



Università
Ca' Foscari
Venezia

Master's Degree programme
in Economics and Finance

Final Thesis

**Instruments for financing green investments,
with an empirical application to solar ABS**

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Matriculation Number 849046

Academic Year

2017/2018

Acknowledgements

After two long and intense years, the day finally arrived: writing these words of thanks is the final touch of my thesis. It was a period of profound learning, not only on a professional level but also on a personal level. Writing this thesis has had a strong impact on my personality. I would like to spend two words of thanks to all the people who supported and helped me during this period.

Special thanks to my rapporteur and professor Antonella Basso for her valuable advice. You gave me all the tools I needed to take the right path and complete my thesis.

To my friends. We have always supported each other, in good times and in bad luck. I also would like to thank my basketball friends who have taught me how to give always the best. In the end, to all who have stayed on my side since the beginning of this path with moments of discouragement and joy.

Finally, to my university friends. To my flatmates who have shared with me three years full of experiences and fun. And a special thanks to all my Erasmus friends who made these incredible experiences unique and made me feel at home even if in another country.

Last but not least, I would like to thank my parents for supporting me during this incredible path and for the wise advice you gave me. And to my sister, for being on my side all the time and for being my partner of adventures.

A heartfelt thanks to everyone!

Chiara Meneghello

5 October 2018

Preface

Since the Industrial Revolution, the increase in carbon-intensive activities is commonly seen as the main cause of the rising global temperature. Many companies and businesses have produced and still produce some hazardous chemicals or carbon emissions into the environment themselves. Moreover, it has been increasingly recognised that banks are inextricably linked to a commercial activity that harms the natural environment by means of their risky lending practices to businesses. Answering this problem, Green Finance tries to safeguard the environment by promoting sustainable ways to do businesses and to invest capital. However, it is not a completely different type of finance but it tries to support projects and investments by means of alternative ways of financing and it helps catalyse and support the transition to a green, low-emissions and climate-resilient global economy.

At the beginning of the 90s, financial and governmental entities and non-governmental organisations decided to admit the relevance of an eco-conscious development in order to find a solution to the current environmental issues which are also expected to increase in the future. In 1992, a few important commercial banks (Deutsche Bank, HSBC Holdings, Royal Bank of Canada), decided to work together with the United Nations Environment Programme to release the Statement by Banks on the Environment and Sustainable Development and also to create the Banking Initiative (UNEP, 1992). The UNEP Financial Initiative publicly stated that sustainable development, a development which gathers the immediate necessities without restricting the possibilities of future generations to satisfy their own needs, must be one of the most important objectives of the banks. Since then, the financial sector has striven to contribute to sustainable development. Moreover, in 2003, the Equator Principles (EP) was launched to ensure that projects financed by banks be socially responsible and environmentally friendly. The initiatives help banks in increasing reputation, public recognition, and investors' favours, but may also impose challenges on stricter standards and more transparency.

Therefore, green finance is similar to a bridge which connects environmental industries to financial institutions. Even if the financial sector has carried out many such initiatives on their own, there is still a lack of capital for eco-friendly projects, such as renewable

energy industries, waste management infrastructures, and green transportation. Both society and the academic world are questioning green finance on its ability to deliver what it has boasted to do. However, mobilising capital for green investments has been limited due to several microeconomic challenges such as problems in absorbing environmental side effects, information asymmetry, inadequate analytical capacity and lack of clarity in the definition of “green”. There are maturity incompatibilities between long-term green investments and the relatively short-term time horizons of savers and, even more important, of investors. Moreover, financial and environmental policy approaches have often not been organised together and this has increased the difficulty and the complexity of the development of this new form of finance. In addition to this, most of the governments do not distinctly report the methods and timing with which they are supporting the green “change”. This uncertainty and all these unanswered questions about how to implement the green finance has given rise to a lack of clarification and to a slow development in this « green » direction.

The objectives of the thesis are several and are related to my personal interest on this precise topic but also to the academic background which has given me the instruments to analyse an argument from different perspectives and also in the context of this historical period. Anyhow, this thesis' Chapter 1 will try to define clearly the concept of Green Finance and how its definition could be very vague in certain situations and it could also lead to misinterpretation problems. Certainly, it is a very young type of finance and the academic world is still trying to give us a specific definition which would need to be accepted globally and which would solve several investors' doubts. Chapter 2 of the thesis will, instead, discuss which are the available financial instruments which can be used in the « green » context and, basically, which are the main characteristics and risks of each one and for who they have been created. Indeed, each instrument tries to draw attention to the market, to a saver, to a bank or to an investor. All these individuals have different needs and objectives, so everything has to be considered taking into account the purposes for which the instrument has been created. Chapter 3's aim is to outline the financial instrument which is derived from the securitisation process, i.e. the Asset-Backed Securities (ABS). It's a tool which has been used widely in the previous decades and it has raised many concerns since the 2008's

crisis which was mainly based on just one type of ABS. In fact, the recent crisis was due to an impressive amount of MBS (mortgage-based securities) which were composed of incredibly risky loans, and their intrinsic risk was a time bomb. Chapter 4, instead, will talk about the solar ABS case in the above-mentioned context, as an alternative to the other available options and as a clear example of how this instrument is developing and increasing in popularity among the financial sector. It could also be an opportunity to restore the reputation of the ABS market as a whole after the well-known crisis of 2008. Therefore, this thesis will assess the viability of solar asset-backed securities (ABS) as a lower cost financing mechanism in comparison to other forms of sustainable financing. First, a fictional company, UpscaleSun, will create a realistic pool of PPAs (power purchase agreements) which are related to the purchase of a residential solar system. Moreover, it will discuss which could be the possible policies and regulations which could help its utilisation in the financial market. Another objective is to present and analyse the existing market and understand the possibilities and the advantages of solar ABS in the context of Green Finance. Indeed, even if there were many projects and initiatives in Europe in the past years, this market is still under-performing and unclear for many investors and businesses. Basically, it is not working at its full potential. And the potential could be incredibly great.

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CHAPTER I

Green finance

1.1 Overview and lack of a clear definition

The concept of sustainable development can also be applied to the financial activity. The basic idea remains that of guaranteeing the "capacity for the future", which can be translated to a rational use of resources in order to not compromise the ability of the resources themselves to continue to produce value over time. Anyway, until today, we do not have a precise and generally recognised definition of green finance for two main different reasons. The first one is that many publications do not try to define the term, and second, the definitions can vary significantly and, somehow, some of them are not very clear. This uncertainty creates many problems in identifying what can be called a « green » investment and what cannot. This research of a generally accepted definition is not just for the sake of definitions and taxonomy but it's essential for the determination of policies and regulations. It is also critical in order to avoid any misunderstanding for investors who are interested in this type of finance and who are seeking clear and transparent information on sustainable investing products. In any case, some of the main definitions which can be found in the literature are the following:

- Höhne, Khosla, Fekete and Gilbert (2012): "Green finance is a broad term that can refer to financial investments flowing into sustainable development projects and initiatives, environmental products, and policies that encourage the development of a more sustainable economy. Green finance includes climate finance but is not limited to it. It also refers to a wider range of other environmental objectives, for example, industrial pollution control, water sanitation, or biodiversity protection. Mitigation and adaptation finance is specifically related to climate change related activities: mitigation financial flows refer to investments in projects and programs that contribute to reducing or avoiding greenhouse gas emissions (GHGs) whereas adaptation financial flows refer to investments that contribute to reducing the vulnerability of goods and persons to the effects of climate change."
- Zadek and Flynn (2013): "Green finance is often used interchangeably with green investment. However, in practice, green finance is a wider lens including more than

investments as defined by Bloomberg New Energy Finance and others. Most important is that it includes operational costs of green investments not included under the definition of green investment. Most obviously, it would include costs such as project preparation and land acquisition costs, both of which are not just significant but can pose distinct financing challenges.”

- Pricewaterhouse Coopers Consultants (PWC) (2013): “For the banking sector, green finance is defined as financial products and services, under the consideration of environmental factors throughout the lending decision making, ex-post monitoring and risk management processes, provided to promote environmentally responsible investments and stimulate low-carbon technologies, projects, industries and businesses.”
- Böhnke, Eidt, Knierim, Richert, Röber, Volz (2015): “According to our definition, ["Green Finance" (] GF [)] comprises all forms of investment or lending that take into account environmental impact and enhance environmental sustainability. A key element of GF is sustainable investment and banking, where investment and lending decisions are taken on the basis of environmental screening and risk assessment to meet environmental sustainability standards.”

To be more clear, sometimes green investments may also be included under the umbrella of SRI (socially responsible investment), but they are fundamentally much more specific and detailed than the previous category. Additionally, there is also a misunderstanding about the positioning of climate finance in the GF context. Generally speaking, climate finance is merely one aspect of green finance, but it is particularly focused on adaptation to the side-effects of climate change or the reduction and limitation of carbon emissions. Therefore, it is just a small segment of the broad area of the Green Finance world. As we can see, there is the need to be very specific and clear because otherwise many investors and financial professionals could be inclined to commit errors for misinformation’s motives. Moreover, the lack of clear and uniform definitions represents an obstacle, inter alia, for investors, enterprises and banks which are seeking to identify opportunities for sustainable investments.

1.1.1 Danger of greenwashing

Given this definition's issues, a clear taxonomy and defined standards will also help in avoiding and restricting another kind of risk, i.e. greenwashing. In broad terms, greenwashing is a form of false marketing made by the enterprises which deceptively promote their products or services as eco-friendly and sustainable. In the late 1980s and early 1990s, when professional purchasers and individual consumers first became interested in buying green products, the following types of claims started to appear on many products: earth-friendly, biodegradable, eco-safe, 100% natural, made with non-toxic ingredients and so on. However, the companies were using the terms indiscriminately and without any attempt to clarify them for consumers and investors. Purchasers were rightly confused about the meaning of the claims and, sometimes, the information about them was also falsely reported. This risk is more present with the emerging green asset classes (ESG funds, ABS or index-linked green products) but it can anyway also concern the green bonds which have a much simpler structure. The problem of greenwash "may seem like a mild issue to worry about. But the advertising giant Ogilvy & Mather puts in a new report that greenwashing is actually "an extremely serious matter...it is insidious, eroding consumer trust, contaminating the credibility of all sustainability-related marketing and hence inhibiting progress toward a sustainable economy."¹ Namely, it's very difficult for customers and investor to know what decisions could make a difference when the marketing strategies are purposely trying to be misleading.

When buyers throw up their hands in confusion, the market and the information will completely lose credibility and will encourage consumers' scepticism. For example, it's possible to think about the case of Volkswagen (Dieselgate scandal)² which have modified the results of the engines' carbon emissions in order to appear as a role model for other automobile companies. Untruthfully, they were producing high performing cars with low polluting engine's systems. On the other hand, other companies are trying to completely change their consumers' perception, also companies which were always considered as not caring about the environment. For instance, McDonald's literally

¹ Winston, A., (April 2010). Avoiding Greenwash and Its Dangers in *Harvard Business Review*

² Hotten, R., (December 2015). *Volkswagen: The scandal explained*, BBC News, <https://www.bbc.com/news/business-34324772>

became green by changing the colours of its signature logo. Now, McDonalds' classic yellow "M" is sometimes displayed with a green, not a red, background³. This remains a very important issue because there is not so much control or sanctions and there is also a deep lack of pieces of information about the products and the criteria's policies. In Europe, the European Commission is recently trying to create new rules to force asset managers to show how they take into account environmental risks in their investments and how they define a product or a service which claim to carry "green" characteristics.

1.1.2 Personal idea of « green »

Another very important issue is related to the personal idea of « green » which is not the same for everyone because there are many different interpretations. In order to understand well to the concept of a green investment, it's also necessary to analyse what is « green » for an investor and as well which are the characteristics for defining the « greenness » of a certain product. In any case, an investor seeking to make eco-friendly investments has many different options. He has the possibility to create a green portfolio which consists of bonds, mutual funds, exchange-traded funds and securities. For instance, there are many green mutual funds which could include: Allianz RCM Global EcoTrends A (AECOX); the TIAA-CREF Social Choice Equity Fund (TICRX); Portfolio 21 Global Equity Fund Class R (PORTX); and the Green Century MSCI International Index Fund. Moreover, green bonds can sometimes be made by governments and could generate profits for several green projects and businesses. Given the fact that individuals have different opinions and ideas on what means a "green investment", it's very difficult to navigate in the area of green investments because it can be considered as a grey area with many different nuances. Some investors are trying to find only pure-play options which mean that they invest in a particular commodity or company. For instance, many companies, which do research into or make products like renewable fuels and technology which could save energy. On the contrary, some investors put money behind companies that simply have good business practices and processes when it comes to the way they use natural resources and manage waste, but

³ NBC News (November 2009). *McDonald's rolling out green logo in Europe*, Associated Press, http://www.nbcnews.com/id/34111784/ns/business-us_business/t/mcdonalds-rolling-out-green-logo-europe/#.W6dqUmQzZQI

draw their revenues from multiple sources. Buying a stock in a business which follows environmentally conscious practices but in a typically non-sustainable industry may be considered a “green” investment for many people, but not for others. For example, consider an oil company, as British Petroleum (BP), which is recognised for its important environmental practices. While it has one of the most transparent and complete sustainability reports⁴ and it is taking precautions to limit direct damage to the environment through its daily operations of drilling for oil, some people may demur to purchasing its stock as a green investment, because burning fossil fuels is one of the main reasons for global warming. Another example could be the construction of a new highway which is able to save time and kilometres to many drivers. Can it be considered as a “green” investment? Perhaps for many people saving time and reducing carbon emissions could be a good reason for considering it as “green”, but the construction of a new highway could not be completely seen as an eco-friendly investment. Sometimes, the border between “green” and “ungreen” is so subtle that it is almost impossible to trace it. Furthermore, investing in green companies can be riskier than other equity strategies, as many companies with this aim are in the development stage, with low revenues and high earnings valuations. On the other hand, if investors consider safeguarding the environment by businesses which are supporting the environmental practices to be a value to them, green investing could be a valid and appealing choice for them to invest their capital.

All investors should be wary of companies that simply bill themselves as green for branding purposes without following through with their pledges. Therefore, prospective green investors should research their available options to see if an investment includes the types of companies which correspond to their personal definition of “green”. Even if it seems very easy, the task of finding trustful information on companies which boast about reducing carbon emissions or about using just renewable energies is not always a straightforward task. Moreover, there are also companies which have made false statements and falsified reports and documentation. On the other hand, there is also a misunderstanding because of the technology which is continuously developing at an

⁴ British Petroleum, (2017). *How will BP respond to global change?*, BP Sustainability Report 2017

ever higher speed. For instance, in the past, a diesel engine was considered environmental-friendly, even if now it's not more the case and other solutions are preferred. The more and more numerous available products and the continuous development of their technology make this « green » concept even more difficult to specify. This issue will lead to a general scepticism and doubts and, perhaps, without a proper regulation, it will make many potential investors run away.

1.1.3 Green Finance in relation to SRI/ESG approaches

Another kind of issue in defining Green Finance is other similar investment approaches which may partially include some of the GF's practices. Two main approaches are socially responsible investments (SRI) and environmental, social and governance (ESG). The first one is related to the idea of social and sustainable investing, the second one, instead, is a wider concept which also includes the environmental aspect in the investment decision-making. SRI and ESG came up strongly in the 1990s with a strong focus on governance issues but generally, they also include environmental factors. In the 2000s, sustainability and long-term investing became rather popular and it started to attract new individuals. Few green funds have been created since the 1980s and 1990s but the climate change has, in the end, fostered the development and success of green investing in recent years. Following this environmental trend, the concepts of investing side-effects, universal ownership and sustainable economy have been introduced in the finance market, raising more and more attention from the investors.

However, there is no general agreement on how exactly all these terms relate to each other. In the ESG case, the applications of the approach are not mutually exclusive and can sometimes be complementary, but, in other cases, they can also compete with each other. For instance, a clean-tech company could have problems with human rights or labour laws, a well-governed company doing good community work may be a serious polluter. Even within the environmental sector, a company producing a green good may use substandard processes from a green point of view, and vice versa. Companies can also counterbalance their emissions or “green” aspects of their value chain through the purchase of emission reduction credits, carbon credits or renewable energy certificates.

