paper "Organizational complexity and innovation: developing and testing multiple contingency models" (1996), talks about technology to give a definition of innovation. This is a very broad definition, which encompasses also a new type of service and new process technologies, which is what drones can offer. In fact, innovation is described as "a process that includes the generation, development, and implementation of new ideas or behaviors" (Ibid), like the one of substituting humans with the machine.

What Damanpour described as innovation, can lead to a change of a business model phase, that is what Vives and Svejenova (2011) describe as a change in the business model. Vives and Svejenova, in their paper "Business models: towards an integrative framework" (2011), in fact, differentiate between change *in* the business model and *of* the business model. The empirical case we are studying can be clearly classified as a change in the business model, since with drones there is a change in just one phase of it, i.e. the one concerning the checking/monitoring activities. In our case, in fact, there is no change of the business model itself, which would have meant a variation of the "overall logic of the enterprise by questioning and/or transforming the guiding motivation" (Ibid).

Also Malone et al., in their paper "Do Some Business Models Perform Better than Others?" (2006), talk about business models. They describe 16 detailed types of business model by matching two dimensions, i.e. the types of rights being sold and the assets involved (such as physical, financial, intangible, and human assets). The one closest to our empirical framework is the one called wholesaler/retailer, in which, following the authors' definition, "the organization buys and sells physical assets" (Ibid). However, this structure does not exactly explain the business model of PV companies already described in the analysis. In fact, in our case not only the company sells the product, i.e. PV cells, but also a long term service concerning the maintenance activities (Interviews D, E and F). This is the reason why, instead of choosing to describe the business model through Malone et al.'s definition (2006), we have chosen to use the definition provided by Gould et al. (2013). In their paper "Business model – background paper for integrated reporting", they describe business models as constituted by the following four elements:

- Inputs: PV cells and the know-how of how to install a PV system and how to monitor it;
- Business activities: selection of PV suppliers and installation of the PV systems;
- Outputs: monitoring and O&M activities;
- Outcomes: production of solar energy, and then the selling of this energy to a third party or the keeping of it for their clients' auto-consumption.

Gould et al. (2006) also mention the fact that, not only internal factors are important in analyzing and creating a business model, but also external factors should be taken into account. In this matter, PESTLE analysis can give a detailed overview of what Gould et al. (2006) call external context. Following, we will take into consideration each factor of this analysis, and explain it:

- Political: incentives from the State for the PV installations;
- Economical: the PV installations are decreasing in number, because on one hand, clean energy is good for the environment, but on the other hand, companies cease to exist when they are not profitable anymore;
- Social: the increasing awareness of the cleanliness of solar energy, opposing to global pollution, global warming and the ozone hole;
- Technological: drones and the remote control of them, thermal cameras that can be installed on the drone directly, the monitoring software for energy production that is becoming more obsolete with the introduction of drones;
- Legal: ENAC legislation, not only concerning the rules of each area to fly on, but also the licenses issued;
- Environmental: the impact that the solar energy has on the environment, greener energy compared to the one coming from the oil or fossils.

# CHAPTER 8: DISCUSSION

In this chapter, we are going to analyze the reasons behind the differences and the similarities of what we have found out while comparing the reality with the theories. We will outline all of these reasons, linking them and showing causality, while giving an explanation for each.

Vives and Svejenova (2011) mention People, Passion and Profits as the three main reasons to initiate change. Looking at our case, we deem this theoretical framework to not be a perfect mirror of reality, especially in the PV sector. We have found several reasons behind this difference: first of all, PV companies are profit-making businesses, therefore they need to be profitable in the market if they want to continue their activities; so it is easy to understand how the management will look first at profits before initiating any kind of change. Secondly, the companies we have taken into consideration are not companies founded by a charismatic person, moved by philanthropic reasons, who identifies her/himself with the company, so that it would have been more plausible to face a change driven by Passion and/or People (Vives and Svejenova, 2011).

After analyzing the root cause of change, it is important also to consider the mechanisms of change. Beer and Nohria (2000) outline two main theories of change, i.e. theory E and O. The authors affirm that generally these kinds of change happen in tandem, through either through sequencing or simultaneously application, thereby raising profitability and productivity. In our example the situation is different: so far, the companies have not actuated any kind of change in regards of drones; but while talking about this topic, the interviewees never mentioned a change in employees skills and in organizational culture to successfully conduct this change process. We are of the opinion that this situation is led by the low level of awareness about drones; people do not exactly know how to change their internal skills and organizational structure, so probably this is the reason why they did not talk about this kind of change. On the other hand, Beer and Nohria (2000) also affirm that the two kinds of change can also happen in sequence; probably this could be the case. In fact, theory O can be actuated eventually, once the company acquires the right awareness and know-how about this new application. However, it is also true that this represents a problem, because if managers do not see the benefits and cannot understand the mechanisms behind the use of drones, they will not seize this new opportunity given by drones.

The low level of awareness about the opportunities drones can offer leads also to the creation of what Chesbrough (2010) calls cognitive barrier. This happens because of the fact that the civilian use of drones is a relatively new application, and there are not so many companies that are offering this service at the moment. Furthermore, the majority of them are very little, as reflected also from the interviews (Interview A, B and C), so much to be considered niche companies; they are not doing any particular and specific marketing campaign also because their core business is not offering the service with thermal camera on the drone for PV companies, but rather artistic shots and 3D modeling for Airvision (Interview A), topographic surveys for Technical Study Mantovano (Interview B), and photogrammetry for Nimbus (Interview C).

After describing the core business of drones companies, the following paragraph will focus on the business model of PV companies. In this matter, Malone et al. (2006) describe 16 different types of business model; none of them, however, is actually fitting the business model of the PV companies we interviewed. In fact, in our case not only the company sells the product, i.e. PV cells, but also a long term service concerning the maintenance part (Interviews D, E, and F). In fact, from the interviews, we got to know that the main source of profits is not the installation of cells itself, but rather the maintenance activities provided after the sale of the panels (Ibid). With these premises, it would not have been logic to offer only the service of installation of the panels.

The implementation of drones in a new field, such as the monitoring and screening of PV panels, can create a new and more effective business model for the PV companies adopting this new technology, mainly because of time reduction benefits. However, if a company, instead of outsourcing the service, decides to buy a drone and therefore bear all the costs related to the license and permissions, it would experience a reduction of costs only in the medium-long term, since for the very short run the big investment of buying a drone is a big liability. In fact, once having bought a drone, the company can decide by itself when it is the right period to use it, without following drones companies timetables. This means that the company, by buying a drone for its checking activities, would be more flexible regarding clients needs and unplanned circumstances, even though the costs at the beginning would be very high. On the other hand, instead, the other cheaper and more feasible option would be to just outsource the drone service. The evaluation for choosing either one or the other option depends on several factors: these can be cash liquidity, distance among PV headquarters, installations and drones companies, the type of clients of the PV company, the degree of needs for periodic checking activities, the service the PV company promises to deliver through the contract etc. This is an example of how to couple the business model with the strategy of the organization. Teece (2010), concerning this topic, asserts that by coupling together these two elements it is possible to protect a competitive advantage. However, in our case we do not think it is totally true, because since the activity is outsourced there is no specific know-how that the company can defend and internalize in order to outperform competitors. As for now, it is only an outsourced service that can be bought from every company without necessary creating a protection for company's business model; this is why we deemed Teece's theoretical framework (2010) to not be truthful in our case.

Furthermore, Teece (2010) talks also about opacity of the business model to defend company's competitive advantage. We deemed this to be not true in our case, since the technological assets, i.e. drones, could be considered as a tool which does not allow competitors to copy a company's business model only when the drone activity is internalized. In light of this, it would be difficult for other competitors to have the same know-how and technology of this type of firm. However, in our case the drone service, if adopted, would have been outsourced, which means that it is not protected by copyright, but instead offered by specialized companies. Therefore, a PV company can buy this standardized service without possessing a specific drones know-how and thereby without creating a real defendable competitive advantage.