As said before, these concepts have evolved rapidly over time, and are continuously changing. In our case, Green Finance is considered as a subset of ESG and SRI approaches which are all considered synonymously.

1.2 Demand and supply for green finance

In order to understand the existing supply of green finance, it is necessary to analyse it considering also the related demand for this type of finance. This will lead to a better decision-making process. A definition for a “sufficient amount of green finance needs to be defined, ideally for each financial instrument, because linking green finance needs with the best-suited disbursement channel is extremely important for its success”⁵. The estimated demand can be supported by information collected from countries’ national regulations and development programs, national and international research institutions, and enterprises’ associations or companies’ strategic initiatives. Many countries, for example, China, have set general political targets for environmental action, including climate change, and businesses are also following with their own pledges. However, only a few countries and companies have defined clear targets on how to involve the private sector in achieving the greening of the economy and of the finance. Against the backdrop of today’s climate-related issues, demand for green finance is best illustrated by reference to green investment. Investment in green energy is a typical example of the changing demand for funding for the purpose of producing energy. Anyway, predicted green finance needs in the real economy still remain rather abstract and somehow obscures for many, especially when it comes to a breakdown of specific financial instruments. The Organisation for Economic Cooperation and Development (OECD) published various papers related to the specific demand for GF:

- 2011 paper explains and analyses some of the existing projects whose aim is to spur pension funds to help to support and sustain green growth initiatives;
- 2015 paper addresses publicly traded green investment banks (GIBs), analysing the motivations for which they are being established and how they could invest capital in environmental projects and investments.

⁵ Climate Policy Initiative, (Nov. 2014), *Global Landscape of Climate Finance*, <<https://climatepolicyinitiative.org/publication/global-landscape-of-climatefinance-2014/>>.

Moreover, in its initial paper to the G20 Green Finance Study Group (GFSG) in 2016, the OECD published a quantitative framework for analysing potential bond contributions in order to achieve low-carbon financing needs on a 2°C compatible emissions trend⁶. In the leading countries, the development of low-carbon technologies may transform the bond markets which can become open to all and they can considerably help in building new assets in the future. The worldwide objective was then translated into targets per country or per major economic region. The EU, indeed, undertook to achieve some objectives, which were then divided among the various Member States. Moreover, a study by Bloomberg New Energy Finance (BNEF) and Ceres published in 2016 stated that in order to achieve the objectives of the Paris Agreement, almost \$12.1 trillion will become necessary over the next 25 years span⁷. This is \$5.2 trillion above current business-as-usual projections, or an extra \$208 billion a year⁸. Furthermore, International Finance Corporation's (IFC) analysis also published in 2016, evaluated that the nationally determined contributions of a group of 21 emerging market countries represent a financial opportunity of \$23 trillion between the 2016 and 2030 period⁹. Considering the broader context of modelling future investment and financial needs, the Intergovernmental Panel on Climate Change's 5th Assessment Report, published in 2014, included a chapter on estimates for investment and finance needs. The panel also published estimates on the total required amounts of money to achieve the Sustainable Development Goals, as did the Food and Agriculture Organisation, the World Health Organisation, the International Energy Agency, and G20. In addition to this, a reasonable level of harmonisation is needed in order to increase the demand for more sustainable alternatives. In this case, harmonisation will mean a converge of financial measurements, of definitions, of implementation measures

⁶ International Finance Corporation, (2017). *Green Finance - A Bottom-up Approach to Track Existing Flows*, World Bank, pg.12

⁷ Ceres, (2016). *New report: \$12.1 trillion must be invested in new renewable power generation over next 25 years to limit climate change*, Press Releases, <https://www.ceres.org/news-center/press-releases/new-report-121-trillion-must-be-invested-new-renewable-power-generation>

⁸ Bloomberg New Energy Finance, (2016). *Mapping the Gap: The Road from Paris*, <https://about.bnef.com/blog/mapping-the-gap-the-road-from-paris/>

⁹ International Finance Corporation, (Nov. 2016), *Climate Investment Opportunities in Emerging Markets—An IFC Analysis*

and guidelines. Without a common harmonisation, the results of new policies and regulations will have the opposite effect and will make useless all the efforts of companies and investors.

1.2.1 Main actors

To understand the demand for Green Finance, it's important to understand who are the individuals, banks or businesses who are interested in putting money into eco-friendly investments. Having in mind the needs and the characteristics of each major actor is crucial to find out more opportunities for the development, and then the success, of green finance. Specifically, regulatory authorities, credit agencies and central banks may affect the pace at which the “greening” of the financial system occurs, while the legal and monitoring regime defines the structure of the financial system¹⁰. The individuals and entities which are interested in this type of “green” change can be summarised in the following way:

- Banks: the banking system plays an important role in the international financial system because they represent one of the most important shares of global financial assets. Specifically, “emerging markets and developing countries have established numerous measures to mobilise finance for sustainable development and to mainstream green finance in the banking system”¹¹. These measures include priority-lending requirements and below-market-rate finance via interest-rate subsidies. However, these measures carry risks because they could also lead to a serious misallocation of financial resources. Therefore, banks are one of the main actors in this area but, as always, everything needs to be managed in a conscious way in order to avoid inefficient allocation of assets and underestimation of risks.
- Institutional investors: it is widely accepted that a wide share of all the capital needed to finance green investments has to come from institutional investors which include pension funds, sovereign wealth funds and also insurances. However, this investor group is constrained by several restrictions: green investments are generally not

¹⁰ Deutsches Institut für Entwicklungspolitik, (2016), *Green Finance: Actors, Challenges and Policy Recommendations*, Briefing Paper, pg.2

¹¹ Alexander, K. (2014). *Stability and sustainability in banking reform. Are environmental risks missing in Basel III?*, Cambridge: University of Cambridge, Institute for Sustainability Leadership

included in the relevant benchmarks of rating agencies as they do not have a sufficient historical data to be given a rating and also because of the fact that just a limited amount of information is available for the necessary analyses. Moreover, green investments are usually not possible on a large scale because of an insufficient number of valid green projects. However, even if institutional investors would be willing to invest in long-term and sustainable projects, the prevailing regulation often prevents them from doing this or allows it only in a very limited way because this regulation requires very cautious investment strategies within well-know sectors of the economy.

- International financial institutions: on the other hand, IFIs can sustain the green transformation in three different manners. First of all, they have a groundbreaking role in verifying new ways of financing a sustainable development: voluntary responsibility to consider climate risks and the carbon footprint of potential investments during the investment decisions by using the theoretical “shadow prices”¹²of carbon. Second, IFIs have also a critical role in the mobilisation and directing private and institutional capital for green investments by supplying innovative instruments such as green bonds. Moreover, international financial institutions are foredoom “to build a coalition of green financiers with the aim of reforming global financial governance to become supportive of sustainable development”¹³. Since, sometimes, the IFIs have different aims and available instruments, one of the main challenges for them is to enforce the identical definition of green finance to everyone. This is necessary in order to prevent or limit the well-known issue of “greenwashing”.
- Central banks and regulatory authorities: in addition to all the other possible actors, central banks and other regulatory authorities could push financial markets towards more sustainable practices and processes by establishing suitable policies, laws and regulations. Nowadays, the financial system is driven mainly by short-term returns and, consequently, a persistent investment lack for long-term projects is one of the most urgent problems. The sustainable projects, instead, require a long-term

¹² Deutsches Institut für Entwicklungspolitik, (2016), *Green Finance: Actors, Challenges and Policy Recommendations*, Briefing Paper, pg.3

¹³ Lindenberg, N. (2016). *Coordinating the willing*. D+C Development and Cooperation e-Paper, 7/2016, 38-39

commitment and this is an issue which the financial regulators should help to solve. Unfortunately, the central banks have many difficulties making decisions in the long-term because they are still trying to recover from the recent crisis and also because common investors always tend to be focused on short-term performance and create what is called as the “short-termism” problem. Short-termism is, indeed, an extreme focus on the short-term at the expenses of longer investments and returns. Indeed, this issue is what block and limit the development of sustainable changes in the companies. One solution is that banking stress tests and standards of due diligence for banks and financial institutions should be used in order to give a greater attention to climate risks which should impact the general investment decision-making. Besides, green financial guidelines and regulations can avoid competitive alteration due to the higher costs which are linked to green financial activities.

1.3 Impact of environmental factor on economy stability

The environment is not just important for the health of our planet but also for the human well-being and lives. Furthermore, it is also essential for the stability of our economy because, generally speaking, an environmental crisis is not much more different from a financial crisis. In addition to this, there is incontrovertible scientific evidence of the global warming. As said before, this has, almost certainly, a progressively significant impact on economies, societies and markets. There is also an evidence suggesting that climate change and environmental risks have important implications for financial stability which cannot be disregarded. Obviously, the present climate change threatens the basic elements of human life such as access to water, food production, health, and the use of land and environment. Policy measures have been created to reduce global emissions of greenhouse gasses which are needed to restrain climate change and reduce climate risk. Imagining a future where the energy is founded on alternative source sets up a deadline for several investments which did not have one. All of this affects valuations, and the result may be dramatic. Because of the fact that so many large sectors of the economy are based on the main energy sources, the consequences could be tragic for many persons, businesses, companies and also countries.

The change itself thus represents a risk for the financial solidity. However, avoiding to transform the economy also implies other risks to the financial stability and far bigger ones. Indeed, the raising of glacial retreat and the soil erosion will reduce the land which can be inhabited and it can jeopardise several cities and countries¹⁴. Extreme weather conditions will challenge people's lives and well-being. In all this process values and assets will be inevitably destroyed. This challenge will be felt throughout the financial system as a whole. This problem will also affect many institutional investors like insurance companies and pension funds. Indeed, this is what Henri de Castries, CEO of AXA, has stated about the issue: "We do not have the choice: a world +2°C warmer could be insurable, but a world at +4°C would certainly not be"¹⁵. The most recent catastrophic events are a clear reminder of the effect drastic changes in the weather can cause to economies. In 2010 only, Moscow was hit by an unprecedented heat wave that caused costs equal to 1% of the Russian GDP¹⁶. The heat wave was then, followed by a long drought and forest fires which has caused the shut down the production of many Russian companies which were trying to limit the consequences of the smoke. In the meantime, during the same year, almost one-fifth of Pakistan was inundated, causing losses up to almost 5% of its GDP. Furthermore, in the USA, the National Oceanic and Atmospheric Administration (NOAA) stated that the average amount of exceptional weather events exceeding \$1 Billion each in the last 5 years has doubled since 1980. At present, the number is up to 11 extreme events each year.

Such events are becoming more and more frequent and they are affecting businesses of all types, and indeed, also areas of human activity; often, they affect whole sectors of the economy. Given this correlation between environmental disasters and financial and economic trend, there is a clear and undeniable impact on the reliability of many projects or borrowers which banks and other financial institutions should take into account. As said before, if we compare a financial crisis with a systemic environmental

¹⁴ European Banking Federation, (2017). *Towards a Green Finance Framework*, Report from EBF, pg.11

¹⁵ De Castries, H., (May 2015). *Climate Change: it's No Longer About Whether, it's About When* in AXA Newsroom, <https://www.axa.com/en/newsroom/news/about-whether-about-when>

¹⁶ DW, (2010). *Heat wave could cost Russia almost 1 percent of GDP*, DW News, <https://www.dw.com/en/heat-wave-could-cost-russia-almost-1-percent-of-gdp/a-5887442>

crisis, we find many similarities. Before a financial crisis, the main part of actors in the investment community behaves with some level of rationality and foreseeability in accordance with their personal interest. Ex post facto, it is often easy to see how the collective sum of individually rational actions has undermined the interest of the whole system and indeed led to major disruption. As stated before, one of the problems is that individual financial behaviour (as well as risk management) tends to be focused on the short and medium-term horizons, while environmental risks have a much longer nature. This, indeed, leads to a postponing of effective regulations and actions which could prevent or limit potential environmental disasters. Moreover, the impact of environmental factors on insurance is undeniable.

However, given the potential impact on banks' loan default rate and potential large implications to financial stability, it is important to incorporate climate-related criteria and the systemic risk deriving from climate change into banks' decision-making and risk measurement¹⁷. It is a process that has already begun, and methods for capturing and reducing these risks are quickly developing. Being able to describe and measure these risks in a uniform taxonomy, will enable a clearer understanding, and perhaps through that, some mitigation of those risks. Today, the regulatory framework on the corporate global environmental impact is still obscure and unclear. Sustainable guidelines and rules for bank lending, trading and investment practices are critical for the achievement of the base mandates of international financial institutions and to examine the related risks for banks. Economic growth and financial development should aim to be economically, socially and environmentally sustainable. In 2017, Mark Carney, Director of the Bank of England and Chair of the Financial Stability Board stated that "that unless we begin to give serious consideration to environmental factors now, we may very well find, from a financial stability perspective, it is too late to make a smooth transition to a green economy"¹⁸. In this regard, it is also essential to note that

¹⁷ Campiglio, E., Dafermos, Y., Monnin, P., Collins, J., (2018). *Climate change and finance: what role for central banks and financial regulators?*, Bank Underground News, Bank of England <https://bankunderground.co.uk/2018/08/30/climate-change-and-finance-what-role-for-central-banks-and-financial-regulators/>

¹⁸ European Banking Federation, (2017). *Towards a Green Finance Framework*, Report from EBF, pg.12

the costs of facing the climate change up-front are much less expensive and complicated than dealing with the potentially disastrous consequences of the global warming. Hence, it makes economic sense to address climate change immediately to avoid larger financial and economic losses. It is to be welcomed that policymakers are beginning to focus more on sustainable finance, following on from the momentum generated by the adoption of the 2030 Agenda for sustainable developments, and also the agreements reached in December 2015, at the Paris Climate Summit. Moreover, the development of an EU comprehensive strategy for sustainable finance is more than welcome in order to develop a harmonised plan to face this problem at the European level.

1.4 The status quo of green finance in the field of renewable energies

Currently, the researches on energy-related to green finance are more theoretical in interpretation, substantially from the aspect of single energy in the energy sector, for instance, natural gas, oil, wind power, solar energy and so on. Therefore, it is very important to understand how to lower the risk and cost of financing using the green finance, improve the financing processes and sustain the growth of the renewable energy sector. For a long period, a neglected factor limiting the development of many sustainable forms of energy was the inappropriateness of a suitable financing system which could support the related technology. The financing system should consider renewable energy processors and demand of users in order to better promote the extensive use of this eco-friendly energy. Continued competitive electricity market will change the electric power in the immediate future and cause a potential impact on renewable energy structure. It is believed that ferocious competition could reduce the cost of financing of renewable energy projects, thus achieving the objectives already set for renewable energy. For example, the financial sector's support for renewable energy can be discussed from the following several aspects:

- from the point of view of a banking institution, financing must have a rational use of funds in a given period of time;
- financial tools have to be coordinated with the pace of science and technology change and financing necessities of sustainable energy;

- energy security law and energy fund accord with the political aim in order to continuously support the growth of the energy sector¹⁹;

Despite this, there is no research on the correlated development of the energy sector and financial sector and no particular investigation on the internal mechanism which concerns relationship, reciprocal penetration and mutual effect between the two industries. Anyway, green finance is an innovative financial pattern aimed at the environmental protection and the accomplishment of sustainable utilisation of resources. If the market process of green finance is rational, green finance can steer the flow of funds and lead to an effective management of environmental risk and also to the optimal allocation of environmental and social resources. The effective regulation of policies will avoid the information asymmetry phenomenon and solve the moral hazard problem. If all of these hypotheses will become reality, the development of the green finance will be the driving force for the success and the imminent transition to renewable energies which could make them available to the general public and to all the countries.

1.5 Business opportunities and motivations

Motivations for green investments differ from investor to investor. Investing in this new concept of finance can lead to many opportunities and advantages but it is important to be aware of the different motivations of the green investors because they model their definition and understanding of what « green investment » means. The main motivations can be summarised in the following way:

- Increased awareness: nowadays, more and more individuals and companies are looking for ways to reduce the industrial and residential pollution and to finance projects and investments which safeguard or, at least, do not destroy the environment. Global warming is an indisputable fact and it is worrying many individuals and businesses because of its potential effects on the world economy. Anyway, individuals and institutional investors are not looking for a completely different type of finance but they are looking for a specific kind of finance which can connect financial

¹⁹ Wang, Y., Zhi, Q., (2016). *The role of green finance in environmental protection: Two aspects of market mechanism and policies*, CUE2016-Applied Energy Symposium and Forum 2016: Low carbon cities & urban energy systems, pg.312

instruments and environmental concerns. Indeed, green investments need to be at least financially at par with the non-green counterparts because otherwise there would not be considered by the investors. The answer to these concerns is the GF because it concerns the environment but does not deny completely the « mainstream » finance.

- Improving reputation: one of the main reason for investing capital by means of green financial instruments or for being more focused on the environmental protection is to create or improve the reputation. Companies try to become « green » to attract more customers and investors²⁰. Basically, it is also a marketing strategy to be a more appealing company in which eco-friendly investors can invest their money without worrying about environmental consequences. There is also a general pressure by many governments, media and NGOs to develop more sustainable processes and practices and to be more aware of carbon emission or pollution side-effects.
- Sustainability is a prudent long-term strategy: typically, many businesses focus only on short/medium term profits but it is necessary to adopt also strategies with a longer nature in order to ensure the survival of the company on the long-term. Indeed, many companies can be in an advantaged position for attracting environmentally-friendly consumers and investors which consider sustainable practices as an added value. An example is the state of the fishing in many parts of the world. Many species are disappearing very quickly and there is the risk of their extinction which, then will be translated into the bankruptcy of many fishing enterprises and companies. Preserving the fishing market and the fauna will, instead, protect the environment and ensure a long survival of the related industry.
- Financial reasons: there is a huge space for market expansion in the area of sustainable development. In these days, the way of producing is not sustainable in the long-term because the main countries are consuming the world's reserves at an excessively high rate. For instance, the speed of oil's consume in the U.S and in other countries will quickly lead to the end of the reserves and incredibly high levels of carbon emissions. Another advantage for the businesses, it's that they can reduce the costs of production by means of sustainable ways to reduce and recycle waste. For

²⁰ Zokaei, K., (2013). Environmentally-friendly business is profitable business in *The Guardian*, <https://www.theguardian.com/sustainable-business/environmentally-friendly-sustainable-business-profitable>

instance, nowadays there new ways and methods to reduce food waste and excessive use of plastic in the supermarkets. All these benefits can be exploited by the businesses but also by the single individuals from long-term investment in renewable energies (PV panels for example) or from the reducing of domestic waste.

The Ecole des Hautes Etudes Commerciales (EDHEC) in 2010 surveyed 97 European investors with over € 300 billions assets more specifically on green investing. The results show that for 86% of respondents, environmental protection is an investment theme. 62% of the former consider sustainable development an investment criterion across all sectors while 21% consider it a specific sector. Moreover, there are differences on what themes are being taken into account. The motivations see a dominance of responsibility for:

- the planet and society
- marketing reasons
- financial and legal reasons

The above survey also showed us that the planet and society concerns are what are mainly leading the choices of the investors and of the consumers, more than the financial purposes. Therefore, for this analysis, it's possible to see that the main transition is led by the increased awareness of the consumers and investors who are more and more concerned about the impact of human activities on the planet. The companies are becoming “greener” as a consequence of this environmental concern and they are, indeed, trying to adapt to the changed consumers' expectations and needs.

1.6 The need for a Green Index

As the market rapidly scales, indices are playing an important role in breaking down some major barriers facing institutional investors in the past decades. For instance, there is a serious lack of understanding of the types of green investments and a lack of clear risk and performance data about them. Many different indices have been created in order to cancel this gap between the green investment opportunities and the available investors and to improve the understanding of this new form of financing. Furthermore, indices suppliers frequently have an incentive to behave in a clearer and a more

transparent way in elucidating their methodologies than what happens with the funds. Indices are a fundamental investment tool for investment managers and investment owners because they represent a reference point for the investment decision-making process. Furthermore, a large number of funds and institutional mandates are run keeping into account the reference indices very closely. Exchange-traded funds (ETFs) and derivatives can be also associated with these green indices. Indeed, the amount of green ETFs has increased considerably in the last couple of years²¹. Liquidity, disclosure and cost benefits were and are the main reasons for the birth of this new typology of funds.

1.6.1 Green indices

Here we will take a look at the main equity indices which they tend to be more numerous and diversified over time. In many cases, the main indices are, somehow, related to the SRI, ESG or other environmental change approaches. However, from a deep analysis, it is possible to divide the main green indices for thematics, issuers and sectors (see Table 1).

Table 1: main green equity indices (source: Inderst, G., Kaminker, Ch., Stewart, F. (2012). OECD working papers on finance, insurance and private pensions)

	RI/SRI/ESG/SI	Green thematic	Sectors	Carbon related
FTSE	FTSE4Good Series	FTSE Environmental Market		FTSE CDP Carbon Strategy
Dow Jones	DJ Sustainability			
S&P		S&P Eco		S&P Carbon Efficient
MSCI	MSCI ESG/SRI	MSCI Climate Environmental		
HSBC		HSBC Climate Change		

²¹ OECD, (2012). *Defining and measuring green investments: implications for institutional investors' asset allocations*, OECD Working papers on finance, insurance and private pensions, no.24, pg. 21

	RI/SRI/ESG/SI	Green thematic	Sectors	Carbon related
Bloomberg			Bloomberg Clean Energy	
Wilderhill			Wilderhill New Energy	
NASDAQ		NASDAQ OMX Green Economy		
Markit				Markit Carbon Disclosure

From the analysis, it is possible to see that some indices have a relatively narrow sectoral or just a thematic focus, for instance, on clean energy or sustainable technology and innovation. Others, instead, are related to just one aspect which is, typically, carbon emissions reductions. Furthermore, for instance, in the MSCI's index, the oldest indices tend to include the environmental factor as just one aspect of the index and not just a single criterion. Another important fact is that the use of the indices also differs across different countries and types of investors. In Japan, for example, there is a focus on environmentally themed indices. Technology and social aspects, instead, are popular in the USA, while in Europe the interest has been generally broader across all responsible investment (RI) approaches. Indices see rising demand for different strands and by all investor groups, driven also by changes in legislation, regulation and government changes (e.g. "green ISAs" in the UK).

Another main difference is based on the metric which has been used to create them. Indeed, some providers select green stocks on a qualitative basis, i.e. because they operate in certain green sectors or produce green technology. Several others, instead, analyse the entire stock market universe and identify « greenness » quantitatively, for instance, 50% or more of the revenue needs to be climate change-related, or stocks with the highest contribution to reducing emissions. Finally, in a best-of-class approach, it is all relative, as the top 10% or 20% of companies in a sector are selected. Because of all these different procedures, the indices seem deeply different in dimensions, market capitalisation and a number of stocks. At the same time, they include prominent companies but also highly specialised niche producers which are also considered as green or at least « greener » than other similar companies.

Table 2: characteristics of the main green equity indices (source: Inderst, G., Kaminker, Ch., Stewart, F. (2012). OECD working papers on finance, insurance and private pensions)

Provider	Index	No. of stocks	Market capitalisation	Definition of « Green »
Dow Jones	DJ Sustainability World	342	9800bn	Top 10% for sector, largest 2.500 companies in the base index based on environment
FTSE	FTSE4Good	730	12900bn	Include environmental and climate factors
	Environmental Opportunities	475	1593bn	Environmental business activities (alternative energies)
	Environmental Technology	50	100bn	Green technology, clean energy and waste control
	CDP Carbon Strategy 350	<350	Similar to FTSE 350	Track base index but reduce exposure to carbon
MSCI	MSCI World ESG Index	790	11700bn	Best-of-class approach relative to sector peers
	MSCI Global Environment	167	413bn	Companies derive over 50% of their revenues from eco-friendly products and services
	MSCI Global Climate	100	2.4bn	100 leaders in mitigating the impact of climate change
S&P	Global Eco	40	178bn	Clean energy, water, environmental services
	Clean Energy	30	60bn	Clean energy producers and technology
	S&P U.S. Carbon Efficient	<375	Similar to S&P 500	Track base index to reduce exposure to carbon emissions (up to 50%)
	S&P IFCI Carbon Efficient	>500	Similar to S&P/ IFCI LargeMidCap	Track base index while considerably reducing exposure to carbon emissions

Provider	Index	No. of stocks	Market capitalisation	Definition of « Green »
BNEF	Wilderhill New Energy Global Innovation	97	187bn	Innovative technologies to generate clean energy
HSBC	HSBC Global Climate Change Benchmark	342	682bn	Generate revenues and produce based on companies with low carbon emissions
	HSBC Investable Climate Change	50	147bn	Climate change related revenue is more than 50% of the total
Markit	Markit Carbon Disclosure Leadership	569	Similar to FTSE All World	Tracks the performance of companies based on their CDP annual scores
Nasdaq	NASDAQ OMX Green Economy Index	417	1271bn	13 green economy sectors in the U.S.

Anyway, there are also many issues which are related to bias based on the sector, country and size. In addition, there is scarce data quality and transparency mainly from small and medium enterprises and also from emerging countries' markets. This, indeed, creates also an intense debate based on the performance and the risks of these « green » indices in comparison to the normal ones. Defining and calculating « greenness » seems to be more an art than a mathematical science. One of the main questions, in fact, is what is the appropriate cut-off point for environmentally-related revenues. Perhaps, it may be 20%, 50% or even 100%. Anyway, for each methodology, there are pros and cons and because of this issue, there is still a heated on-going debate.

In addition to all the previously listed indices, there is another one which evaluates the world main financial centres. The Global Green Finance Index (GGFI) is a ranking of international financial centres (for example London, New York, Luxembourg, Hong Kong, Singapore, etc.) based on the perceived quality and depth of the green financing

activities in each location²². It ranks the world's financial centres according to perceptions of the quality and depth of their green finance offerings. The index's aim is to encourage the 'greening' of financing markets to support a more sustainable and eco-friendly economy. The ranking provided much important information related to the commitment of many financial centres. From the ranking's results, it is possible to clearly see that the western financial centres outperformed the ones on another side of the world. In fact, in the first five places of the ranking, there are only old continent's cities. In conclusion, this ranking index, although rather new and not perfect, can provide good insights about the efforts made by many financial centres to provide and support several instruments to finance sustainable projects and investments which could improve the quality of the finance. Furthermore, the index also takes into account the perceptions of financial professionals because they have to assess the commitments of the different locations in order to define which is the investors' main opinions.

²² Luxembourg for finance, (2018). *Luxembourg continues to rank among the top 3 financial centres in the EU*, <http://www.luxembourgforfinance.com/en/news/luxembourg-continues-rank-among-top-3-financial-centres-eu>

CHAPTER II

Green financial instruments

2.1 Overview

Green finance (GF) is therefore not just a single product or activity financing, rather an entire financial system which have different available instruments to finance a range of activities whether non-revenue water reduction (water which is lost before arriving to the customer), forestry expansion, or transportation but under the single goal of promoting a green economic transformation toward low-carbon sustainable and inclusive pathways. This also means that finance can no longer be considered as an enemy of sustainable development but instead as a powerful means to facilitate this energy transition. Using the right tools and with specific objectives, sustainable finance can coexist and collaborate with the "mainstream" one. GF is, therefore, a « climate change plus » financing approach, linking financing to natural capital, societal and financial sustainability.

Green finance, therefore, has to be sought both from a larger number of sources and used more efficiently. Greening infrastructure projects will likely evaluate the above risks by means of additional green costs, such as the need for a more advanced technology to meet green targets, while the green benefits from projects often remained unquantified and thus do not get captured as direct revenue benefits to projects²³.

The overview of the green finance leads us to ask which are the main or the best financial instruments to sustain and foster the concept of green finance which we tried to define above. As said before, the term “green”, despite becoming a nearly ubiquitous one, can be somewhat vague and unclear. When people talk about "green investments", they are generally speaking of investing in activities that, in a popular context, can be considered good for the environment in a direct or indirect manner but this is not always so clear. Anyway, there are many financial instruments which can be an answer to the

²³ European Banking Federation, (2017). *Towards a Green Finance Framework*, Report from EBF, pg.14

always increasing demand for a sustainable finance. These instruments can be based on debt or on equity but, essentially, what they have in common is the objective which they have set for themselves.

2.2 Green equity

Equity for sustainable projects can come from a utility that is financing the whole project; or from the developer who is contributing partial equity (usually 20% to 40%) of the investment cost; or it may also originate from outside investors such as infrastructure funds, private equity funds and insurance companies²⁴.

Capital for private equity can be used to finance new technologies, expand working capital, make acquisitions, or to even strengthen the balance sheet. Whether they are venture capital in a start-up electric vehicle company or the financing of a solar power project, green technologies represent investments that are crucial to our transition to a low-carbon society. The first beneficiaries of private equity are renewable energy, energy efficiency, clean transport, forest management, water management, sustainable land use and other low-carbon projects, all of which are urgently required in the developing world. Green equity products have been mushrooming throughout the market, using all sorts of different approaches to green investing. The level of methodological clarity and transparency is mixed.

Cleaner Energy	Environmental Resources	Energy and Material Efficiency	Environmental Services
Power Generation: solar, wind, clean coal, geothermal, hydro, fuel switch (gas, biomass), nuclear	Water: desalination, wastewater treatment, distribution and management	Advanced Materials: advanced coatings, lightweight substitutes, solvents and biodegradables	Environmental Protection: land conservation, environmental restoration, timberland, forestry
Clean Tech Innovation: infrastructure and supply chain management	Agriculture: irrigation innovation, clean pesticides, seeds and breeding technologies	Building Efficiency: building management, heating and cooling systems, lighting systems, insulation and materials	Business Services: insurance, logistics, green focused banking, micro-finance, consultancy/ advisory, intellectual property

²⁴ OECD, (2012). *Defining and measuring green investments: implications for institutional investors' asset allocations*, OECD Working papers on finance, insurance and private pensions, no.24, pg. 53

Transport: emissions reduction, propulsion systems, battery technology	Waste Management: recycling, toxin management, waste of energy, land remediation	Power Grid Efficiency: transmission, distribution, storage, infrastructure, energy management systems	Carbon credit developers
Sustainable biofuels: bio-diesel, ethanol		Enabling Technologies: lasers and others	

Figure 1: Climate Change Investment Universe (source: re-edited from DB Climate Change Advisors, 2012)

An example of a wide, complete “climate change investment universe” is provided in a recent report by DB Climate Change Advisors (2012). It distinguishes three broad categories: cleaner energy, energy and material efficiency and environmental resources which are then sub-divided into smaller categories²⁵ (see Figure 1).

2.2.1 Green venture capital

Venture Capital, or Venture Capital fund (VC), translatable into venture capital, is a form of high-risk investment, but it can also give exceptional economic returns²⁶. It is the type of alternative finance that startups are targeting, companies that by their nature have a high percentage of bankruptcy (3 out of 4 go bankrupt), but when they are successful they guarantee their investors exit that repay them abundantly also of what they have lost in failed businesses. Indeed, one of the main financing way to create a new and innovative start-up company is by means of this instrument.

Anyway, recently, venture capital has been used as a tool to develop entrepreneurial business initiatives which want to works towards sustainability goals. This current focus is also linked to the more and more popularity of socially responsible investments (SRIs) and environmental social governance (ESG) approaches which have inspired a sustainable way of collecting capital for mutual funds. A research on the topic of “green venture capital” does not show enough results to understand well and clearly this

²⁵ OECD, (2012). *Defining and measuring green investments: implications for institutional investors: asset allocation*, Working papers on finance, Insurance and Private pensions, pg.20

²⁶ Zider, B., (1998), How Venture Capital works in *Harvard Business Review*, <https://hbr.org/1998/11/how-venture-capital-works>

phenomenon. Sometimes, many other words as “ecological” or “environmental” are used as a way to describe this kind of financing tool. The current problem is also that many business and firms do not market themselves with these adjectives because they think that it will decrease their possibilities of accessing to funds. On the whole, there is no sufficient academic and literature which makes clear a link between venture capital and sustainable goals. In spite of this important lack, it is often possible to find an environmental theme or aim in the new start-ups which have been created in the past years.