Through outsourcing the drone activity, PV companies will experience a change in their supply chain, in particular among their suppliers. This is the reason why we are of the opinion that the PV industry will most probably face what Zott et al. (2011) call industry model. However, as for now, it is true that the new application of drones is changing the supply chain of the single firm which has adopted the drone service suppliers; but with time, we deem this change concerning the suppliers will be spread all over the PV industry, since this new application is very advantageous in terms of costs, so much to be seen as something that will soon be adopted by every single firm in the sector.

A change in the supply chain as just described, could be interpreted as a change in the business model of PV companies. Vives and Svejenova (2011), in fact, distinguish between change *in* the business model and *of* the business model. They state that a change in the business model happens when "elements of design and functioning are transformed with different degrees of disruptiveness, and innovation" (Ibid). A change of the business model would not be possible in the case analyzed in our thesis; this would have meant changing the business model entirely, but drones cannot do the work that is done now by the electricians and/or internal workers (Interviews D, E and F). In fact, it is impossible for drones to replace a fuse or a panel, thereby making the phase of the business model of fixing the problem impossible to be wholly replaced by the machine. Drones can only substitute human actions in the phase of checking the PV systems, and therefore we can talk about a change *in* the business model, since only the maintenance phase would change instead of the whole activities process that leads the company to make profits.

It is clear how machines have been substituting the work earlier done by humans. Also Orlikowski (2007) talks about the discrimination created by the machines and we affirm that this is true also in our case, since in a certain way drones discriminate among humans. The license to pilot a drone, in fact, is given only to people that fulfill certain requirements concerning physical characteristics, like for example the sight level (ENAC website). To be able to get the license, a person has also to be at least 18 years old and has to know air rules; for this last matter, a civilian flight certificate would be enough, in fact many schools dedicated to this are being built in recent years. One has also to have been trained with the specific drone he will be using. Once got the license, a person can start to operate with her/his drone by previously asking for a temporary permission for the specific area (Ibid).

Moreover, Orlikowski (2007) deems also the technology to acquire an always more central role within organizations and this is reflected also in our case. Before the new application of drones, in fact, PV companies used (and most of them are still using) a software as a technology to check potential malfunctions; this software reveals the energy production of the whole PV system, differentiating only by strings, that can be constituted by more than ten panels each (Interview E). With the use of drones, checking activities are becoming more and more accurate, since, thanks to the thermal camera arranged on the drone, it is possible to identify a malfunction on the single cell instead that only on a whole string, and it is also easier to pinpoint the root causes of the problem rather than the only presence of it (Interview E).

The central role that technologies are acquiring nowadays is also described by Callon's concept (2008) of socio-technical agencement. While flying, the technology, i.e. the drone, and the humans, i.e. the pilot and the assistant at the ground station, become a single entity, since the drone cannot fly without pilot's commands and the pilot cannot conduct the activity required without the machine.

Lastly, we mentioned in the analysis the fact that the PV sector, especially in Italy, during the last years, has been witnessing a crisis; since the Government is not giving subsidies anymore, many people have been laid off, and many companies shut down their activities (Qualenergia, 2013). Therefore, the number of companies still present in the sector has become much smaller than it was before: this led to a creation of what Kim and Mauborgne call *red ocean*, in their paper "Blue ocean strategy" (2009). We deem that this industry has always been a red ocean, especially during the incentives and boom years: it is still one now, because only the most profitable companies can survive, since the market gets smaller and smaller in size. In these conditions, as the authors say, a company can survive only by outperforming competitors; this can be done only by the biggest companies, since the smaller ones do not have enough funds to innovate (for example with drones) and to be at the forefront of this sector.

# CHAPTER 9: DELIMITATIONS

The delimitations in research papers are usually grouped into three different categories, i.e. what the researcher is studying and what not, what are the method procedures used and which not, and what is chosen in the literature review and what not (bcps.org). In this chapter, we are going to explain all of these three categories in detail, and which motivations brought us to exclude for each of the category mentioned.

The first delimitation is given by what we studied and what not, precisely the population and samples taken in consideration. For example, we could have taken in consideration as target market not only Italy, but more in general all the European Countries, since the general regulation about the civilian use of drones is given at European level, so the scenario would have not changed significantly. However, we have chosen to focus only on the Italian market because we found differences regarding the morphology of the land and norms for the PV industries compared to the European scenario, and also because we did not have enough time to conduct such a wide research. Italy was considered by us a good target, because it was the third Country in the World in 2011 in terms of solar energy produced; given the hard times and the crisis faced during the past years, we figured out that with our research we could have helped some of the Italian companies to achieve the levels of production that were reached in the past. Due to limits in time, cost and knowledge, it was also actually impossible to not set up boundaries and delimit our research.

Another delimitation is given by the methods used while getting the data and writing the thesis. However, because of our research question - "How can Italian PV companies successfully implement the use of drones in their business models?" -, we deemed not necessary to conduct a quantitative type of study. In fact, as Yin says in his book "Case study research: Design and Methods" (2014), in contrast to "what" questions, "how" and "why" are more explanatory types of question and are likely to lead to the use of a case study, history, or experiment as the preferred research method. In light of this, no in-depth statistical testing has been used. This was not conducted also because we do not have the right competences to use a quantitative method to create a regression, which would have taken in consideration companies' activities within several years, thereby creating a more accurate model for the generalization of our results. Besides of our lack of experience in using quantitative methods, the companies interviewed were also not willing to provide us with numerical data regarding the drones and the companies themselves. Therefore, because of these reasons just listed, we decided to use for our work only a qualitative method of research. There was the possibility to use also a third method for our study, i.e. mixed method, which is derived by combining both qualitative research and numerical data; however, this method of research is deemed to be very complex, very time and resources consuming (resourcecentre.foodrisc.org). It might also be difficult to implement one method with the findings of the other one, and the interpretation of these findings might be unclear at the end (Ibid).

Given all the assumptions above, we have decided to opt for a qualitative research, since we are of the opinion that it is the most suitable for what we wanted to study. Baxter and Jack (2008) affirm that "rigorous qualitative case studies afford researchers opportunities to explore or describe a phenomenon in context using a variety of data sources. It allows the researcher to explore individuals or organizations, simple through complex interventions, relationships, communities, or programs and supports the deconstruction and the subsequent reconstruction of various phenomena". In fact, what we have done was describing a relatively new phenomenon by considering all the relationships among organizations, institutions, industries and programs (concerning especially the PV sector); then, we deconstructed and reconstructed every single piece of the puzzle.

As third category of delimitation mentioned in the first paragraph of this chapter, we find the literature review. The literature we decided to use focused basically on two major and broad topics, i.e. innovation and business models. This is because of our research question, since it included aspects such as business models and drones. We could have used other papers, for example something regarding transformational change, precisely the ones coming from the mergers and acquisitions literature. In fact, we could have considered the merger of drones and PV companies to create a unique entity, but this was not done. Due to the fact that drones for civilian use are a relatively new application, it would have been impossible to analyze the output of an eventual acquisition by the PV companies interviewed, since at the moment, none of them are even using this service.

# CHAPTER 10: CONCLUSION

In our thesis, we have analyzed how to implement the use of drones in the photovoltaic industry. This market can be described as a red ocean, using Kim and Mauborgne's words (2009); in order to survive, the only solution for companies is to outperform the competitors. This is the reason why we have chosen this industry and analyzed this case, since we thought drones could have been a useful resource for outperforming the rivals, with the downside, however, that if everyone adopts this technology, there would not be any outperformance anymore.

We proceeded by interviewing people both in the drones and in the PV industry, in order to deeply understand their opinions and visions about this new application of technology; we then found, based on these insights, the best way to include drones in PV companies' business models.

We analyzed this innovation through the eyes of Damanpour (1996), Callon (2008) and Orlikowski (2007), getting to know how it is almost impossible nowadays to not rely on technologies and machines, if a company wants to survive in the market.

We then considered the business model, both of PV and drones companies, to understand the most suitable way of using drones. We have done this process by using Vives and Svejenova (2011), Gould et al. (2013) and Malone et al. (2006) theoretical frameworks; these authors, in different ways, talk about business models. The first ones give a general description of business models and of the reasons that lead to change it, the second ones describe the core element of it and the relation with the external environment, and the last ones provide a strict list of 16 distinct kinds of business models.