An important conference was also held in Switzerland on 19th January 2000 with the objective of collected data and information on this financing tool. Moreover, in order to understand the phenomenon, it is essential to identify who are the main individuals or firms who could be interested in the green VC industry. Many venture capitalists are seeking “eco-entrepreneurs” who are creating innovative eco-friendly products or services and who need financial support. VC is often thought of as a ‘neutral’ way of financing start-up companies, independently of kind of business and typically it has a short-term nature. Sustainable development, on the other hand, is interested in the direction and “the actual theme of companies’ products, services and practices, having a commitment to long-term orientation”²⁷. In the mainstream VC capitals, the environmental characteristic is just one part of the investment decision-making process and it is not essential for the development of the start-up as in the green VCs case. Sometimes environmental issues are just seen as a risk factor or a potential liability for the new business activity, but in the green VCs, the environmental factor should be considered as a value-added characteristic for the enterprise. In fact, some green VCs are said to able to generate “double dividends”²⁸ because they create economic and financial benefits for themselves but also they are also protecting the environment from side-effect risks. However, there are other differences between the two types of VCs which are mainly linked to the young age of the green ones which are still at an early stage or phase of their development and also to their risk (see Table 3).

²⁷ Rennings K. (2000). Redefining innovation - eco-innovation research and contribution from ecological economics in *Ecological Economics*. 32: 319-332

²⁸ Porter, M., Van der Linde, C. (1995). Green and competitive in *Harvard Business Review*

Table 3: Difference between mainstream VC and green ones (source: J. Randjelovic, data from publications of European Venture Capital Association (EVCA) and Venture Economics)

VC in Europe and USA	Mainstream VC	Green VC
Investment size	€154 Billion	€100 Million
Number of VCs	About 1600	Around 45
Average amount of investments	€120 Million	€1,1 Million
Duration of investment	2-3 years	3-5 years
Environmental prerogatives	Environmental risks and liabilities	Environmental or/and social screening
Sources of financing	Pension funds and banks	High net-worth individuals
Investors orientation	Typical ROI	ROI plus ecological orientation
Current targets for investments	Communications, Software, Information Technology	Renewable energy, water and cleaner technology equipment

However, there are still many problems which are restricting the capacity of the VCs to success and to develop at a higher speed. For example, an English start-up which is called “WaveGen” is working in the manufacture of equipment for wave energy production²⁹. The technology carries many hopes and promises because the UK government and the United Nations Framework Convention on Climate Change are demanding more and more renewable energies and this will facilitate the spread of wave technology. Despite its aim, WaveGen is not fully exploiting what the market could offer to the innovative eco-start-up because it has not been promoted as a green VC. The issue here, as said before, is that often the adjectives “sustainable”, “eco-friendly” and “environmental” are creating many problems in the promotion of the enterprise. Indeed, these factors are also perceived as an added risk to the already well-known risks of innovating. Another issue is also linked to the fact that there is no a proper network which could facilitate the meeting of eco-entrepreneurs and VC firms. In Europe, for example, there is not a platform for information, trade fairs or conferences for sharing

²⁹ Collinson, P., (August 2004). Will energy funds ride the crest of a wave? in *The Guardian*, <https://www.theguardian.com/society/2004/aug/28/environment.alternativeinvestment>

the knowledge about new green VCs, while in the U.S. there is an “Investor Circle” which is considered as the world’s largest and most active early-stage impact investing network. In spite of all these challenges, the main problems could be resolved in time as the field becomes more developed and the market is more informed about new environmental technology and sustainable practices. It’s important to note that there is a growing market for investment in eco-friendly initiatives and this could be one of the main ways to finance new start-up and projects which are essential for the necessary innovation in the renewable energies and environmental protection.

2.2.2 Green funds

Another very important tool in environmentally investing includes funds and ETFs with an environmental and sustainable nature. Since the beginning of 2017, the European green funds have raised 222 million euros, reversing the negative trend that has characterised the last three years. Generally, a green fund is a mutual fund or another investment vehicle that will only invest in companies that are deemed socially conscious in their business dealings or directly promote environmental responsibility. A green fund can represent a form of an investment vehicle for companies which are committed to environmentally-friendly activities, as for example alternative forms of sustainable energy, eco-friendly transportation, reduction of waste, and eco-friendly ways of living. Looking at yields, it seems that investors have underestimated the potential of the so-called clean energy.

Green funds have a positive performance and what is more important they are resisting to the negative financial context³⁰. In addition to this, more than € 32 billion have been invested in equity and environmental bond funds in 2017 in Europe³¹, with France and Switzerland leading the ranking as the two most active European countries. This huge increase in environment-themed funds has also been examined in the Novethic study entitled "2018 European Green Funds Market". The increase of 49% of the total amount, from 2016 to 2017, is four times higher than + 12% of the market for European

³⁰ Adamo., R., Federico, D., Notte, A., (2014). Performance and risk of green funds in *Investment Management and Financial Innovations*, 11(1-1)

³¹ Blanc, D., Plus, E., Bonnin, M., (2017). *The European green funds market - March 2017*, Novethic Research Centre, pg.2

funds in general³². Anyway, it is essential to verify how much a fund is sustainable and for this reason, the investment funds which boast a sustainable label have to demonstrate their nature and composition. Indeed, Morningstar and other firms have tried to find a system or a methodology to measure the sustainability of every fund. For instance, Morningstar's system evaluates how companies incorporated into a fund's portfolio to manage risks and opportunities related to ESG factors and allow comparisons between similar funds or towards a benchmark based on ESG criteria. Based on data from the ESG rating at the individual company level, provided by Sustainalytics (world leader in the ESG research), Morningstar assigns its Sustainability Rating to all those funds for which at least 50% of the holdings in the portfolio are covered by ESG reviews³³. A recent study found out that sustainable funds as a group performed better than the overall fund universe in 2017.³⁴ This index measures the degree of involvement of a company in harmful events for the same, but also for the environment and society. This includes disasters such as the spillage of crude oil caused by the breaking of an oil pipeline, the burning of oil wells or the explosion of an oil tanker, which are sadly inscribed in the history of the main oil companies.

In addition to this, based on performance, it is not always clear whether green funds and socially responsible investing (SRI) can consistently create better returns for investors, but they do represent a proactive step toward environmental consciousness, which many investors see as incredibly valuable. Some have said that green investing has begun during the 1990s, a period in where there was an increased in environmental focus and investors were more seriously taking into account the harm which many businesses were creating to the environment. Following the serious events like the Exxon Valdez oil spill which, in 1989, has created one of the most devastating human-caused environmental catastrophes, several investors started to look for businesses which were

³² Novethic Research Centre, (2018). *The European Green Funds Market +49%*, Paris, Novethic Report

³³ Pelusi, D., (April 2016). *The New Morningstar Sustainability Rating: a new lens for investors*, Morningstar SRI Breakfast, Morningstar

³⁴ Hale, J., (2018). What Are Sustainable Funds and How Have They Performed? - A view of the sustainable investing landscape in the U.S. in *Morningstar blog*, <https://www.morningstar.com/blog/2018/01/31/sustainable-funds.html>

working towards a better way of managing their impact on the planet³⁵. In fact, these types of companies, for many investors, were not only operating in a more environmental way but they also have a competitive advantage over the other business which is not trying to limit their impact on the environment. Nevertheless, many investors believe that investing capital into environmental-friendly companies is a moral and an ethical obligation. For this reason, many different funds have been created to satisfy the requests of many investors who were seeking to invest in eco-friendly industries or companies without the danger to make mistakes for a lack of deep information.

2.2.2.1 Green funds' characteristics

In 2017 Novethic Research Centre analysed the main European green funds from 2009 to 2012³⁶. Its review examined how the European market's development was influenced by the two main agreements whose aim was to change the face the climate change and to reduce the carbon emissions. These agreements were the Paris Agreement and the COP 21 climate commitments. Moreover, the research centre also took into account the change and transformation of business models in many clean-tech companies which were related to the technological improvements in wind and solar energies. The selection used for this analysis includes 226 green funds (which comprise 590 sub-funds or compartments) that have been sold in Europe and managed in 16 countries over the past ten years. Within this selection, 165 funds (466 share classes or sub-funds) were open for investments at 31 December 2016. The analysis of the available documentation recognise the main themes which are included in investment portfolios over time. However, it is always possible to understand the precise even though it is generally not possible to know the exact decomposition of every portfolio. From the survey, it possible to see that the renewable energies theme is one of the most utilised among all the other themes. In fact, the 75% of the total funds include sustainable energies (solar, wind, biomass energy, etc.) as a core of their investing strategy. The second most

³⁵ Robards, M., (March 2014). Exxon Valdez: what lessons have we learned from the 1989 oil spill disaster? in *The Guardian*, <https://www.theguardian.com/environment/blog/2014/mar/24/exxon-valdez-oil-spill-disaster-arctic>

³⁶ Blanc, D., Plus, E., Bonnin, M., (2017). *The European green funds market - March 2017*, Novethic Research Centre

popular theme includes the energy efficiency's topic which affects almost 70% of the funds under consideration. On the other hand, the water theme is part of nearly 65% of funds, whereas the other themes (waste management, pollution control, sustainable mobility and energy efficiency for buildings), have a smaller presence in the funds with a percentage of 50% on average. found in half of the funds. Lastly, at the end of the list, there is the agricultural and forestry theme which is scarcely present in the considered funds with a percentage of 20% (as in Figure 2).

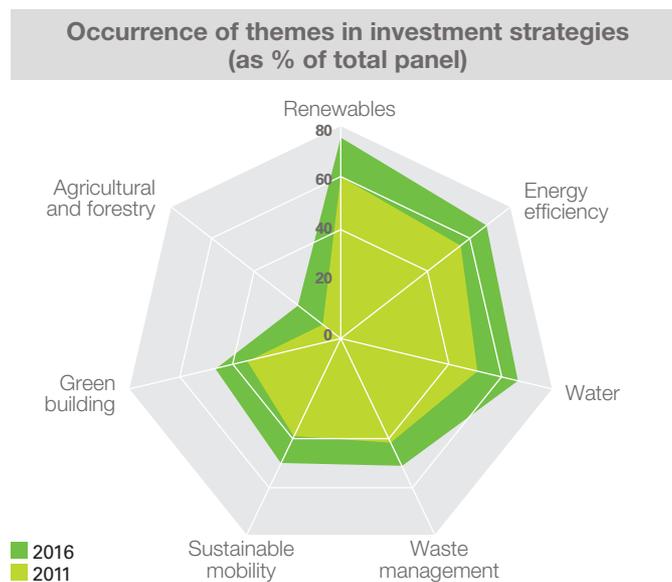


Figure 2: main themes investment strategies (source: Novethic Research Centre, The European green funds market - March 2017)

On the other hand, an additional common investment approach is to invest by means of specialist funds. In 2012, Bloomberg New Energy Finance (BNEF) has made a research about the available energy public equity funds which has been created during the 2000-2012 period. The chart created from this study shows a peak in 2007, which was then followed by a deep fallout in the following years because of the well-known financial crisis (see Figure 3).

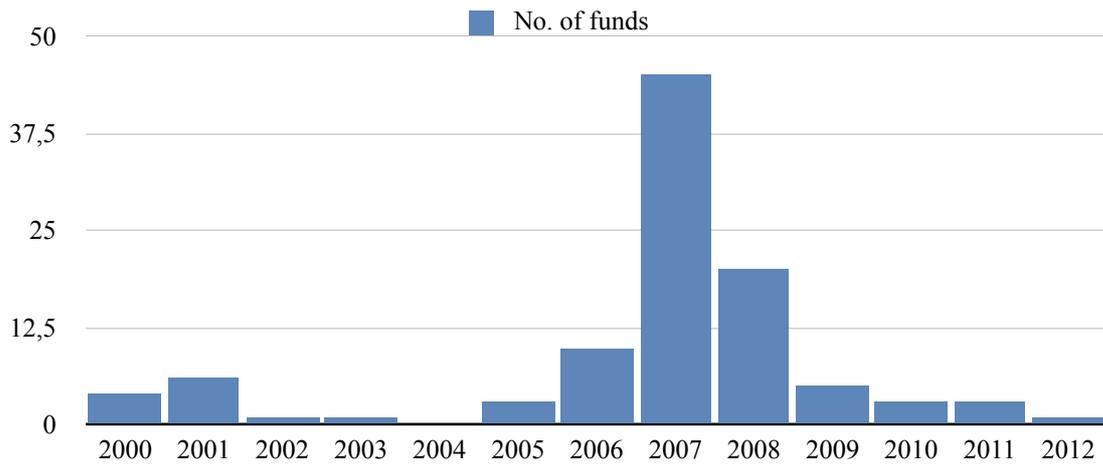


Figure 3: Number of sustainable energy public equity funds launched, 2000-2012 (source: OECD Working papers, no.24)

Anyway, in the recent years, there was a new increase in Green Funds which in Europe grew up by 49% in 2017 and reached an amount equal to €32 Billion. On the other hand, an additional important issue to discuss is about the difference between common funds and the green ones. It's, indeed, essential to verify if there is some kind of advantage or disadvantage in terms of financial characteristics of the two different funds. Thomas Reuters Eikon has executed an analysis on this issue and has compared the volatility of the S&P index with the historical volatility of Green Share Indices (Figure 4).

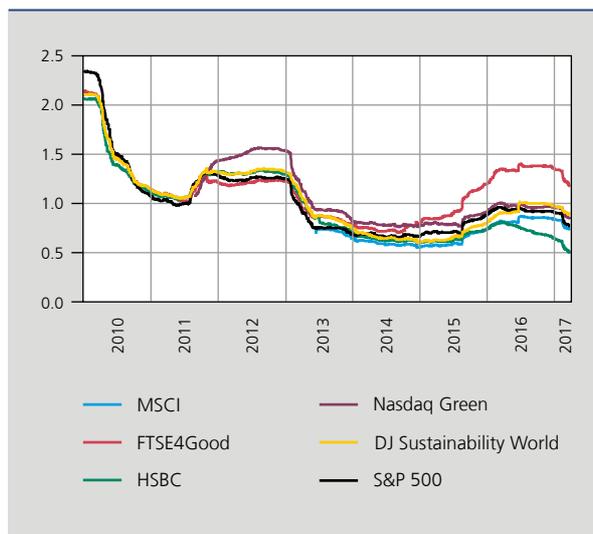


Figure 4: volatility of S&P Index compared with the one of Green Share Indices (source: Hadj, S., De Mulder, J., Zachary, M., (2017). *Sustainable and green finance: exploring new markets*)

Except for the case of the FTSE4Good Index, the other indices seem to follow the general behaviour of the “traditional” market S&P. In conclusion, from the analysis, the green indices does not appear riskier than their general counterpart and do not appear to be affected by the specific risk characteristics of green and sustainable projects, for example, its long-term nature. Different reasons can explain this perception of a normal risk. First, the indices only provide information on projects funded partly by the equity of publicly-listed companies. Moreover, there can be some disputes concerning the fact that green indices are able to represent the “traditional” green and sustainable investment investments which are typically managed by quite young and inexperienced (and often unlisted) companies and which usually are also financed heavily by means of debts. An additional factor is that the companies which offer shares to the public are certainly more experienced and rely less on debt.

2.3 Carbon finance

Carbon finance is the term applied to the resources provided a project to purchase the “greenhouse gas emissions reductions”³⁷ Anyway, carbon finance is a general term applied to resources provided to projects that are generating or are expected to generate greenhouse gas (GHG) emission reductions in the form of the purchase of such emission reductions which are tradable on the carbon market. Carbon markets provide an additional source of revenue for sustainable energy projects by creating a commercial value for reducing greenhouse gas emissions. This can improve the commercial feasibility of RET initiatives and then it can have a critical part in supporting and making enlarge renewable energy enterprises. In the following table it’s possible to summarise some of the advantages and disadvantages of carbon finance:

Advantages	Disadvantages
A viable instrument of obtaining up-front financing secured against carbon revenues	Only a small number of potential buyers of CERs exist. This is translated in a problem of “liquidity”.
Support the financial viability of low-carbon investments and initiatives	Significant risk is transferred to the public financing agencies, if the sales are made before of project registration (under the Clean Development Mechanism) or if carbon earnings are not certain.

³⁷ World Bank, (2012), *Carbon Finance for sustainable development*, Annual Report, pg.39

Efforts to catalyse a market for greenhouse gas reduction by forcing the companies to choose more sustainable options, which are necessary to decrease the cost of global action on climate change	Process of realising carbon revenues can be complex and costly and sometimes it is difficult to calculate how much carbon emissions have been created.
Provide an incentive to transform the traditional processes and the practices of an enterprise into more sustainable and eco-friendly ones	Front-end loading of carbon finance revenues has been difficult to realise in practice given the regulatory and operational uncertainties of these projects.
	Not all the countries follow the carbon emissions regulations so there is a free-ride issue.

Table 4: advantages and disadvantages of Carbon Finance (World Bank, How to Keep Momentum up in Carbon Markets? October, 2011)

Looking at the different benefits, which Carbon Finance could bring into the market, is undeniable to say that the system is not perfect yet but the change which could bring to many businesses is a big step towards a low-carbon emissions society.

2.3.1 Process of Carbon finance

On this topic, unfortunately, there is a low level of knowledge and a low use of the operational tool in order to make cooperation projects less dependent on public funding and more oriented towards the principles of environmental, social and economic sustainability. This is a fundamental challenge that is very difficult to impose, involving institutions, NGOs, companies and development policies designed with a view to environmental, social and economic sustainability. International carbon market mechanisms were first implemented on a large scale as part of the flexibility mechanisms under the Kyoto Protocol³⁸. The use of international carbon market mechanisms was, and remains, an appealing option because of the prospective to achieve emission decrease most cost-effectively by taking advantage of the cheapest softening potential inside a specified trading system, and furthermore, because of the potential to in part re-incorporate the social cost of gas emissions. Markets with stable conditions demand a variety of market actors for both the supply and the demand. The crisis and the resulting economic paralysis in the EU had a considerable effect on the

³⁸ The Guardian, (July 2011). *What is the Clean Development Mechanism (CDM)?*, Sandbag, Guardian Environment Network, <https://www.theguardian.com/environment/2011/jul/26/clean-development-mechanism>

demand for Certified Emissions Reductions (CERs), because of the lack of a manifold group of credit purchasers; the EU ETS contributes for the most part of all CER credit purchases. Because of unexpected developments, emissions in several countries and EU ETS installations decreased to surprisingly low levels, with the consequence of impeding the demand for CERs. The attendance of the major countries as main credit buyers would create a longer-term market stability to global carbon markets, and considerably decrease the risks for investments. Anyway, the system is based on the fact that the more diligent and scrupulous companies and businesses have an economic advantage for their effort in improving their technology and production processes. A simple example is a company, which replaces an inefficient technology with a more sustainable one (one which produces fewer carbon emissions), which can gain from the sale of carbon credits and become more profitable (as in Figure 5). The entire process is verified by auditing and regulatory bodies (Golden Standard and United Nations) which have the duty to supervise the credibility and to test the real reduction of carbon emissions.

Carbon Finance

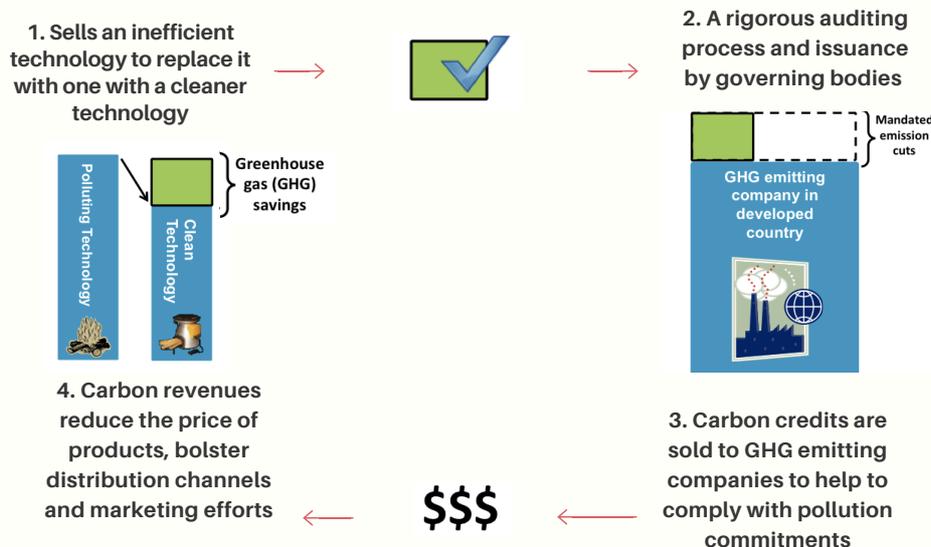


Figure 5: Carbon Finance mechanism (re-edited from Envoy Magazine, <https://www.theenvoy.eu/la-carbon-finance-unopportunita-mondo-della-cooperazione-internazionale/mag-carbon-finance-101-big/>, [5 September 2018])

2.3.2 Role of the World Bank

The Bank's engagement in carbon finance started with the establishment of the \$180 million Prototype Carbon Fund in 1999. Since then the Bank has also decided to manage the country carbon funds for many governments (mainly European ones)³⁹. Furthermore, the Bank funded the Community Development Carbon Fund in 2003, and the BioCarbon Fund in 2003. The development of the carbon funds in the last years has been very fast. The carbon funds managed by the Bank increased from \$413.6 million on July 1, 2004, to about \$ 914.7 million in the same period in 2005⁴⁰. Moreover, with the Umbrella Carbon Facility, Bank supervised carbon funds are forecasted to be almost \$ 1,352.7 million by July 1, 2006.

Even if, in the beginning, the Bank's mission was to encourage and support the market for carbon emission, carbon finance is now developing as one of the main objectives of the Bank's program. Moreover, given the creation of the Kyoto Protocol in 2015, the Bank clearly defined three main targets which it decided to achieve in the close future:

- to guarantee that carbon finance makes its part in supporting a sustainable development, in addition to its contribution to global environmental initiatives;
- to help in constructing, supporting, and enlarging the international market for carbon emission reductions and its institutional and administrative bodies;
- to reinforce even more the ability of the developing countries to take advantage of the emerging market for emission reduction credits

Furthermore, the Bank can also establish a joint relationship with other international institutions and entities in order to transmit the knowledge acquired by the Bank during the years of activity. An example of an important collaboration is the creation of a

³⁹ ZhongXiang, Z., (2004). *The World Bank's prototype carbon fund and China*, MPRA Paper No. 13222, posted 06. February 2009 / 20:54, pg.14

⁴⁰ World Bank, (2014). *The Role of the World Bank in Carbon Finance: An Approach for Further Engagement*, pg.1

carbon fund with the European Investment Bank (EIB)⁴¹ in order to support the carbon finance. This cooperation will bring to support the collective technical and financing abilities of both institutions to arrange and invest in projects which decrease carbon emissions and in this manner lessen climate warming. Moreover, such an initiative would permit the Bank to decrease transaction costs by means of strengthening future resources from Europe for carbon purchases in just one fund.

2.4 Green bonds

Debt investments usually involve less risk than the equity's alternative. Anyway, debt financing can come from a lender's loan or from selling bonds to the general public. While a loan is a transfer of money from a bank to a company or to an individual, a bond is a transfer of money from the public or market to a company which issues that bond. Unlike loans provided through bank debt, bonds traded on public debt markets tend to involve larger amounts of capital and are also open to the general public for investments. In the beginning, bonds in the green finance field have tried to target more qualified and specific investors. In any case, some types of notes (for instance, note payables and structured notes) have also been made advantageous and affordable to individual investors because of the fact that it is not necessary to give a high upfront investment.

Anyway, generally green bonds can mobilise resources from domestic and international capital markets for climate change adaptation, renewables and other environment-friendly projects. However, they are no much different from conventional bonds. Indeed, their only different characteristics are the specification that the proceeds have to be invested in projects that generate environmental benefits and advantages. As in the traditional case, a bond issuer will collect a given amount of capital, repaying the capital, called the principal, and accrued interest, called coupons, in a given length of time. The issuer will have to produce enough cash flows to pay back the interest and the

⁴¹ European Investment Bank, (2007). *EIB launches New Post-2012 Carbon Fund, the first Carbon Fund targeting post-Kyoto credits*, Press releases, <http://www.eib.org/en/infocentre/press/releases/all/2007/2007-092-eib-launches-new-post-2012-carbon-fund-the-first-carbon-fund-targeting.htm>

capital. Therefore, green bonds, in their structure, cannot be distinguished from the common counterparts but they have raised many questions because they are one of the main available instruments for the “eco-friendly” investor and because, somehow, they are leading the GF development.

2.4.1 How do we define a green bond?

One of the first question to answer is linked to the definition of « green ». In fact, green bonds carry out the same difficult questionings of the general Green Finance term. In order to define how we can distinguish a green bond from another one, it’s necessary to understand which are the characteristics that define this new kind of bonds. As a matter of fact, they are innovative financial tools where the money raised are allocated exclusively to green initiatives which produce climate or environmental advantages. Renewable energy, energy efficiency, eco-friendly waste management, sustainable use of the land and biodiversity protection are just a few examples of the several ways to sustain an environmental development.

In spite of these specifications, it is not always clear whatever a bond corresponds to those criteria. Answering this problem, the Green Bond Principles (GBP) have been created as non-binding general rules which strongly suggest divulgation of information and the encouragement of honesty in the development of the Green Bonds by elucidating the mechanism for the issuance of this type of bond. They were established in 2014 by a union of the biggest investment banks: Bank of America Merrill Lynch, Citi, Crédit Agricole Corporate and Investment Bank, JPMorgan Chase, BNP Paribas, Daiwa, Deutsche Bank, Goldman Sachs, HSBC, Mizuho Securities, Morgan Stanley, Rabobank and SEB⁴². Moreover, the current monitoring and development of guidelines have since moved to an independent secretariat hosted by the International Capital Market Association (ICMA)⁴³.

⁴² Citigroup Inc., (January 2014). *Green Bond Principles Created to Help Issuers and Investors Deploy Capital for Green Projects*, Citigroup News, <https://www.citigroup.com/citi/news/2014/140114a.htm>

⁴³ International Capital Market Association, (2018). *Green Bond Principles Voluntary Process Guidelines for Issuing Green Bonds*, The Green Bond Principles, pg.4

Therefore, nowadays it is possible to determine whether a bond qualifies as green or not, even if it is not always so clear and sometimes could also be subjective. Furthermore, the GBPs are also capable of assisting underwriters by moving the market towards standard transparency and disclosure which will facilitate its development. In fact, generally speaking, green bonds must undergo third-party objective verification to establish that the proceeds are funding projects that truly generate environmental benefits and advantages. Therefore, these are the four Green Bonds Principles which define a green bond in relation to its main characteristics:

- the use of proceeds: the issuer should state which is the suitable green project which he intends to finance. Then, he should also supply a clear description and analysis of the environmental benefits of the projects or initiatives which he wants to financially support;
- process for the evaluation of a project and the subsequent selection: the issuer should define the investment decision-making process he follows to determine the eligibility of individual investments by means of the green bond's earnings;
- management of returns: the proceeds should be moved to a sub-portfolio or otherwise attested to by a formal internal process which should be made known to the public;
- reporting and disclosure: typically, the issuer should report at least annually on the investments which have been made from the proceeds. Furthermore, it should also conduct a detailed analysis out of the potential the environmental benefits accrued with quantitative/qualitative indicators;

However, the Green Bond Principles do not give a specific definition of “green”. Its specification is left to the issuer which has the duty to determine it. Anyway, broad green project categories suggested by the principles include⁴⁴:

- Energy
- Buildings
- Transport
- Water management
- Waste management & pollution control
- Nature-based assets including land use, agriculture and forestry

⁴⁴ International Capital Market Association, (2018). *Green Bond Principles Voluntary Process Guidelines for Issuing Green Bonds*, The Green Bond Principles

- Industry & energy-intensive commercial
- Information technology & communications (ICT)

In conclusion, the Green Bond universe is composed of different levels of standardisation (see Figure 6). The following figure can give us an overview of the complex structure of the GB market's specification.

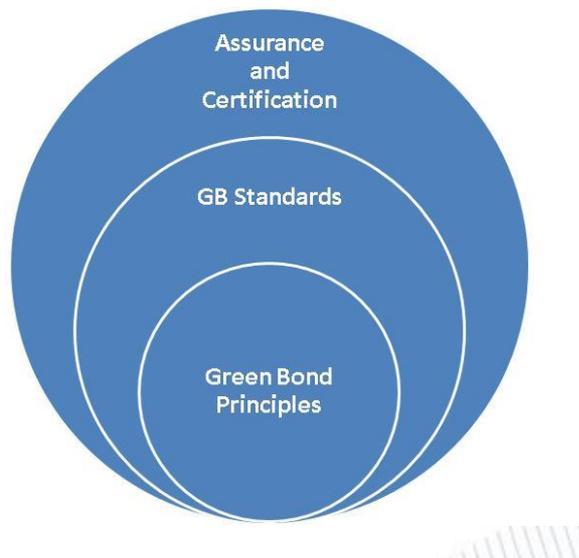


Figure 6: the green bond market ecosystem (source: ICMA, *review of GB principles in 2016*, Beijing)

The inner level the green bonds' ecosystem includes the main market's founding principles, the intermediary circle, instead, consists of the GB standards and taxonomies, and the wider area includes the external reviews which are made by accountancy firms, ESG experts and academics. Looking at all these systems created by the major banks, it has been possible to be more specific when defining a Green Bond. However, the system is not perfect yet and ICMA is still working to improve the standardisation and the harmonisation of regulations, transparency and disclosure. Moreover, it is also trying to market the idea of sustainable bonds in underdeveloped countries which could benefit from this simple instrument.

2.4.2 Categories of green bonds

There are many categories of Green Bonds. However, an initial general distinction can be made dividing the bonds into the category of green labelled bonds (which are essentially certified as green) and that of the unlabelled green ones (whose issuance is linked to projects which generate advantages for the environment). On the other hand, climate bonds are just a sub-category where the proceeds are related to projects which face and try to limit the climate change. On the other hand, the Climate Bonds Initiative (CBI) has also identified other categories for the Green Bonds. Indeed, other four different categories of eco-friendly bonds have been defined:

- Green Use of Proceeds Bond: it is a common debt with recourse to the issuer in which the credit rating is the same for the issuer and for the bond itself. For instance, the European Investment Bank (EIB) has issued the Climate Awareness Bonds in 2007. By means of these initial bonds, the bank has raised almost €16.8 billion between 2007 and April 2017⁴⁵. Furthermore the State of California issue \$300 millions of Green Bonds with maturity in 2037⁴⁶. The proceeds came from several projects with green-related activities.
- Green Use of Proceeds Revenue Bond: contrary to the previous one, it is a debt without recourse to the issuer and it is bound to a revenue stream which has been generated by fees, taxes, etc. Then, the bonds' proceeds can be invested in projects or initiatives which are linked to eco-friendly or sustainable activities. Usually, they can be issued by any government agency or fund. For instance, New York's Metropolitan Transportation Authority (MTA) chose to issue Green Bonds in February 2016. Thanks to the capital collected, the MTA used the \$500 million of revenues to invest into infrastructure renewal projects, including upgrades on its railways⁴⁷. Another example is the Iowa Finance Authority which has issued \$321.5 million of State

⁴⁵ UNDP, <http://www.undp.org/content/sdfinance/en/home/solutions/green-bonds.html>, [20 September 2018]

⁴⁶ State of California, (2014). *Third Annual Report, 2014 Green Bonds*, <https://www.treasurer.ca.gov/publications/2014green.pdf>, pg. 1

⁴⁷ Metropolitan Transportation Authority (MTA), (2016). *MTA to Issue Its First 'Green Bonds'*, <http://www.mta.info/news-bonds-green-bonds-mta/2016/02/10/mta-issue-its-first-%E2%80%98green-bonds%E2%80%99>

Revolving Fund in 2015⁴⁸. The proceeds were allocated for an eco-friendly project whose aim was to reduce the waste of water in the country.