What we have found out after this analysis is that the change, brought about by the introduction of drones into PV companies business models, is still far to be actuated: the primary reason for this is the lack of awareness that people in the PV industry have about this innovation.

The path is still long, but we can already assert that the best way to adopt this new technology is by externalizing the service. In fact, the costs of possessing a drone are very high: from the acquisition, to the practice course and the license exam, costs are deemed to be too high compared to the benefits deriving from them.

The suggestion of externalizing the service is the one we have arrived to, given the current scenario and legislation; however, also from the interviews done with the people working in the drones industry, we noticed that the legislation about the civilian use of drones is still not so clear. Laws are in continuous development, and they might change depending on new improvements made on drones, which can modify the modalities of flight known today. This situation does not incentivize PV companies to acquire the technology, since, as usually happens in general in each industry and for each uncertain situation, a company does not want to invest money in something with an unreliable future.

However, when the legislation will be stabilized, the use of drones will lead to a huge boost of all the maintenance activities, especially in terms of timing.

We deem our research to be useful for PV companies, because we make them aware of the possibility of differentiation within the sector. This process of differentiation needs to be started immediately, so that it would be possible to exploit the first mover advantage. In fact, although the legislation is not well formed yet, on the other hand, it is also true that PV companies do not need to make a long-term investment by buying a drone, but just short-terms ones, i.e. the externalization of the service when needed.

In this thesis we analyzed the case by using a multiple case study based on qualitative method, since to answer "how" research questions it is better to use a qualitative one (Yin, 2014). However, by combining both methods - qualitative and quantitative - we could have created a more detailed study in order to prove our conclusion. In light of this, it is easy to understand how potential future research on the use of drones in PV companies can give more proofs about the usefulness and convenience of this new application.

Furthermore, as the civilian use of drones is useful for PV industry, the application can be helpful also for other industries; therefore, it could be interesting for future research to see how the new application can influence the other sectors.

Summing up, the answer of our research question "How can photovoltaic companies successfully implement the use of drones in their business model?" is by externalizing the service. At least this is what should be done at the beginning, since PV companies do not have the right know-how yet (Interviews D, E and F) and since the legislation is still in progress (ENAC website). Only after this "trial" period, both for PV companies with the externalized drones service and for ENAC for understanding the most suitable legislation for the civilian use of drones, it will be possible to evaluate how to further proceed. In fact, it would be possible either to continue to outsource the service, or to internalize it, if the conditions will allow it: this means that the legislation will be clearer and the PV companies will have acquired the right know-how and capabilities to use drones.

# APPENDIX

## 1. DRONES COMPANIES

In red you will find the interviewer parts (Silvia and Marco).
In black the answers of the employees.

INTERVIEW A

- Company: Airvision
- Interviewee: Andrea Giorgio

Can you tell me what are your role and tasks in the company just to understand your figure within the company and then I have 9 questions, which may already find an answer in your presentation.
I am the director of the company, which was founded five years ago. At the beginning, the company was simply a service provider with controls in the civil field and then over time we became manufacturers of drones. We design and assemble them ourselves: clearly some of the pieces may be bought from other companies. I take care of both the administrative and the sales department; sometimes also of the design part, and my partners deal with the production, the assembly, the testing and all the rest that is needed. We worked with a solar farm a couple of years ago and the work gave good results. We simply offer the data, we do not make post flight processing. Usually the customer calls us, he just requires the flight with the camera and later he does the analysis either by himself (maybe because it is a company that manages the photovoltaic field or so) or he relies on specialized professionals for this.
So five years ago you founded this company with the goal of providing drones services. But you had already decided to enter the photovoltaic industry?
Yes. Let's say that at the beginning it was more critical because cameras with a little mass didn't exist, so the use of civilian drones was not ready because light things were needed in order to provide a cost effective service.
Are thermal cameras used only for the monitoring of photovoltaic systems?

No, they are also used for inspections for example on the external installations of companies, in certain areas.

So you take care of drones and you use only thermal cameras or also regular cameras? I mean is the product differentiated?

It absolutely is. Most of the jobs are with the regular cameras, then we use thermal cameras, then you can use multispectral machines (especially in agriculture), and then you can also use laser scanner to make three-dimensional measurements in real time.

You have the whole Italy as market?

Yes, the whole Italy.

So the main areas where you offer your services are the photovoltaic and then what else?

Lately, is much more about the technical part, so the photogrammetry, measurements, 3D modelling etc. The more "photographic, cinematographic" part slowed down because in Italy there are rules fro which in some areas you are not allowed to fly. Usually we try to find work in non-critical areas.

As for the customers, what type of customers do you have? Large or small businesses? Can you also indicate an approximate number?

As services specifically for the photovoltaic industry we have worked for a firm that handles 4-5 camps throughout Italy. The company is pretty big and its name is TERNA. We have been called from the agency that dealt with all the analyses, therefore also in that case we only did the measurements.

And it was the only enterprise in PV?

Yes.

Typically the other companies that call you are SMEs?

They are usually technical studies, photographers, videographers, smaller enterprises rather than big ones. Large companies have a problem, i.e. the bureaucratic point of view, it is very difficult to collaborate with them, also because of quality, procedures and so on.

So another question is: what is the most popular service you offer, I mean in which industry you offer it?

There is not a in particular, it is well distributed among photogrammetry, normal photographs, some types of aerial photography.

But not in photovoltaic?

Exactly

Which is the most profitable industry for the use of drones?

If I knew I would gladly tell you! (He laughs). Let's say that the service can be effective in every industry, there is not one who lets you make more money than another.

So even changing the camera does not bring to a difference in price?

There is difference in the sense that if a drone has a thermal camera, we have to rent this type of cameras and this increases the overall costs of the service.

Ok, so you just have the drone, you do not have cameras available; these ones are offered by the customer?

Yes, or they can be rented from a third part.

OK understood. What motivated you to offer your services in the PV industry?

Two years ago people began to talk about drones, and certain operators of installations of photovoltaic panels wanted to know if it could be useful for them to use drones to generate data about inspections.

So you did not do an advertising campaign aimed at the PV industry?

Absolutely no

Can you briefly describe the company's business model: how do you make profits starting from the drone?

We design the drone, build it, and then sell it to technical studies, photographers and other types of operators, or we offer the service to those who contact us precisely to make photogrammetry, measurements and so on.

And you just offer the final movie, nothing more?

Exactly. We do not have internally or externally the chance to do post-processing. We have however collaborations with professionals who do it but it is not our business.

I got it. We researched how to fly drones, the licenses you need, but we did not understood what is the specific registration and authorization one needs to be able to fly a drone. Can you explain this thing that it is not very clear to us?

I'll try because it's not really easy (he laughs). So basically there are two types of areas in which you can work: critical areas and not critical areas. The difference is that the non-critical areas are those where there is no group of people, roads, harbours, industrial activities, also photovoltaic fields in theory, that is, all those areas that may potentially be dangerous for people. For these non-critical areas, just a self-declaration has to be sent to ENAC, Italian Civilian Aviation Authority, along with the manuals of the aircraft, the certificate of medical examination and the certificate of the mandatory theoretical course.

Is it a theoretical course online?

It can be done either online or you can go to the authorized flight schools; it is a course of 33 hours on the rules of the air, where it is explained what it means to fly a means in the air. Once this is done, and also the medical examination is done, you have to fill in the manual of the drone, the operations manual and a series of other documents, and then you have to send these documents to the ENAC. ENAC receives the documentation, checks if there are mistakes on the form and substance of the documents, and only then you can be inserted in the official register (that can also be consulted online) on the website of the ENAC. With this type of certification, you can then do all the operations in non-critical areas without asking permission again. You can just do it everywhere.

This authorization has an expiration date?

No, but every year with the new regulation a kind of a report must be sent, about flying hours, about what has happened. We have to keep a historic of flights.

For critical areas instead you need to contact the ENAC; then a very long and very expensive process begins (which has currently not been made yet except in very specific cases) and once the ENAC estimates that the documentation is valid, then at that point it authorizes the use of drones.

Authorizes the person or area?

Authorizes the person to fly with a specific drone as for now.

Later it can operate in any critical area?

No, only in the critical area for which it has been enabled. For example, if you send a request for authorization for an oil facility, then you can fly on all oil facilities or other systems with conditions similar to those for which I have requested and have been authorized to fly over. Only with the drone and the person for whom they have authorized us, however.

Last question: how is your company structured? How many people are there in the company and who has which background? Are they engineers or economists?

We are in 5. There are engineers and people with 20-30 years of practical (rather than theoretical) experience in the field of drones. We have no economics experts.

Ok understood. I want also to ask if it is possible to do another interview with another person in your company?

Of course!

That is really kind of you. If we can keep in touch via email, that would be great. Of course at the end of the process we will send you the thesis; however, it will be in English. Thank you very much for your time! Goodbye and thanks

Goodbye to you and thanks of the interest! See you soon.

INTERVIEW B

- Company: Studio tecnico Vincenzo Mantovano
- Interviewee: Vincenzo Mantovano

Can you describe what is your role within the company and the tasks that you have?

I am Vincenzo Mantovano, I have a technical studio, I am a surveyor, and my organization regarding drones consists of 2 APR, one fixed-wing (aircraft) and an esacopter (6 wings). The APRs that I posses, have different purposes. The esacopter with vertical take-off has more features as it has a standard gimbal, several sensors can be located on this esacopter and not on the plane that mounts a single sensor camera. The organization consists of me being in charge of flight operations and two authorized flight attendants (they also have a culture regarding the operation and the use of drones, but do not have the license to fly drones, so they cannot use them in critical areas).

So you are in charge of all the management and the flight of the drones?

Yes

I understand. So first question: when was the company founded and when did you start to be interested in drones?

So I started working with drones towards the end of September 2014, when I realized that it was something on which it was possible to invest. In November 2014, I obtained a license (authorization for the use of drones) and in January 2015 I obtained at the company FlyTop in Rome the training for the practical use of the drones.

This technical study has been founded before 2014?

Yes, it has been almost 20 years, since 1995.

What kind of employees is there inside your study? What kind of education did they have, are they surveyors or do they have a different background?

They are intern surveyors; they are doing the training at my studio. I hope that in a couple of years they can make the qualifying examination to be registered on the professional register and work as freelancers.

So you offer the service with the drone. How does this service work? The company contacts you or you go around to hear if there is need of your service?

We do many conferences, workshops, participate in trade fairs to advertise our service: as always, the company offers professional services, so we do not shoot, make photos or videos, but we use thermal imaging sensors, spectral cameras with very high resolution, we do aerial photography, cameras for thermographic surveys, and the use of spectral camera for the vegetative index. As for the companies, I believe that one can use his knowledge through various channels; I am a member of AZOR PASS, I publicize our products through advertising, knowing various companies, knowing the various companies that deal especially in certain sectors, and geological studies, agronomists or thermal imaging operators, so we have contacts with several companies in more fields.

So, when a company comes to you regardless of the industry in which it operates, what do you do? Give an estimate, make an inspection, how is the process?

An inspection is made to see if the photovoltaic system is part of some critical areas, inaccessible areas, in areas that need certain NOTAM issued by ENAC. A first inspection is then made to see if it is feasible to fly the drone, then you acquire all the permits necessary if you want to work in the woods the authorization by the forester guard is needed, on an archaeological site the region needs to give you the permit, we must have the authorization of those who have a say in the area to be surveyed.

The inspections for the feasibility of the flight are made on-site or through Google maps?

They have to be done on-site because Google maps does not give you any obstacles like the Enel pylons, hill slopes, obstacles that may make flying dangerous, both for the operator and for the pilot and for those who assist, also for homes, vehicles or it can damage third parties. First you establish the both civil and criminal factors, then you give an estimate.

What are the timings from the moment the company comes to you and asks for the service to the estimate?

If there is a need of a NOTAM issued by ENAC in particular areas, ENAC takes about three weeks to issue it. It is granted for a given day for a certain time.

What if there are bad weather conditions during time set?

You must request a new NOTAM and wait for other three weeks. ENAC will send a dispatch to all those airports and warns that are in that area and in the volume of air in which there will be air operations in progress, so that all aircrafts that intersect the area are warned.

What are the areas where you offer your services in?

The sectors are the aerial photogrammetry, so using the sensors with camera in scale RGB (Red-Green-Blue) color for quarries, landfills, and to calculate volumes or to have a state of affairs, or to detect the conditions at a given time. It also serves to determine if there are abusers in progress, to date a certain area at a given time, then we create a database with a GIS system of what could be a building site or an industrial zone for example. Another area in which we use drones is the multispectral one, consisting on the use of a particular sensor (called multispectral) that detects the infrared, the ranges of red green and near-infrared.

For this kind of services, what kind of companies can call you?

We have research companies, so universities which study the evolution of plants and agriculture, biodiversity, how certain plants respond according to different climatic conditions, or even, for example, today there is the paulownia which is a shrub that, if worked in a certain way, can be replaced to high strength materials, can be substituted at the basic materials, ferrous, and then to steel: it has the very considerable mechanical resistance to traction. Whereby we offer the service also to monitor the progress of paulownia with photogrammetry to understand the degree of development of the plant and with the use of multispectral to understand the state of the plant to see if it is deficient in certain fertilizers, if you have special conditions parasitic, then holding to monitor what might be defined agricultural purposes. The production can also be increased, for example, in the vineyards: the multispectral survey will help to identify whether some areas of the vineyard have greater shortage of fertilizer or are attacked by pests; we identify these conditions with a prescription map what is the vegetative state of the whole sector of the vineyard. This detection will then be transmitted to the agronomist responsible for the system, and it will be up to him if to do a site visit and see what that particular area is lacking of to increase production.

So in summary photogrammetry, multispectral and thermal imaging.

Exactly. We use thermal sensors, which detect video and temperature data.

And which are the companies that offer this service?

They can be photovoltaic companies. The drones can also be used to detect environmental pollution, in groundwater, in rivers, and in all the areas where it is possible to detect a temperature difference.

Even in the wind industry?

It is possible to detect the micro-cracks on the ridge of the blade due to the temperature difference between the slit and the one on the surface part of the blade.

As for environmental pollution, which are the companies demanding these surveys?

For example here in Puglia there is a public company called ARCA: it is a branch of the ministry in charge of environmental monitoring, and pollution of groundwater.

What is the most popular service?

As for now, the multispectral surveys, because we have a collaboration with the university Tuscia, that has a specialization in agriculture, they do a lot of research and have a great need of the service and the sensors that we offer since they have none.

Could you tell me which is the most profitable industry in terms of sales and costs?

Since in Italy there are many photovoltaic systems, I think that the PV industry will be the major source of income. As for now, however, the practice of using drones for photovoltaic system monitoring is not widespread.

How many customers do you have?

As for now still nobody in the photovoltaic sector, because they are very skeptical in our area about the use of drones for monitoring their facilities. Obviously we gave some estimates, did some tests to open the eyes of the companies that do not yet know about useful applications of drones that can be exploited to their advantage. So we're trying to break the wall of distrust that exists in the use of APR.

Customers using the most of our services are currently quarries and landfill sites with the service of photogrammetry, because in our area there are many.

Do you have an indicative number of how many customers you have?

Seven quarries for photogrammetry.

And in general?

A total of fifteen, including universities. In our area there is a lot of skepticism. We have ongoing relationships with all customers. We are in fact also founding a start-up with the university TUSCIA, specializing in photogrammetry of precision, i.e. with the use of multispectral camera.

So you have never worked in the photovoltaic industry?

We ran some tests

Why did you decide to undertake this service in the PV sector?

It is actually just one of many services that can be offered with our cameras. So it was not a choice only for PV; thermography embraces a wide range of services, everything where it can detect the temperature difference. For example they can detect leaks in blast furnaces.

If you could get into the PV industry, would you see it as an area easy to penetrate?

Monitoring PV systems is easy standing on the plains.

So, in short, there are no obstacles?

No. At least those systems which are not put on the slopes. The flight would be standardized, there is no difficulty in planning here, except in special areas which need special permissions.

Can you explain how to become a licensed operator for the flight of drones?