- Green Project Bond: a project bond for a single or multiple green projects which is used to find fundings from capital market investors and for which the investor is directly exposed to the potential risk of the projects. For instance, OPIC, a US development finance institution, has offered US\$47 million Green Guarantees to US investors. The proceeds will be invested in the Luz del Norte project in Chile, one of the largest photovoltaic project in Latin America⁴⁹.
- Green Securitised Bond: a bond collateralised by one or more specific projects, including covered bonds, ABS, and other structures. The first source of repayment is generally the revenue generated by the assets. This type of bond covers, for example, asset-backed securitisations of rooftop solar photovoltaic panels and/or energy efficiency assets.

2.4.3 Who are the stakeholders?

In order to understand well the Green Bond's market, it is necessary to know who are the main actors involved in the issuance and in the purchase of this type of products. Making clarity about this point will help us to understand the motivations behind this choice and why GB could be a better investment in comparison with their common counterpart. The main individuals and entities involved in this eco-friendly market can be summarised in the following list:

- Green Bonds issuers: the green bonds issuers could be any company, government agency or financial institution which generates, registers and finally, sells a bond in the market. As seen before, the World Bank and the Government of China are only a few examples. Furthermore, the number of issuers is continuously increasing and this pushes many banks and companies to participate. Typically, in order to manage and administer the bond, the issuer has to select an underwriter which purchases the newly

⁴⁸ Iowa Finance Authority, (June 2016). *Basic financial statements and schedule of expenditures of federal awards*, Financial statement report, www.IowaFinanceAuthority.gov

⁴⁹ Forbes, (July 2014). First Solar Makes Progress In Chile As Funding For Luz del Norte Project Is Approved in *Forbes News*, <https://www.forbes.com/sites/greatspeculations/2014/07/01/first-solar-makes-progress-in-chile-as-funding-for-luz-del-norte-project-is-approved/#41d3e0ae15ed>

issued bonds from the issuer and then sells them to the available investors. Anyway, the issuers are generally composed of corporates and banks, followed immediately by energy and utility companies and then by public entities (see in Figure 7).

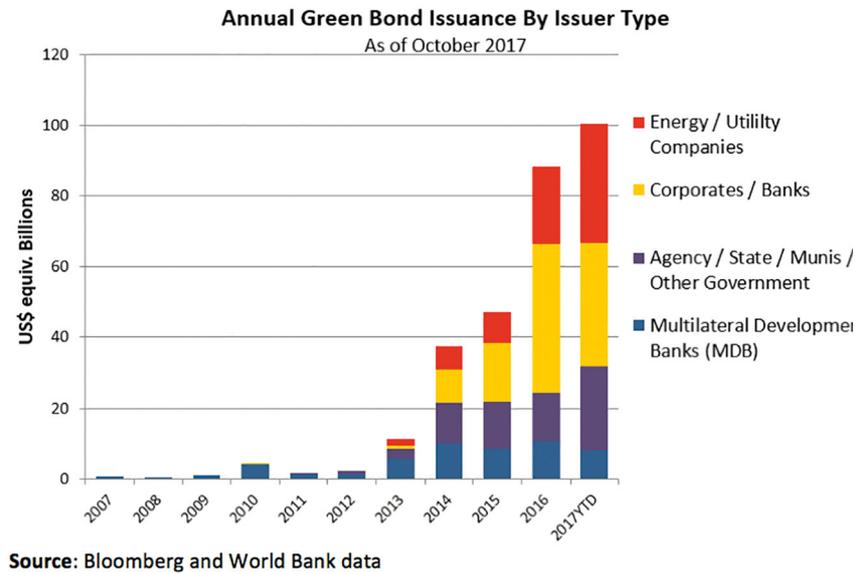


Figure 7: annual green bond issuance by issuer type (Bloomberg, World Bank, <http://www.worldbank.org/en/news/feature/2015/01/22/green-bonds-changing-investor-expectations-three-trends>, [10 September 2018])

- Green Bonds investors: individuals, companies or institutional investors who buy green bonds with the expectation of a positive return. Investors, indeed, are increasingly interested in environmental themes and demand financial instrument with green objectives. This group includes individuals, companies and every type of institutional investors (for instance, endowment funds, hedge funds, insurance companies, investment companies, investment trusts, mutual funds, pension funds, sovereign wealth funds, etc.).
- Green Bonds partners: this group is composed of a wide series of organisations which are focused on developing a commercially viable green bonds' market. They are including financial institutions, development banks (for instance, the Asian Development Banks and the African Development banks), NGOs and credit rating agencies (for instance, Moody's).
- Credit rating agencies and auditors: they are responsible for verifying compliance with the standards for green bonds or also with general credit standards of bonds.

- Regulators: they are the financial authorities which are responsible for the regulation and the supervision of capital markets. In order to do this, they examine the qualifications of underwriters as well as the securitisation of credit assets and bonds' custodial arrangements; and regulate the issuance, clearing and settlement provisions. Regulators include a wide range of entities, they range from securities commissions and other regulatory bodies to stock exchanges and central banks.
- Credit guarantors and other intermediaries: creditor guarantors can provide credit guarantees and credit enhancement instruments in secondary markets. This process will improve the risk profile of the underlying bond and thus will decrease the risk for the investors. A wide range of financial entities offers a variety of intermediation and credit enhancement services, including raising investor capital, establishing special purpose vehicles etc.

2.4.4 Reasons for the Green Bonds boom

Companies, banks and governments are continuing to increase the amount of Green Bonds which are available to the investors. Their aim is to finance eco-friendly projects which then will lead to a low-carbon future. Looking at the data, it is possible to see that the Green Bonds issuance doubled from 2015 to the 2016 and also 2017 shows a considerable increase in the amount (see previous Figure 7).

In fact, Green bonds have been welcomed in the market as an ideal fixed-income investment opportunity for the investors, and a “starter product” for fixed income impact investing. Anyway, green bonds are financially comparable to non-green bonds and also offer transparency and disclosure which facilitate broader portfolio analysis by integrating sustainability concerns. Their investors generally evaluate issuers' ESG (environmental, social and governance) credentials and green bond criteria to ensure consistency with their own expectations and requirements, although some investors focus on the use of proceeds, with less regard to the issuer's ESG track record.

A unique feature of the green bond market is that investors are keen to be associated with green bond issuances. The World Bank was the first green bond issuer in which the

identities of the investors became public knowledge, upon request, in its green bond news releases. Because of that, it is not difficult to find out who are some of the investors in Green Bonds⁵⁰. With the development of the market, there are more and more cases of concrete and constructive debate between investors and bond issuers. Often this becomes a virtuous circle of strong involvement which can help to attract new and different typologies of investors. For example, in the case of the World Bank, investors interested in green bonds range from traditional income investors to pension funds, insurance companies and asset managers, corporate treasuries and banks. Although some exceptions, green bonds have been generated with prices which are similar to the ones of the traditional type of bonds. This important result means that there are not higher costs associated with the issuance of green bonds, even if the issuer has the additional duty to provide more reports and analyses on the bonds issued than the traditional counterpart. This is because Green Bonds have more advantages and benefits which are kept into account by the investor when he decides to invest in them. Some benefits can be summarised as:

- investors can diversify their portfolio by adding these bonds
- closer investor involvement, open dialogue between investors and issuers
- raising consciousness for an issuer's activities
- helping to build a market which can solicit the private sector financing for climate and environmentally friendly initiatives
- clearer transparency and disclosure about the bonds' proceeds⁵¹

Issuers are also able to reach investors focused on sustainable and responsible investing and those that incorporate ESG as part of their investment analysis, investors that might not otherwise have considered their bond offerings. On the other hand, “despite the exponential growth in volume, green bonds have still performed in an orderly way, roughly in line with the broad market”⁵². This means that Green bonds will not go out of fashion very soon but they will continue to be issued in the foreseeable future.

⁵⁰ Pension Fund Service, (2017). *Green Bonds*, The World Bank, pg.3

⁵¹ Pension Fund Service, (2017). *Green Bonds*, The World Bank, pg.4

⁵² Morgan Stanley, (October 2017). *Behind the Green Bond Boom*, Research, <https://www.morganstanley.com/ideas/tax-reform-framework>

2.4.5 Transparency as the key to the success

Recently, many firms and banks have launched different types of Green Bonds. For instance, in 2017 ENEL launched its first Green Bond program, which had an amount of 1,25 million euros⁵³. Furthermore, other banks have broken the ice and started to issue the sustainable version of the bonds (Société Générale which has started the issuance of Green Bonds in 2016). The success seems very tangible but there are still many issues and doubts which cause the investors to worry. Many issuers are understanding that this is the direction of the future bonds' market, but the next generation of investors will ask for a more transparent reporting and disclosure on what bond proceeds are being used for. Issuers, indeed, are playing a vital role in trying to build a market that is playing an increasingly important part in green finance and climate transition. Therefore, they are helping to achieve a fixed-income market which is sustaining environmental investments and projects⁵⁴. However, the green bond market's growth and development have been very stable and static in the past five years. Anyway, in spite of its limited size, compared to the overall bond market, the green bond market has been incredibly important for fostering and supporting sustainable fixed income markets, disclosure and a focus on environmental issues. The key to the success is to continue with a dialogue between investors and issuers to improve the transparency of these eco-friendly bonds. Then, this close relationship will lead to the fidelity of current investors and an appeal for new ones.

On the other hand, since the initial green bond in 2008, the World Bank has been one of the main leaders in fostering the market's integrity while this market continues to increase and enlarge itself. Its initiatives have built the basis for strengthening capital markets which are focused upon ESG risks and realise a positive impact on the society and on the planet. Furthermore, the World Bank is also helping several underdeveloped countries to implement many country-level initiatives (for instance, it has helped the government of Fiji, Malaysia and Nigeria⁵⁵). Indeed, following these efforts, Fiji is the

⁵³ ENEL, (2017). *Seeding Energies Sustainability Report 2017*, Green Bond report, pg.1

⁵⁴ Pension Fund Service, (2017). *Green Bonds*, The World Bank, pg.4

⁵⁵ World Bank Group, Green Bonds, Pension Fund Service, (2017). *Green bonds, Public Document*, pg.5

first developing market which has issued green bonds raising 100 million Fijian dollars, corresponding to a value of USD 50 million with the aim to limit global warming⁵⁶.

Effectively, it is supporting the green bond issuance and impact reporting based on its ten-year experience and knowledge as a market leader and it is also publishing resources for new green bond issuers through publications which are available to everyone. The all-embracing principle of transparency and disclosure has the objective to “ensure that investors have the information they require to assess the suitability of a green bond in terms of its specific mandate and evaluate the impacts of the underlying investments”⁵⁷. In addition to this, the issuer undertakes to use the resources collected with the sale of green bonds only to finance projects dedicated to climate sustainability or energy efficiency. And then, the Green bond is combined with a specific project or investment and the investor is promptly informed about the progress of the work. Green finance, in this sense, can become a guarantee of full transparency, accountability and compliance. This characteristic is what distinguished the green bonds from the mainstream ones which, usually, do not involve such a deep involvement and carefulness from investors. However, this is not always true and some investors could be the victim of the “green-washing” problem. Indeed, in many cases, the Green Bonds are “not more than pieces of paper sold by banks that do nothing to verify their sustainability credentials”⁵⁸. Therefore, the green bonds need to affirm their reputation and for this reason, a change in regulation and in incentives has to be made. It’s undeniable that many steps have been made in the past years but investors are always demanding more and more disclosure in order to be part and almost « communicate »⁵⁹ with the green projects and investments.

⁵⁶ World Bank Group, (October, 2017). *Fiji Issues First Developing Country Green Bond, Raising \$50 Million for Climate Resilience*, Press release

⁵⁷ World Bank Group, Green Bonds, Pension Fund Service, (2017). *Green bonds, Public Document*, pg.5

⁵⁸ Koh, A., (February 2018). Will a lack of transparency hurt the green bonds? in *Eco-Business*, Singapore

⁵⁹ Shishlov, I., More, R., Cochran, I., (June 2016). *Beyond transparency: unlocking the full potential of green bonds*, Institute for Climate Economics, pg.4

2.5 Green loans and securitisation

In 2018, however, much of the uncertainty left by the crisis has finally passed. The US risk retention rules⁶⁰ have been fully implemented and the EU Securitisation Regulation entered into force on 18 January 2018⁶¹ (but with an effect from the following year). As a result, regulators have started to reconsider many financial instruments which have been reduced in volume during the financial crisis. Indeed, regulatory initiatives have the potential to foster the demand for green loans and green mortgages at a time when investor demand for green investments already far exceeded the supply. From an investor perspective, green loans offer a number of benefits, in addition to the main advantage of preventing and fighting the climate change. In simple terms, green securitisations pool together loans which have been identified as ‘pure play’, that is, loans which are specifically targeted towards financing projects with an environmental objective, commonly to address climate change. For instance, these loans could comprehend the financing for electric or hybrid vehicles, renewable energy infrastructure and energy storage.

In addition to this, compared with a common loan, green loans need a more detailed analysis of their underlying assets. This deep analysis will then allow banks to gain greater insight into the credit quality of the borrower. Using proceeds to improve efficiency and reduce negative environmental effects also tends to increase the value of the underlying assets and reduce the risk of depreciation as markets become more sensitive towards sustainability themes. Furthermore, the compliance with use of proceeds regulations leads the companies and businesses to have a system which is able to register and record the effects of their activities on the environment. Many companies are already created these systems in order to reply to more and more pressing influence both from government policies (for instance. the recommendations made by the Task Force on Climate Related Financial Disclosures (TCFD))⁶² and from investors and

⁶⁰ Morgan Lewis, (2018). *Guide to the credit risk retention rules for securitizations*, pg.1

⁶¹ Regulation (EU) 2017/2402 of the European Parliament and of the Council, (December 2017) in *Official Journal of European Union*

⁶² Hay, A., Higgs, S., (October 2017). *Australia: Eye of the storm for directors - climate change risks*, Mondaq: connecting knowledge & people, <http://www.mondaq.com/australia/x/641004/Corporate+Governance/Eye+of+the+storm+for+directors+climate+change+risks>

shareholders (for example, shareholder legal action against Commonwealth Bank for failing to make environmental impact disclosures in its annual report), reducing the additional burden of compliance for companies interested in green loans⁶³. Moreover, green loans also have several benefits which are not present for the green bonds. Indeed, green loans are available to a much larger range of borrowers than green bonds, including small and medium enterprises (SMEs) and individuals, and can be made for smaller amounts which are economically feasible for a bond offering. Because they are entered into directly with one or more lenders, green loans also give greater extent for supervising and enforcing the use of proceeds and other covenants than bonds counterparts, with sanctions for violation adapted to the specific circumstances (for example, if the quantitative sustainability targets set in a green loan facility agreement are not met, a higher interest rate can be debited). In 2017, the scheme encouraged significant private sector financing and approximately \$25bn of green ABS were issued⁶⁴. This, in fact, can be translated as an increase of 500% from the 2016's level (see Figure 8).

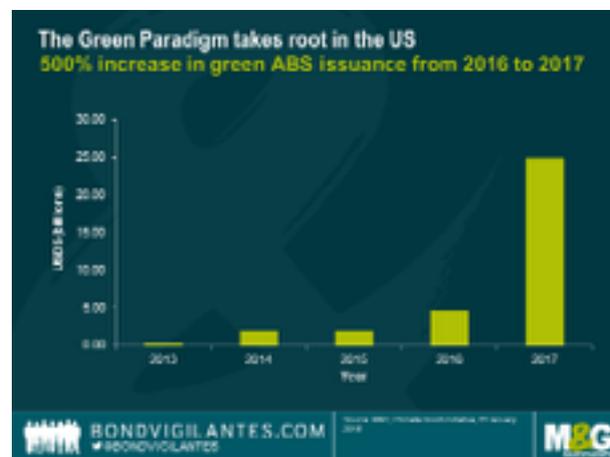


Figure 8: issuance of green ABS in U.S. (source: M&G, Climate Bond Initiatives, (January 2018). Green securitisation - the “green” paradigm)

⁶³ McGarry, C., (April 2018) *Set to be the Breakthrough Year for Green Loans and Green Securitisations*, <https://www.whitecase.com>

⁶⁴ Shott, M., (2018). *Green securitisation – the ‘green’ paradigm*, A view from the desk, <http://aviewfromthedesk.co.uk/2018/01/green-securitisation-the-green-paradigm/>

On the other hand, when compared to the US, Europe has been very slow in developing similar green securitisation initiatives. To date, there have been only a few of green ABS issuances (of which three deals since 2010), including the Toyota's green auto bond and the only RMBS issuance by Obvion in 2016 which is a €500m deal with the aim to supporting residential energy efficiency in the Netherlands⁶⁵. Therefore, there has been a very scarce development in the European countries, and this can be linked to many causes, namely the strict control over asset-backed securities and cultural/political diversity within the EU.