As for the operation of licensed pilot, you must first obtain a certificate of qualification as a pilot in a flight school authorized by ENAC. After attending a special course and having passed a final test, you will receive a certificate. After the certificate, you must obtain a medical certificate with psycho-physical tests for using airplanes. After that you buy the drone, authorized by ENAC, the manufacturer shall be authorized for the production of drones, and this binds the drone directly with the pilot. Because the pilot can only fly an APR on which he has authorization.

Once you do this, you have to send documents to ENAC, so all the self-certifications, risk assessments, manual of operations, and the compliance with ENAC regulation.

Can you buy drones even if you do not have a patent?

Absolutely not, because you cannot fly. Legally you cannot buy one without a patent.

The differences between an aircraft and a drone is the presence of a sensor (so the profit-making use of the APR, not for fun) and the issue of an authorization to fly. Beyond the airfield and the areas known as non-critical, you are not allowed to fly an aircraft, or drone, as a matter of safety.

What is the difference between critical and non-critical operations?

The non critical ones are in an agricultural area, where there are no people or industries and no homes, away from infrastructure like roads, airports, railways and so on.

Do you have the qualification for both areas?

No, only for non-critical areas.

What changes in critical areas?

The authorization shall include a risk assessment different from the one used in non-critical areas. Also the risk scenarios change, and drones must be equipped with a DATRON cable (a type of cable that has a high tensile strength).

The path for the patent is different?

No, it remains the same. Once you are recognized as operator by ENAC, it is only the permission that changes depending on the areas in which you want to use the drone.

What changes? Is it more expensive, the process longer?

It is more expensive because the insurance covers different damages, and the authorization needs to be repeated every 6 months.

And for non-critical areas?

Flying on these zones is always allowed. The permit is released on self-declaration.

But earlier you said that you have to request to fly in a certain area…

If you want to fly over the dangerous zones. Even if you are flying at a distance within 5km away from the airport, there is a need for a NOTAM by ENAC.

Otherwise, if they are non-critical areas there is no need for communication and authorization?

Exactly.

The flight assistant must have a minimum requirement to be considered as such?

The flight assistant does not need a minimum requirement, but he needs to be mentioned in the Manual of Operations which is communicated to ENAC when you self declare and self-certify drones that will be used, and be authorized to operations in non-critical areas. So the flight assistant may be present only in a company that is authorized by ENAC.

What is your business model? How do you make profits?

We buy the drone and make an investment on it, because we as a technical study aim to be innovative and always keep up with technological developments. The biggest problem is that the use of drones should be implemented by our potential customers. Once you digest the fact that the drones can be useful for companies, then our product can really make a profit.

So you have invested heavily on drones and sensors?

Yes, the technical study has two drones and also sensors, cameras, and even a spectral camera leased by Tetracam.

The service you offer is just the survey of the area requested by the customer right?

Yes, our aim and our skills are only extracting data. After that, there will be more specialized operators responsible for data analysis.

This is offered by you as a service or is the customer enterprise who hires a specialized operator?

It depends on who gets the job. If it is awarded directly to our company, we will give the data to people we know to interpret it, and then give the final result directly to the company that requests it. Or, if the company contacts the operator who is specialized in analyzing the data, we will be contacted and we will provide the data that they will have to interpret.

Are more specialized operators who require the data or businesses that require the data directly to you?

I would say 50%

So another question: do you repair drones?

No, we are not manufacturers of drones, we are only operators using drones, authorized by ENAC.

Well, this was our last question.

It was a pleasure.

INTERVIEW C

- Company: Nimbus
- Interviewee: Elena Firmano

Can you briefly describe your role within the company?

I'm the engineer Elena Firmano, I am a business developer within the company.

How many years have you been working in this company?

It is actually from January that I am here (she laughs).

So you are still fresh! (She laughs). When was the company founded and since when do you deal specifically with drones?

The company was founded in 2006, and we have been therefore for 10 years in the drones market.

So it was actually born specifically for drones?

Yeah, exactly.

How many people work in the company and what type of expertise do they have?

Employees are 4 and all of them are aerospace engineers.

How does your company work? Do you sell drones or offer only the monitoring service with drones?

We produce drones, and if necessary, we also offer services for specialized operations to be carried out with our drones.

What kind of specialized operations can you perform?

Monitoring in Green zones, motorways, maintenance of photovoltaic systems: in this we are definitely the leader in Italy.

What is your most profitable business? The sale of drones or the Services?

I would say Services

To which companies do you offer your services? Who are your customers?

It depends, they can be both private and public.

What kind of private companies? Are there any PV companies?

Yes, there are solar companies, companies that deal with the Green areas, railway and motor areas, or anything about security issues, so even the police, fire men etc etc.

Ok. These different services are offered with different cameras or is it a standardized service? With a single drone and a single camera?

The drone is always the same, just the camera changes.

Can you tell me if one service you offer is more profitable than another one?

This depends on the type of operation and on what the customer wants as a result. Each mission is different and is made specifically for the customer. The service therefore suits the type of customer and the type of activities that should be carried out.

Can you explain the regulations concerning the drones in the civilian field?

The Regulation currently in force is the second edition of unmanned aircraft flight, where are precisely highlighted a few key points about the use of drones. The regulation is however still under development.

And what about the division between critical areas and not?

This division still exists. Non-critical areas are those areas on which the drone can fly freely and on which there are no persons or things, while critical are all the remaining areas. So, if you fly on a field, the operation is non-critical; but for example in the city or on PV systems (since they are very expensive), these are critical areas.

So photovoltaic systems are considered a critical area?

Yes, because if the drone accidentally falls on one of the panels, the repair cost is very high.

Ok. Can you operate in both areas?

Yes. You have to differentiate between certification done on the machine and the one done by the pilots. To operate in critical areas, the machine must have special characteristics, such as high visibility; the driver must be authorized to fly the drone in critical scenarios.

How do you get this permission?

Through training centers authorized to fly the drone in critical scenarios and the certificates on the machine that are released and evaluated by the Civil Aviation Authority (ENAC) directly.

For non-critical areas is there a need for this type of authorization?

The pilot must still be trained and the machine must have the characteristics of reliability, but there are no special permissions in this case. You must still apply for a permit on the flight for each operation.

Within your company, all the employees have pilot's certification?

We only have two drivers.

Since you also sell the drone, do you also train your employees to use drones?

No, you need to contact a specialized training center, which trains pilots for both critical and non-critical areas.

Can you sell the drones to anyone?

Potentially to anyone, it is then up to the person or company to approach a training school. We can indicate and suggest some if they want to.

You know how many customers you have and among them who is working in the field of photovoltaics?

No, data cannot be discussed. There are many customers in the photovoltaic, but I cannot tell you an exact number.

How does the service you offer in the PV work?

The drone flies over the photovoltaic system, does field mapping with a camera so to make a more or less in-depth technical analysis possible, depending on the customer's request, to assess how efficient the system is.

So then you also deal with the technical analysis of the data?

Yes, through our partners.

How do you make profits? What is your business model?

Either selling drones, or by performing the service directly ourselves.

And are you also in charge of the research and development phase?

Yes, we design and build within our company and we also deal with after-sales assistance.

Do you have any partners who help you in maintenance activities for any faults detected in the photovoltaic system?

No.

Many solar companies recognize big benefits from the use of drones to detect any flaws in the PV system, but consider the price of the service too expensive. What do you think about that?

Everything relies on the effectiveness of the data that the drone produces. It is the client company which is to assess the risks and benefits of the service cost. The proposed price to the customer is evaluated from time to time, because it varies according to the type of PV system and the time required to acquire the data.

You can tell me the name of photovoltaic companies your customers?

No no no, I cannot do that. It is a sensible data.

I understand perfectly. Well, this was the interview, thank you for your time!

Perfect, thanks to you. Have a nice day!

Goodbye!

## 2. PV COMPANIES

INTERVIEW D

- Company: MyEnergy
- Interviewee: Simone Foti

What role do you have in the company?

I am a founding member and managing director of the company, founded in 2006. As a cumulative turnover size for PV, we have around 100 million euro since 2006. We have achieved about 75 MW of PV systems, of which 25 MW are those of maintenance, divided over one hundred customers (from a few tens of kW to hundreds of kW). The maximum size that we monitor is 1 MW. The service for customers is divided into two types: the first is the monitoring (for few customers), the second is maintenance, according to which the PV plant performance should not fall in the first year below 80%. Basically we put on the system some arrangement environmental sensors, which show us how much the facility could potentially produce: from this data, we "allow" to have a 20% loss (often environmental factors, temperature too high, incidents of short circuit etc etc). At each higher grade centigrade after 25, the photovoltaic module loses

0.4% of such production efficiency. With the camera and the drones you can identify performance and possible problems of the PV modules. We then give the guarantee to the customer that the PV system produces a total of at least 80% of its maximum potential capacity, offering routine maintenance and repairs.

So you also deal with the repair of PV modules?

Not the module itself, but its electric part, which can be a cable, a fuse, an inverter. The module itself, if damaged, must be replaced.

How do you identify anomalies in the system? Do you have programs or do you send people directly to the site?

Usually the analysis is done with thermal imaging cameras on site, to identify exactly the anomaly.

So basically you know that there is a fault, but you are not sure what it is and where it is?

Yes, exactly.

What are the timings for the identification of the problem?

The analyzes can last days or even weeks. The repair can last days, weeks or months.

Are you therefore also in charge of such legal and other procedures?

Yes, yes, we do the part of technical consultants.

Perfect, this was a very long introduction (laughs).

True! Sorry if I spoke too much (laughs).

Let me ask you now; how many employees do work in your company?

At the moment we are 18.

What are their qualifications?

A dozen are technical engineers, then we have an administrative support that follows the auctions and the commercial sector.

How big is the solar system on which you do maintenance?

We have about a hundred plants, ranging from tens of kW occupying 100-200 square meters, to plants that extend to 10-30 thousand square meters, producing from 10-20 thousand KWH per year to 1.5 million kWh per year.

What is your business model? How do you make profits?

The 10% is made from PV systems maintenance, the remaining 90% is given by the construction of new plants. We work both in Italy and abroad, like China, Mexico, Uzbekistan, Switzerland and Ghana (10-15% of total sales). The most important system is the one of Ferrari in Maranello, and also the one of the State railways.

You are not in charge of the production of the panels but only of the construction and maintenance?

Exactly. Our company is an EPC, i.e. Engineering Procurement and Construction, we have projects and different suppliers that give us the necessary materials.

Where are the PV systems placed? Above the buildings, on flat ground?

Our 90% of panels are installed on the roofs, 10% is on the ground and on flat areas.

What do you mean when you say ordinary plant maintenance?

It may be cleaning the PV system, the coupling of the modules to the structures, the structures attached to the roof, the electrical inspection, if there is electrical leakage, cleaning the inverters, filters, etc etc. Basically, the verification that all electrical and mechanical functions work properly.

For the maintenance of plants carried on-site, do you rely on your own employees or do you outsource the activity? Is there a difference between ordinary and extraordinary maintenance activities?

We both outsource and let our employees do the job, it depends on the type of operation and the place of intervention. Sometimes we call electricians or companies specialized in the cleaning of the facilities. Generally, for extraordinary administration activities, we prefer sending our employees on-site, while for most of the routine activities commonly we call external companies.

Have you ever heard of the possibility of using drones for monitoring PV cells? If yes, have you ever considered the idea of using them?

Yes, but the idea has never been deeply examined, given the high costs of the service. The operator, which identifies the fault manually, takes a little longer but costs much less. In itself, the drone service is very useful. For a 1 MW facility approximately (10000 MQ around the implant) it takes about 2-3 days and about 800-900 euro to locate the fault manually: in my opinion, even though I never asked for a quote, with a drone the cost could skyrocket to at least 3000-4000 euro. When we identify the problem, firstly we do an analysis of the data, and then send the operator to a certain part of the field (be it the inverter, fuse, etc etc) to check the system more in depth.

Perfect, this was very kind of you. The interview is over.

It was a pleasure.

Thanks, see you soon.

Bye Bye.

INTERVIEW E

- Company: Loccioni
- Interviewee: Marco Piccinini

How big is the solar system you have, in terms of area, but also produced Watts?

We have plants owned by us; we are talking of about 1.5 MW, of which 1 MW plant is on the ground, and the remaining instead is on the roofs of our buildings. A precise number of square meters honestly cannot be given, because I don't know it. The remaining 12 MW are some installations we have done with our customers: these are about 70 plants.

Do you also do maintenance?

Yes, we have running maintenance contracts for several plants.

So, what is your business model for the PV sector? How do you make profits? Do you directly produce cells, or do you purchase them from third parties?

We are integrators of solutions: in practice, we go to the customers to suggest different solutions and one of them is precisely the installation of PV systems. First you do the technical design, which should be the installation of the PV system, then the customer gets an economic proposal: if he accepts it, we buy the material and organize ourselves with the manpower to do the installation. So then the system is mounted, started, and then from there we make a maintenance contract, which in most cases is for twenty years.

And what about your PV systems?

Our largest plant is for sale, because being a ground system, it is sold throughout the GSE electricity (Energy Services Manager), so we take an incentive; the remaining plants are used to make self-consumption, and to be self-sufficient.

Where did you locate the PV cells?

Customer cells are placed on the roofs; they are mostly industrial customers, and we install the cells above their establishments.

Do you have them all over Italy?

Yes, 90% are in the Marche region, the remaining 10% we have in Northern Italy, but few facilities. Some in Milan and some in Rome.

How do you organize your maintenance?

We have a daily monitoring for PV systems via a remote connection. So, either by the ADSL of the customer or through the installed SIM card of the modem, we have the ability to connect at any time on PV systems, and see if there are active alarms or whether the plant is producing energy properly. Obviously, this thing has been automated through a dedicated software, and therefore we are not we going physically to see if there are problems, but there are some sensors that run and send automatically emails or SMS if something is not working properly.

But still you cannot see where exactly the problem lies, right?

Well, with the level of maintenance and control that we do, we can actually manage to find the problem that plagues a single string. Then, of course, we do not know what the problem is caused from.

How long is a string?

The string´s length depends on how the system has been set. On small plants, they consist usually of a dozen panels, on the larger ones even more. It also depends on the type of panel, if it is pluricrystalline or monocrystalline etc. etc.

In the mail you had already written me that you had heard about the use of drones in the PV field.

Yes, actually we talked about that a few weeks ago with a company called PR Italy: this company deals with drones in general and with their various civil applications.

How do you see this introduction? Do you think it is something positive, which might reduce costs?

On ground facilities it could be convenient, because they are systems that take up a lot of surface. A drone speeds up the analysis by giving an overview from above, instead of having one or more persons to analyze every single panel.

However you said that you have a program that identifies the malfunctioning?

Yes, but with the programs we have actually it is not certain that you will be able to fully understand the issue. It could also be a problem that gets worse and worse, and within a few years the whole PV system could blow up. Actually the problem is that maybe we can identify the problem, but no one knows what caused it; it could be dirty, or a broken fuse. With the drone thermographic camera, there is the opportunity to see the individual cells of the PV system.

After you have identified the problem with this program, how does it work? Do some people go on the site to fix it?

We go physically on site to detect any problem in any case in every system; at least once a year we have a team that goes on the site and is responsible for making the necessary checks, to see if everything works all right. In cases where we have doubts of failure, we can take a camera (which would also be the instrument used by the drones).

What are the timings to check the whole plant manually?

If the program already identifies the problem, what are the timings of repair? It depends on the problem?

Yes. In most cases it is a fuse that is broken. We just have to replace the fuse and it does not take long. Another problem is the breakage or malfunctioning of PV panels; in this case, if the panel is under warranty, you must drop a message to the supplier, even sending him photos and a thermographic survey, then from there an analysis is to be done by the supplier. You may be asked to send a sample of panel, to see what is the problem in the laboratory, and then from there the replacement process begins. Another problem could be represented by the inverters, in which case the drones are unable to give their support, because it is an electrical problem.

How many people are needed to go to repair a fuse?

For this problem, just one person or two people are enough if you have to replace an entire panel. During maintenance, teams usually consist of more than two people.

Are those people your employees or do you call a third party company?

We have both employees and outside contractors.

Why have you given this maintenance service to an outside firm?