Indeed, one of the main challenges in reaching a favourable regulatory capital treatment for green loans and green securitisations in the U.S. and mainly in Europe. This has been emphasised by the Expert Group Report in its report of 2018⁶⁶. Indeed, there is a shortage of generally accepted principles which are necessary to distinguish the sub-segment of “sustainable assets”. Some green loans already have some regulations and restrictions which limits the use of their process. However, this does not apply to all kinds of loans and some of them are, in fact, rewarded with a low cost of funding because they are investing the money in order to increase the “greenness” of the company. In a similar way, the owners of residential mortgages can ask for a “green mortgage” for their property. With this system, all the capital spared because of the energy efficiency improvements on the property can be added to the homeowner's income in order to increase his possibility to ask for a loan. It is possible to say that this positive trend in the green loans/leases and green securitisations markets will continue during 2018⁶⁷. This can be accomplished with a set of generally accepted principles for any loans which have to comply with the eligibility criteria and standards. In order to be useful, the principles have to be accepted by the main industry organisations, governments and regulating bodies for the purpose of supporting projects and investments for a sustainable finance. In the end, this system should foster and support

⁶⁵ Climate Bonds Initiative, (February 2017). *Green Securitisation: unlocking finance for small-scale low carbon projects*, Briefing Paper, pg.1

⁶⁶ McGarry, C., Jirtle, J., (April 2018). *2018 Set to be the Breakthrough Year for Green Loans and Green Securitisations*, Publications, <https://www.whitecase.com/publications/alert/2018-set-be-breakthrough-year-green-loans-and-green-securitisations>

⁶⁷ see McGarry (April 2018)

the increasing issuance of green securitisation in the economy with an inclusion of other types of renewable energies (wind, solar, hydroelectric, etc.) and with a geographical expansion.

2.5.1 Different types of green securitisation

As said before, “green securitisations” could be attractive investment opportunities not only for institutional investors seeking to participate in the development of a new class of sustainable investments but also for those seeking exposure to highly rated, floating-rate assets with an attractive risk/return profile in anticipation of rising interest rates. Generally speaking, there are two types of green asset-backed securities (ABS) which can be divided as:

- ABS where the cash flows which are supporting from the issuance of the bond arise from green assets and the proceeds, which are raised from investors for the issuance of the bond, are allocated to green assets. This type of green ABS is suitable for new green asset classes such as renewable energies.
- ABS where the cash flows which are supporting the issuance of the bond arise from non-green assets (or a mix of green and non-green assets) but the proceeds raised from investors from the issuance of the bond are allocated to green assets. This type of green ABS is suitable for use within existing asset classes that are already being securitised. Usually, this type of ABS involves loans on electric cars or mortgages on green buildings.

Therefore there are different types of asset classes which could fit into the area of green securitisation and which are at different stages of development and spread in the market (see Table 5).

Table 5: ABS by issuance type and issuer (source: Climate Bonds Initiative)

	Definition	Example	2017 issuance	Issuer
CMBS	Commercial mortgage-backed securities are ABS agreement based on commercial mortgages	Offices, shopping centres, multi-family housing, hotels	Less than 1 USD Billion	CSAIL (joint platform of the US operations of Credit Suisse and Natixis)
RMBS	They are asset-backed securities based on wide pools of mortgages of residential properties	Home-equity loans and subprime mortgages	2 USD Billions	Dutch lender Obvion, National Australia Bank

	Definition	Example	2017 issuance	Issuer
Agency MBS	Fannie Mae's Multifamily Green Initiative Program's aims is to invest in mortgages of low-carbon buildings and invest projects of energy and water reduction improvements.	Low-carbon buildings, energy and water efficiency improvements	26 USD Billions	Fannie Mae, Freddie Mac
Auto ABS	Secured on the cash flows from current car leases and with the revenues which are used to finance new leases and loans on only hybrid and electric vehicles.	Hybrid and electric vehicles	Less than 1 USD Billion	Toyota Finance
PACE ABS	The US Property Assessed Clean Energy (PACE) model is an innovative system for investing in energy efficiency projects and renewable energy development.	Energy improvements on residential and commercial properties	2 USD Billions	California State
Solar ABS	Solar ABS are a kind of securitisation which is based on cash flows from solar assets. The majority of securitised assets are backed by lease payments and PPAs	Installations of solar panels	2 USD Billions	U.S. SolarCity (now Tesla Energy), Northland Power in Canada, Flexigroup in Australia
Chinese ABS	In China, issuers have issued 11 ABS agreements for an amount of USD 2.4bn and they were secured on receivables from wind turbines and other types of sustainable energy equipment leasing and reduction of waste amount	Water treatment plants, switchgear and electrical substation equipment	3 USD Billions	Beijing Enterprises Water Group
Synthetic ABS	In a synthetic ABS, the issuing bank keeps the ownership of the loans/ leases which it wants to utilise as collateral for the securitisation but moves the related credit risk to the investor by means of the ABS system.	Variety of loans, including project finance on renewable energy	4 USD Billions	Credit Agricole CIB, privately placed with a US-based Mariner Investment Group

It's also important to see the development of these ABS deals, which are growing at a high speed, especially from 2016 to 2017 (see Figure 9).

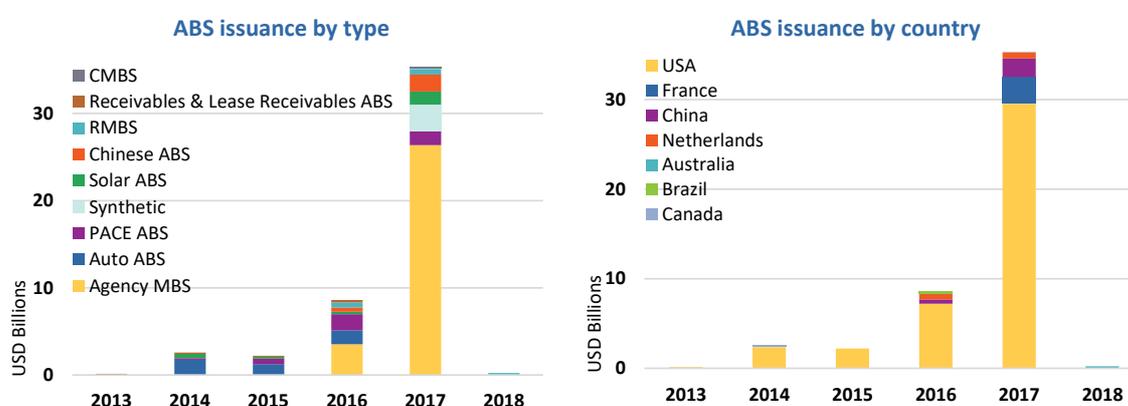


Figure 9: ABS statistics by issuance type and country (source: Climate Bonds Initiative, (2018). *Green securitisation: unlocking finance for small-scale low carbon projects*, Briefing Paper)

Green ABS issues to date include mainly mortgage-backed securities but, as said before, also PACE ABS backed by loans for energy efficiency improvements, solar and auto ABS. Moreover, it is interesting to note that the countries more involved in the issuance of this financial product are U.S. and France, which together are issuing more than 90% of all the overall green ABS deals. Anyway, it also possible to see a clear development of other countries (for instance China and Netherlands) which, even if at a smaller amount, are increasing their amount of ABS issuance year after year.

CHAPTER III

Asset-backed securities

3.1 Securitisation overview

Asset-backed finance, commonly referred to as securitisation, is regarded as one of the « main culprits of the recent financial crisis »⁶⁸. Although it is the U.S. that is perceived to be the largest market for the securitisation activities, securitisation programs are also becoming widespread in Europe. In simple words, the assets or assets are transferred to third parties, and the recovery by third parties of the value of these assets or assets should guarantee the repayment of the principal and interest coupons indicated in the obligation. If this recovery is not possible, those who bought securitised securities will incur the loss of both the paid-up capital and the interest due. While many writers stated that the origins of securitisation come from precedent episodes, including the farm railroad mortgage bonds of the 1860s, the mortgage-backed bonds of the 1880s and a form of securitisation of mortgages before the 1929 crash, the modern era of securitisation is commonly accepted to start in 1970. Indeed, born in the United States during the seventies and initially employed with the purpose of mobilising mortgage loans in institutional portfolios financial institutions, it represented an operation that arose mainly with the simple objective of meeting a need for liquidity. Today this technique has registered one significant evolution, both in terms of the asset classes that have been the subject of securitisation and both from the point of view of the individuals or entities which have used it. Anyway, the innovative idea behind this operation is that in fact, it allows the transformation of any activity which is normally not negotiable into one which is capable of generating homogeneous and predictable cash flows, i.e. in marketable assets. Therefore, it becomes a considerable advantage both for the originator and for the investors and the system financial in general.

The term securitisation appeared for the first time in 1977, under the heading "Heard of the street "from the Wall Street Journal, to describe a completed operation from the Bank of America and the Salomon Brothers consisting of the issue of MBS: we find

⁶⁸ Brunnermeier, Markus, K., (2009). Deciphering the Liquidity and Credit Crunch 2007-2008 in *Journal of Economic Perspectives*, 23 (1): 77-100.

ourselves in the years when the so-called baby boom generation had reached the age to buy a house, resulting in an exponential increase in demand for mortgages on the US real estate market and an increase in the price in the sector residential estimated at around 6% per year. Given these market conditions, the Federal Reserve observed that a liquidity crisis will probably hit the economy because of the impossibility of finance the more and more increasing demand for mortgages. The market response to that problem was made by bonds guaranteed by mortgages, which are also called "saving and loan association". The latter, also called thrift institution, is a financial entity which is specialised in accepting savings, deposits or in making mortgages or other kinds of loans. However, in order to respond to the needs of the market and succeed in placing securities with investors, it was necessary to carry out significant an over-collateralisation on the securities themselves or issue bonds with a nominal value lower than the value of the guarantee provided. Because of the fact that this process made the entire operation unprofitable, it was just a partial and temporary solution to the initial problem. The final solution was based on a legislative intervention which gave birth to the increasing market of securitisations. The key points from the legislative point of view, it was the fiscal neutrality of ABS securities, which avoided double taxation on them, as well as the creation of some companies that guaranteed solvency of the issue (the Government National Mortgage Association, GNMA), in a manner to find wide and favourable reception on the market (through a AAA judgment rating agencies). In 2007, it was estimated that the value of securitised products exceeded 2 trillion dollars in the US market which has been heavily refinanced with the securitisation technique⁶⁹.

3.1.1 The large world of securitisation

The securitisation world is very large and contains several different asset-backed securities, but the mortgage market is perhaps the most well-known ABS segment, especially in the U.S. The subset of it focused on lower rated sub-prime borrowers is even more familiar: it was, indeed, the primary cause of the 2007-8 financial crisis. However, as said before, the total ABS market is much larger and complex in its

⁶⁹ Kiff, J., Mills, P., Spackman, C., (October 2008). *European securitisation and the possible revival of financial innovation*, Vox CEPR Policy Portal, <https://voxeu.org/article/european-securitisation-and-possible-revival-financial-innovation>

composition. Securitisations extend beyond home equity loans, too. Student debt, auto loans, and credit cards are other famous examples which are very common and used nowadays. Investor appetite for ABS has increased and esoteric securitisations also abound, including everything from the franchise royalties of Domino's Pizza to loans and leases on aircraft⁷⁰. If the assets have steady cash flows and reasonable credit risks, securitisation is not very uncommon and it is an opportunity to create many benefits for the investors. However, there are also several challenges associated with esoteric ABS, indeed, "sourcing new and different types of assets that possess predictable credit and cash flow characteristics are one step. Another one is the long time it takes to market these securities to investors and secure ratings from the agencies, which may not be enough familiar with the underlying assets"⁷¹. This lack of information could lead to many risks and, as we know from the recent crisis, these instruments have the potential to create financial problems for the investors and for the issuers themselves.

Despite the possible initial investors' doubts, esoteric ABS is not always more complex than the "mainstream" ABS, but the problem is that the related documents may be difficult to interpret and can lead to a unique operational dynamics between the counterparts. But, on the other hand, the risk can profile vary considerably. For example, some esoteric ABS such as solar and cell towers carries a moderately low correlation to the macroeconomic conditions, offering them a great opportunity for diversification, whereas others such as container leasing have a quite high correlation. Anyway, the technology continues to work well when it is used on a large scale and it is able to adapt to large positions and complicated calculations, and it is also adequately adaptable to support fast innovation and the changes of the market, which is terribly critical for esoteric ABS⁷². However, nowadays, the cornerstone of many discussions is on how the technologies of the future can improve the efficiency and lower cost and also riskiness even further. Perhaps, the next generation of instruments will help

⁷⁰ Tempkin, A., (March 2012). Domino's raises dough via revived franchise-fee ABS deal, Reuters, Bond News, <https://www.reuters.com/article/markets-credit/dominos-raises-dough-via-revived-franchise-fee-abs-deal-idUSL2E8E1H4K20120301>

⁷¹ Patel, S., Taylor, A., (2016). *Next Generation for Esoteric ABS*, <https://www.bnymellon.com/us/>

⁷² see Patel and Taylor

business users to even analyse and model data on their own. Consequently, this will make it faster to value esoteric ABS and assess the legal and regulatory requirements as well as the risk.

In any case, there are several ways to distinguish between the products according to the nature of the collaterals:

- cash flow: the interest and the principal payments which are created by the assets are passed through to the notes. Anyway, usually there is a legal transfer of the assets;
- synthetic: the securitisation "synthetic", in which the transfer of risk takes place without the sale of the assets, but through the use, typically, of contracts credit derivatives. They belong to the group of securitisations synthetic operations assisted by credit protection (real or personal) that implement forms of risk segmentation. Essentially, they are created to achieve the same credit-risk transfer as common asset-backed securities, but without the physically transferral of assets;
- existing assets: the asset pool consists of existing assets, an example could be the loan receivables which already have current cash flows;
- future flows: securitisation of the expected cash flows of assets that will be created in the future, for instance, airline ticket revenues and pipeline utilisation fees;
- corporate-related: they are related to the activity of a company, they include, for example, commercial mortgages, auto leases and trade receivables;
- consumer-related: automobile loans, residential mortgages, credit cards and student loans;

Although it is possible to call all types of securities created through securitisation asset-backed securities it seems to be simpler to make some distinctions in order to understand this broad category. Typically, the most common type of asset-backed securities is the one backed by mortgages and are called mortgage-backed securities (MBSs) which can also be divided into other two smaller categories which are residential mortgages backed securities (RMBS) and commercial mortgages backed securities (CMBS). Instead, collateralised debt obligations (CDOs) are commonly viewed as a separate structured finance product group, with two main sub-categories: corporate related assets (loans, bonds, and/or credit default swaps) and re-securitisation assets (ABS CDOs, CDO-squared). In the corporate-related CDOs, other two sub-

classes can be discerned: the collateralised loan obligations (CLO) and collateralised bond obligations (CBO)⁷³. As we have seen, the ABS's world is very complicated and there are a lot of sub-categories which makes even more difficult for a common investor to navigate in this system and to identify what is best for him.

In conclusion, securitisation is a very complex process which needs a considerable amount of time and resources to be exploited in the best way. In order to achieve that, it's necessary to understand which are the objectives of the banks or societies which want to use this instrument. Despite the general complexity, the main objective of securitisation is that it permits to attain the improvement of the budget indices, i.e. the alignment of liabilities maturities with asset maturities, the diversification of the financial sources and the reduction of the supply costs.