To be closer to customers' needs: especially for trips to distant cities, if you just have to replace a fuse, which is a trivial operation, it is inconvenient to send a person from our town to get to the destination. For this kind of operations, we rely on third parties who are located in the same city of the PV system to be repaired.

So you asked already for the drone service: have you ever thought about buying a drone?

No, because as I understand it, it is not that simple: the costs are quite high, and particular knowledge is required for piloting them. As for now, we only have had a preliminary and cognitive meeting, nothing important.

And how often would you use the drone?

Usually once a year, for the routine maintenance of the installations: it could be used in case we detect malfunctions of the plant, but these are rare and unforeseeable circumstances.

Perfect, the interview is over. Thank you for your time, goodbye!

You're welcome, it was a pleasure. See you soon!

INTERVIEW F

- Company: Enerpoint
- Interviewee: Jacopo Leone

What is your role within the company?

I'm a structural engineer, within Enerpoint in charge of maintenance of PV systems: I take care of the structural part and procurement, purchasing office, coordination of activities, a project manager basically.

When was the company founded and how many employees work there?

The company Enerpoint was founded in 2003, but the operations O&M branch exists since 2014. Enerpoint O&M has about 10 employees: we also employ subcontractors for maintenance throughout Italy, if there are local electricians. They, under our supervision (we are engineers), make the activities needed for maintenance.

How big is the photovoltaic system that you manage, in terms of MW produced per year?

The total capacity of MW owned by us is about 50 MW, spread all over Italy, in particular on a system that has 26 MW in Sardinia (on a green house). Then, there are other systems ranging from 700 W up to 4 MW, depending on the plant.

In total, how many plants do you have?

I'd say bout 15.

Where are the most PV cells located? On rooftops or on the ground?

The greatest part is on ground installations, with a maximum height of 2-3 meters; Another part is on greenhouses; the rest are those on the roofs, and usually they are small in size. Our typical customers are investment funds and banks: the energy is totally sold to the grid.

What is your business model? How do you make profits?

We do maintenance activities and we also assemble installations. The Italian market for residential PV is still going strong. But we gain basically from the services we offer; in particular maintenance.

How do you organize your maintenance?

There are preventive activities, i.e. those activities aimed at minimizing the possible future damage, and corrective maintenance activities, when there is a failure: over time, the system will deteriorate, and we intervene to restore proper operations.

How do you notice when there is a fault in the PV system?

With a monitoring system: all the systems are connected to a system which records and monitors the energy production; through the web, it sends signals to the maintenance staff, that by identifying the fault zone, will solve the problem (which can be a simple fuse, or even the entire power transformer).

Is the process centralized for all systems?

Yes, the monitoring center is just one and it sends signals or email to the heads of the project and the PV field, who then will coordinate the maintenance activities.

For the maintenance of plants carried on-site, do you rely on your own employees or do you outsource the activity? Is there a difference between ordinary and extraordinary maintenance activities?

The electrical maintenance is carried out by employees, with the exception of installations away from headquarters: in this case we use subcontracted labor. The control is always under us. Other activities such as monitoring or cleaning modules is subcontracted, apart from the case of a large facility where a dedicated employee also cuts the grass.

Routine maintenance means programmable activities (e.g. cleaning cabins, periodic monitoring of the cadres, security checks etc), they are usually well specified in the contract.

Unscheduled maintenance is divided into:

1) extraordinary corrective activity - for repair of an accident or breakdown
2) extraordinary extra contractual activities - programmable activities which are not included in the contract and typically arise from a customer's initiative (for example a change in operation, an anti-intrusion improvement etc ...)

Can you precisely spot the problem and what caused it without going on site?

Our monitoring system allows you to identify the faulty strings, in blocks of about 24 panels. From this data, the maintainer can understand where the problem lies.

How long does it take for the maintainer to understand where the precise point is?

The process is fairly straightforward once you get the email of the malfunction: it identifies the area and action is taken immediately.

Have you ever heard about the use of drones? What are your opinions about it?

The drone is a great way to monitor a PV system from above through thermography: if done by hand, this activity has a high hourly cost. With drones, instead, it allows me to instantly locate hot spots, where the modules have problems. The doubt stays more on the economical side, and not on the advantages of time that a drone offers. Also, you must have a person able to read the report that the drone produces, and a person who knows how to fly it. The downside is that, while the operator works and finds something, he can solve the problem right away; with the drone, this process becomes more laborious.

If you already have the programs identifying malfunctions, what advantages does a drone bring on the table?

The thermal images are used to identify serial defects that would otherwise be undetectable through the email monitoring. This thermographic analysis we do on customer's request. The drone can still be useful for larger systems, such as our 26 MW above the greenhouse, so hardly accessible by a person.

Do you do the thermography by yourselves or is it given to a third party company?

We do the thermography; however, the drone is provided by another firm. We ourselves have the skills to read the data provided by the drone, but a qualified operator (who is able to fly the drone) must retrieve this data; afterwards, we can read it.

Without the drone, how long does it take to make a thermographic analysis of a PV system?

Imagine a 1 MW system on the ground, extended for about 2-3 hectares: in this case, it takes at least 3-4 days with a person provided with a thermal camera. They analyse all modules and focus on those that are considered critical, in order to see them in detail.

The ground-mounted systems are usually on flat surfaces or hills?

Puglia is the best Italian region for installing ground systems, because the ground is flat. The system that we have in Abruzzo, of about 10 MW, is also on the ground but on hills. They are mono panels; in this case, the drone must fly on a 3D space.

Perfect. This was the interview, thank you for everything!

My pleasure, bye!

## References

*Acea.it*. (2009). Based on http://www.acea.it/document.aspx/it/rinnovabili_fotovoltaico_italia_triplica_la_produzione/$3e62837b2a9d44598f43d49058892222?lang=it#.Vw6462PsJ0F

Airvision. (s.d.). Based on Airvision.it: http://airvision.it

Baxter, P., & Jack, S. (2008). *Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers.*

Bcps.org. (s.d.). *Planning the Methodology - Limitations and Delimitations*. Based on https://www.bcps.org/offices/lis/researchcourse/develop_writing_methodology_limitations.html

Beer, M., & Nohria, N. (2000). *Cracking the code of change.*

Bellis, M. (2014, Dec 04). *Aboutmoney*. Based on http://inventors.about.com/od/timelines/a/Photovoltaics.htm

Boston Consulting Group. (2009). *Business Model Innovation: When the Game Gets Tough, Change the Game.*

*Business Insider*. (2015, May 27). Based on http://uk.businessinsider.com/uav-or-commercial-drone-market-forecast-2015-2?r=US&IR=T

Casadesus-Masanell, R., & Ricart, J. (2009). *From Strategy to Business Models and to Tactics.* Harvard Business Review.

*Casaeclima.com*. (2013, Jun 07).

Cheng, A., Howard, A., & Meyer, T. (s.d.). *Nationalsecurityzone*. Based on http://nationalsecurityzone.medill.northwestern.edu/droneproject/index.html

Chesbrough, H. (2010). Business Model Innovation: Opportunities and Barriers. (p. 354 - 363). Long Range Planning 43.

Chesbrough, H. (2006). *Open innovation: a new paradigm for understanding industrial innovation.* Oxford university press.

Clegg, S., Carter, C., Kornberger, M., & Schweitzer, J. (2011). *Strategy Theory and Practice.* SAGE Publications Ltd.

Codegoni, A. (2014, May 26). *Qualenergia.it*. Based on http://www.qualenergia.it/articoli/20140525-perche-poca-industria-fotovoltaica-in-europa

Damanpour, F. (1996). *Organizational Complexity and Innovation: Developing and Testing Multiple Contingency Models.* Management Science, Vol. 42, No. 5.

Demil, B., & Lecocq, X. (2010). *Business Model Evolution: In Search of Dynamic Consistency .* Long Range Planning 43.

Dictionary, C. (s.d.). *Dictionary.com*. Based on http://dictionary.reference.com/browse/drone

Dobrott, N. (2014, Jul 23). *Apricum*. Based on http://www.apricum-group.com/beyond-pv-industry-consolidation-investment/

Dronitaly.it. (s.d.). *Dronitaly*. Based on http://www.dronitaly.it/en/

ENAC. (s.d.). Based on Enac.gov: https://www.enac.gov.it/Home/

ENAC. (21st December 2015). ENAC amendment 1.

Enerpoint. (s.d.). Based on Enerpoint.it: http://www.enerpoint.it

European Union. (2004). REGULATION (EC) No 785/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 April 2004 on insurance requirements for air carriers and aircraft operators.

*Expoclima.net*. (2014, Dec 31). Based on http://www.expoclima.net/focus/incentivi/gse_pubblicato_il_rapporto_statistico_fotovoltaico_2013.htm

Flyvbjerg, B. (2006). Five Misunderstandings about Case-Study Research. *Qualitative Research Practice* , 390-404.

FoodRisc Resource Centre. (2016). *Mixed methods research* . Based on http://resourcecentre.foodrisc.org/mixed-methods-research_185.html

Godin, B. (2008). *Innovation: The History of a Category.*

Golden, M. (2013, Apr 2). *Stanford*. Based on http://news.stanford.edu/news/2013/april/pv-net-energy-040213.html

Gould, S., O'Sullivan, M., Tilley, C., & Topazio, N. (2013). *BUSINESS MODEL BACKGROUND PAPER FOR <IR>.* Integrated reporting (IR).

House of Lords. (2015). Civilian use of drones in UE.

Infobuildenergia. (s.d.). *Infobuildenergia.it*. Based on http://www.infobuildenergia.it/search_aziende.php?Nome_Azienda=0&regione=9&provincia=0&id_cat=129&invia=CERCA

Kay. (2015, Oct 15). *Droneii.com*. Based on http://droneii.com/drone-market-and-key-player-unveiled

Kim, W., & Mauborgne, R. (2009). *Blue ocean strategy.*

Knafl, K. A., & Breitmayer, B. (1989). *Triangulation in qualitative research: Issues of conceptual clarity and purpose.*

Kovalyova, S. (2010, Dec 20). *Reuters.com*. Based on http://www.reuters.com/article/italy-solar-idUSLDE6BJ1OU20101220

Latour, B. (2005). *Reassembling the Social: An introduction to Actor-Network-Theory.*

Latour, B. (1992). *Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts'.*

Loccioni. (s.d.). Based on Loccioni.com: http://www.loccioni.com

Magretta, J. (2002). *Why business models matter.* Harvard Business Review.

Malone, T. W., Weill, P., Lai, R., D'Urso, V., Herman, G., Apel, T., et al. (2006). *Do Some Business Models Perform Better than Others? .* MIT.

Markides, C. (2013). *Business model innovation: what can the ambidexterity literature teach us?* rhe Academy of Management Perspective.

Markides, C. (2006). *Disruptive Innovation: In Need of Better Theory.* Product Development & Management Association.

Mathison, S. (1988). Why Triangulate? 13-17.

Mertens, & Hesse-Biber. (2012). Triangulation and Mixed Methods Research . 75-79.

Mints, P. (2010). *Solarserver.com*. Based on http://www.solarserver.com/solarmagazin/solar-report_1108_e.html

Mosca, G. (2015, Oct 27). *Wired.it*. Based on http://www.wired.it/attualita/tech/2015/10/27/numeri-droni-italia/

Myenergy. (s.d.). Based on Myenergy.it: http://www.myenergy.it

Nemet, G. (2009). *Demand-pull, technology-push, and government-led incentives for non-incremental technical change.* Elsevier B.V.

*Nesta.org*. (s.d.). Based on http://www.nesta.org.uk/drones-history-flying-robots

Neutech. (s.d.). Based on Neutech.it: http://neutech.it/home-neutech/

Newton, N. (2010). The use of semi-structured interviews .

Nimbus. (s.d.). *Nimbus.aero*. Based on http://nimbus.aero/site/

NREL (National Renewable Energy Laboratory). (2014). *NREL.gov*. Based on https://www.nrel.gov/analysis/sam/help/html-php/index.html?mtf_lcoe.htm

O'Reilly, C., & Tushman, M. (2011). *Organizational Ambidexterity in Action: How Managers explore and exploit.* CALIFORNIA MANAGEMENT REVIEW VOL. 53, NO. 4.

Orlikowski, W. (2007). *Sociomaterial Practices: Exploring Technology at Work.*

Patrick, K. (2009, 08 20). *Johnny Holland*. Based on "How to combine multiple research options: Practical Triangulation": http://johnnyholland.org/2009/08/practical-triangulation/

Pauner, C., & Viguri, J. (2015, Oct 27). *democraziaesicurezza.it*. Based on http://www.democraziaesicurezza.it/Saggi/A-Legal-Approach-to-Civilian-Use-of-Drones-in-Europe.-Privacy-and-Personal-Data-Protection-Concerns

Phdstudent. (2016). Based on Stating the Obvious: Writing Assumptions, Limitations, and Delimitations: http://www.phdstudent.com/Choosing-a-Research-Design/stating-the-obvious-writing-assumptions-limitations-and-delimitations

Poole, S. (2004). *Central issues in the study of change and innovation.*

Porter, M. (1996). *What is strategy?* Harvard Business Review.

*Qualenergia.it*. (2013, Dec 13). Based on http://www.qualenergia.it/articoli/20131213-fotovoltaico-italia-persi-8000-posti-di-lavoro-e-meno50-percentodel-fatturato

*Qualenergia.it*. (2015, Feb 03). Based on http://www.qualenergia.it/articoli/20150203-fotovoltaico-italia-nel-2014-installati-quasi-1400-mw

*Robert Wood Johnson Foundation*. (2008). Based on http://www.qualres.org/HomeTria-3692.html

Rossi, & Ciprari. (2012, Apr 12). *Scienzainrete.it*. Based on http://www.scienzainrete.it/contenuto/articolo/tendenze-del-mercato-fotovoltaico-litalia-leader-mondiale

Sandrin, F. (2015, May 26). *Milk the Sun*. Based on http://it.blog.milkthesun.com/news-energia-solare/fotovoltaico-italia-2015-cresce-o-non-cresce

Saunders, M. P. (2009). Research methods for business students. *P. E. Limited* .

Schumpeter, J. (1934). *Entrepreneurship as innovation.*

Sifton, J. (2012, Feb 7). *Thenation.com*. Based on http://www.thenation.com/article/brief-history-drones/

*Solaridea.com*. (2014). Based on http://www.solaridea-fotovoltaico.it/Storia-del-Fotovoltaico.html

Teece, D. (2010). *Business Models, Business Strategy and Innovation.* Long Range Planning 43.

*TelecomItalia.com*. (2014, Dec 29). Based on http://www.telecomitalia.com/tit/en/innovazione/droni.html

*TGcom24*. (2015, Mar 2015). Based on http://www.tgcom24.mediaset.it/green/fotovoltaico-italia-terza-al-mondo-per-impianti-installati-15-del-totale-globale_2101029-201502a.shtml

*The Economist*. (2014, Mar 27). Based on http://www.economist.com/news/special-report/21599524-drones-will-change-warand-more-up-air

Thies, F. (2013). *PV Power Plants*. Based on http://www.pv-power-plants.com/industry/europe-can-regain-a-leading-position-in-further-developing-pv-markets/

Torchiani, G. (2013, Dec 19). *ilsole24ore.com*. Based on http://www.ilsole24ore.com/art/nuove-energie/2013-12-19/cambia-geografia-solare-corrono-cina-giappone-e-usa-male-italia-175553.shtml

Vives, L., & Svejenova, S. (2011). *Business models: towards an integrative framework.*

Weber, A. (2010, Apr 26). *Assemblymag.com*. Based on http://www.assemblymag.com/articles/87689-nikola-tesla-father-of-unmanned-vehicle-technology

Weick, K. (2001). *Making sense of the organization.*

Yeasmin, & Rahman. (2012). 'Triangulation' Research Method as the Tool of Social Science Research. *BUP Journal* , 154-163.

Yin, R. (2014). *Case study research. Design and methods* (5th ed.).

Zott, C., Amit, R., & Massa, L. (2011). *The Business Model: Recent Developments and Future Research.* Journal of Management, Month XXXX.