3.1.2 The effect of the 2008's crisis

As said before, the securitisation was of one of the financial technique which was considered guilty for the 2008's financial crisis. It's not easy to forget a crisis which has hit the U.S. and, then it has spread into the European markets with disastrous consequences. In 2007, the volume of securitisation was almost equal to \$11.2 trillion in the U.S while in Europe the amount was quite lower but still a significant part of the economy (€595 billion)⁷⁴. In 2015, after the burst of the financial bubble and the mistrust of this instrument, the volume of securitised products was incredibly lower and it amounted to almost \$1.9 trillion in the U.S. Moreover, in Europe, the amount declined less in percentage but it reached an amount equal to €214 billion⁷⁵. Despite the fact that many investors are still looking at securitisation with suspicious eyes, this financing tool is trying to reconquer its market share. In Europe, for instance, the European Commission is trying to foster the use of this instrument in order to facilitate the capital

⁷³ Campolongo, F., Jönsson, H., Schoutens, W., (2012). *Quantitative Assessment of Securitisation Deals*, Springer Science & Business Media pg.4

⁷⁴ Securities Industry and Financial Markets Association, (2008), Report from 2008, <http://www.sifma.org/>

⁷⁵ Securities Industry and Financial Markets Association, (April 2016). *SIFMA Issues 2015 Securitization Year in Review*, Press release <http://www.sifma.org/newsroom/2016/sifma-issues-2015-securitization-year-in-review/>

market financing and to create a viable alternative way to bank-related finance for enterprises and companies which are established in the European Union market⁷⁶. In order to accomplish this objective, two legislative proposals were presented to introduce new rules on securitisation:

- a simple, transparent and standardised securitisation regulation (STS)
- a regulation that modifies the regulation on capital requirements

On 30 May 2017, the Council and the European Parliament reached a defined political agreement on both initiatives. The final version of the regulations will be adopted after the texts have been developed on a technical level. The two regulations set common rules for all securitisations, provide a framework for secure, simple, transparent, standardised and adequately controlled securitisation products and help to differentiate them from more complex and risky financial instruments. Moreover, the new rules will help investors to assess the risks associated with securitisation, both within the various products and also across them. This should in turn help to create new investment opportunities in the EU and provide an additional source of finance for the economy, in particular for small and medium-sized enterprises and start-ups⁷⁷.

The revival of securitisation will depend mainly on rebuilding confidence⁷⁸. This should be translated in an attempt to create a regulatory framework which can help to highlight the benefits of the securitisation process and to decrease, or at least limit, the dangers and the risks related to this financial tool. Europe is making some steps in this direction and the U.S. should follow this example. Taking care of the securitisation market and trying to return it healthy is a job the financial industry must necessarily achieve, most importantly by making ABS much less obscure and complicated so it is possible to give a right price to them⁷⁹. Perhaps, a conscious use of this technique could help the

⁷⁶ Council of European Union, (October 2015), Inter-institutional file: 2015/0226 (COD), Brussels, pg.4

⁷⁷ Council of the European Union, (November 2017). *Capital markets union: Council adopts securitisation rules*, Press release 672/17, <http://www.consilium.europa.eu/en/press>

⁷⁸ Segoviano, M., Jones, B., Lindner, P., & Blankenheim, J., (Apr. 2015). *Reviving securitization*, Banque de France Financial Stability Review No. 19, pg.52

⁷⁹ Financial Times, (September, 2010). World waiting for securitisation 2.0 in *Financial Times*

economy to recover from the crisis which has been mainly caused by a careless exploitation of this financial product.

3.2 Structure of ABS

Basically, securitisation is a form of off-balance sheet debt financing⁸⁰, i.e. it does not show up in the balance sheet of the originator. In fact, the originator of ABS bundles its cash-producing assets (loans, receivables or bonds) into a special purpose vehicle or entity (SPV) which is, then, protected from potential bankruptcy claims. Rating agencies assess the pooled assets according to the probability of default (e.g., AAA, BBB+, etc.) and may provide guidelines to several tranches with different risk/return profiles which are available to the different investors. The SPV, which owns the originator's securities, then offers them to fixed income investors seeking yield. The ABS investors receive the interest payments, benefitting from the fact that the securities are pooled together, tranching, and also rated. Theoretically, the larger the pool, the more risk is diversified and so reduced for the investors. Moreover, credit enhancements may also help to reduce the concentration of default risk and performance problems. The originator, in turn, receives the ABS principal at theoretically lower yields than would be possible in corporate debt markets or by means of bank loans. In this way, the originator is able to make what was previously highly illiquid and a burden on the originator's balance sheet a useful asset (see Figure 10).

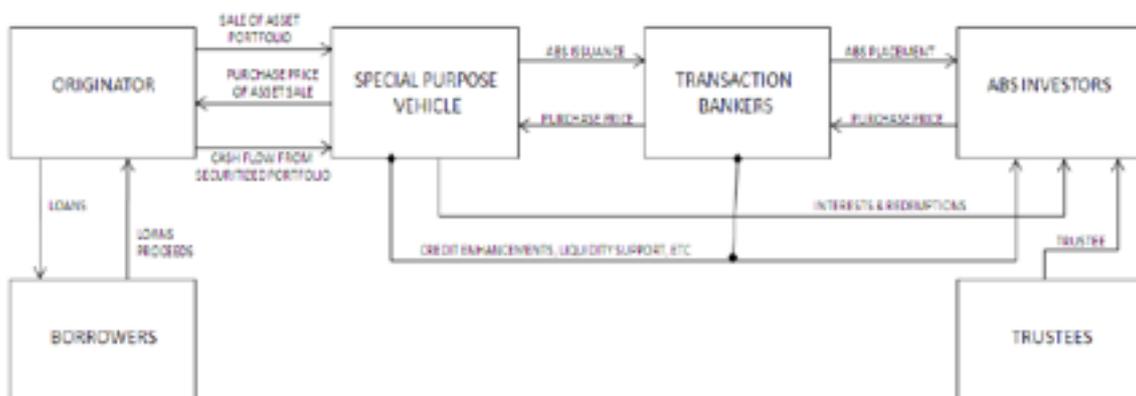


Figure 10: transaction structure (source: Dincă, S., (2014). Covered Bonds vs. assets securitization, University of Craiova)

⁸⁰ Yiawei, D., Zhaoxia, X., (2016). *Off-balance sheet securitization, bank lending, and corporate innovation*, University of New South Wales Business School

An ABS will usually have 3 different tranches, in order: senior, mezzanine (which then can be divided into other sub-groups), and equity. Obviously, the latter two tranches pay a higher yield because they have a lower credit rating quality. Indeed, sometimes the last class tranche may not even have a credit rating and so, it may not even be offered to the public because of its scarce reliability. Therefore, it is typically kept by the issuer or by the sponsor of the ABS. The lower tranches always receive most or all the losses, and if the losses are significant, then also the highest class tranche will start to have some issues. The senior tranche is, by far, the largest tranche, and ABSs are structured this way so that the senior tranche will have an investment grade rating, so that it can be a valid financial product to be sold to institutional investors, who are the main purchasers of ABSs, and who, in many cases, can only buy investment grade securities. In fact, for instance, in the U.S. pension funds can only buy securities that comply with ERISA (Employee Retirement Income Security Act of 1974⁸¹) which is a law that defines the criteria and minimum standards in the private sector in order to protect the common investors. Generally, in order to be considered an investment grade securities, the company or the financial product must be rated at 'BBB' or higher by Standard and Poor's or Moody's. Anything below this credit rating is evaluated as non-investment grade and cannot be bought by investors to protect them from dangerous financial activities.

3.2.1 Process of securitisation

Therefore, securitisation is a process consisting of several different phases. At first, a bank or a society interested in a securitisation selects a portfolio of credits which are available and ready to be securitised. Then, a statistical analysis of the portfolio is performed to define which is the average life of the credits and what is the credits' percentage of the under-performing ones which could stop the flows of the payments. In fact, securitisation involves a "true sale" (the actual removal of the assets from the balance sheet) of the underlying assets from the balance sheet of the originator. This is why a separate legal entity, the special purpose vehicle or entity (SPV), is created to act as the issuer of the securities. In fact, the assets being securitised are sold onto the

⁸¹ Employee Retirement Income Security Act of 1974, [Public Law 93–406] [As Amended Through P.L. 114–255, Enacted December 13, 2016]

balance sheet of this additional entity. Generally, this process involves the following steps:

1. carry out “due diligence” on the quality and future proceeds of the assets
2. establishment of a SPV and then effecting the transfer of assets to the issuing vehicle
3. underwriting of loans for credit quality and servicing
4. analysing and creating the structure of the securities, including how many tranches are to be issued, in accordance to originator and investor requirements
5. the notes being rated by one or more credit rating agencies to evaluate their characteristics
6. the SPV issues the asset-backed securities, which are divided in different tranches, and sells them to capital markets investors

Moreover, the sale of assets to the SPV needs to be carried out in a way in which it is recognised as a true legal transfer. Typically, the originator may also need to hire legal professionals to advise him during this process (see Figure 11).

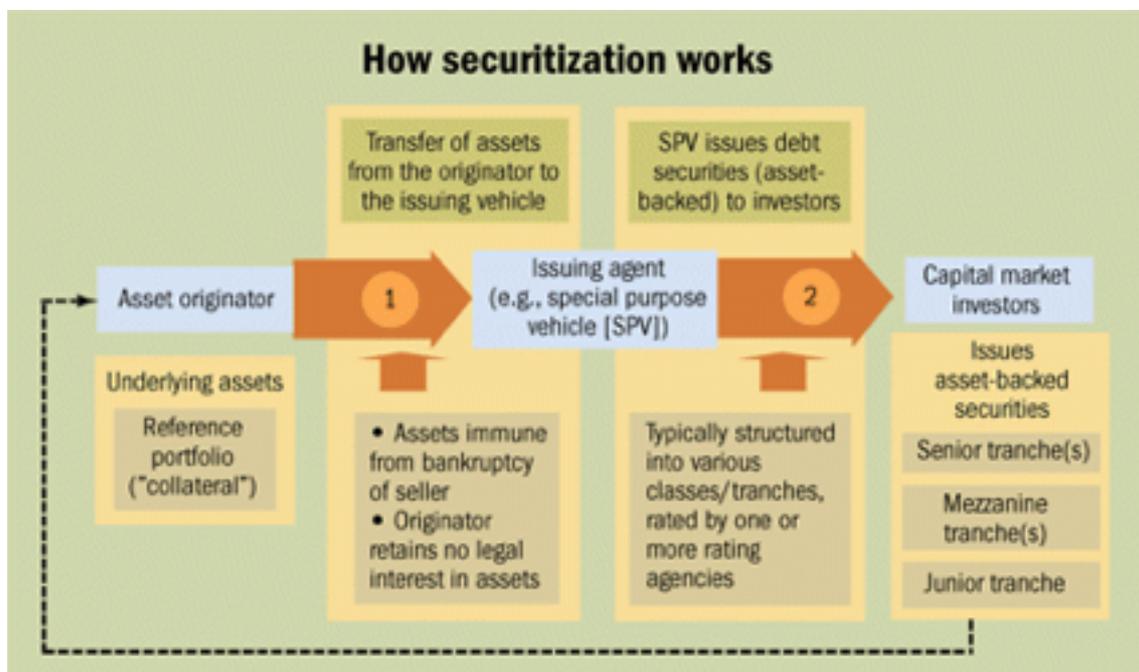


Figure 11: shows the securitisation process (source: Jobst, A., Fund, (2008). *Finance and Development magazine*, International Monetary)

On the other hand, the credit rating procedure evaluates the character and quality of the assets, and also whether it is necessary to add some form of credit enhancement for the assets in order to improve their credit quality. This credit enhancement procedure can include the so-called over-collateralisation or other forms of credit improvement techniques. The first one, which occurs whether there is a posting of collateral for obtaining a safer and more secure financing, is one of the main used methods of credit enhancement⁸². Another very important decision for the originator is the selection of the underwriting bank (or arranger), which manages the transaction and help to place the securities in the market. The originator has the right to choose the institution which will be responsible for the entire deal. His choice is affected by the characteristics of the bank, like for example its fees amount, its marketing abilities or experience with this typology of securities.

3.2.2 Credit enhancement

As said before, credit enhancement is a risk-reduction technique which provides protection, in the form of financial support, to cover losses from unfortunate cases (for instance defaults) and stressed situations. We can consider credit enhancement as a type of financial protection that allows securities backed by a pool of collateral to absorb losses from defaults on the underlying assets or receivables. Thus, it's not the case that through securitisation, poor credit assets somehow "transform" into liquid investments; instead, credit enhancement helps to offset potential losses. Indeed, credit enhancement is also used in financing a project, in public-private partnership transactions, and in structured finance to help reduce the risk for investors. Many securitisation transactions make use of this technique to improve credit ratings and therefore decrease the required yield, hearten investors, and protect issuers. This can be done in two ways: in an external and in an internal way. The latter, the internal credit enhancement, is the one which is provided by the originator itself and it can be done by means of three different strategies: subordination, over-collateralisation and excess spread. On the other hand, when an independent body or party, not directly involved in the securitisation process, is providing guarantees on an asset-backed security it is possible to define it as an external

⁸² Jönsson, H., Schoutens, W., (2009). *Asset backed securities: Risks, Ratings and Quantitative Modelling*, European Investment Bank, EURANDOM Report 2009, pg.5

credit enhancement. This external body or entity could be an insurance company which guarantees the timely payment of interests and it assures the safety of the financial instrument. However, when third-party and independent bodies are difficult to find in the market, there are other available forms of credit enhancement which can help the securitised assets' issuers in obtaining an interesting cost of capital and foment investor interest in the product. Anyway, as highlighted before, the most used methods of credit enhancements are the following:

- **Tranching or subordination:** it is the process of prioritising the order in which the loan losses are allocated in various segments or tranches by risk, tenor and intrinsic characteristics. After this subdivision, each tranche will have its own credit rating and its yield rate. The tranche with the higher rate will be paid first, and then each following segment will follow in the established hierarchy. Each investor purchases the tranche which reflects their risk/return desires and needs.

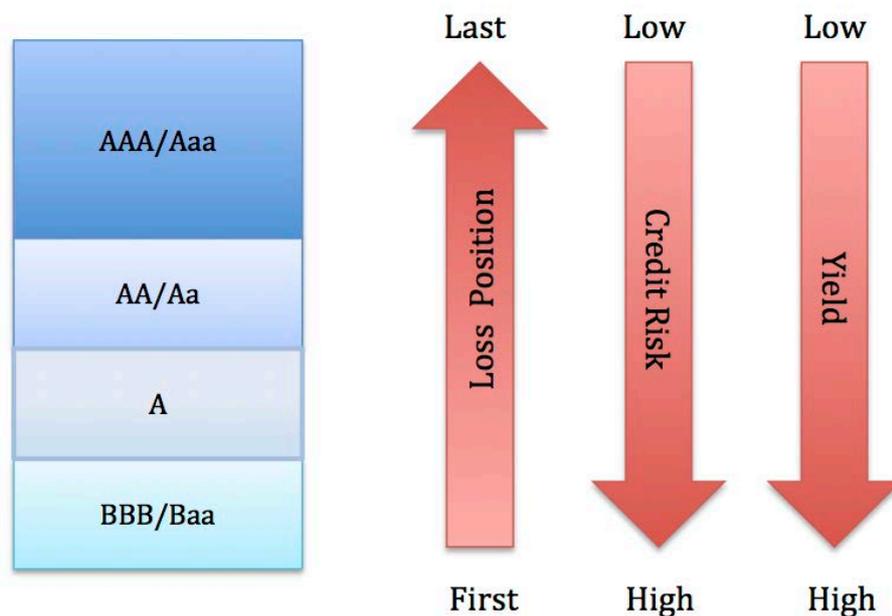


Figure 12: tranching process (source: Lowder T., Mendelsohn, M., (2013). National Renewable Energy Laboratory)

- **Over-collateralization:** it is a method through which additional assets are placed in the SPV but without wanting to securitise them and adding them to the securitised assets.

For instance, if the fund has 10€ billion in assets with 1€ billion allocated as a collateral, the securities will be only be issued for 9€ billion. In fact, the collateral will be used as a financial cushion in case of excessive losses in order to cover the demands of the investors (see Figure 13).

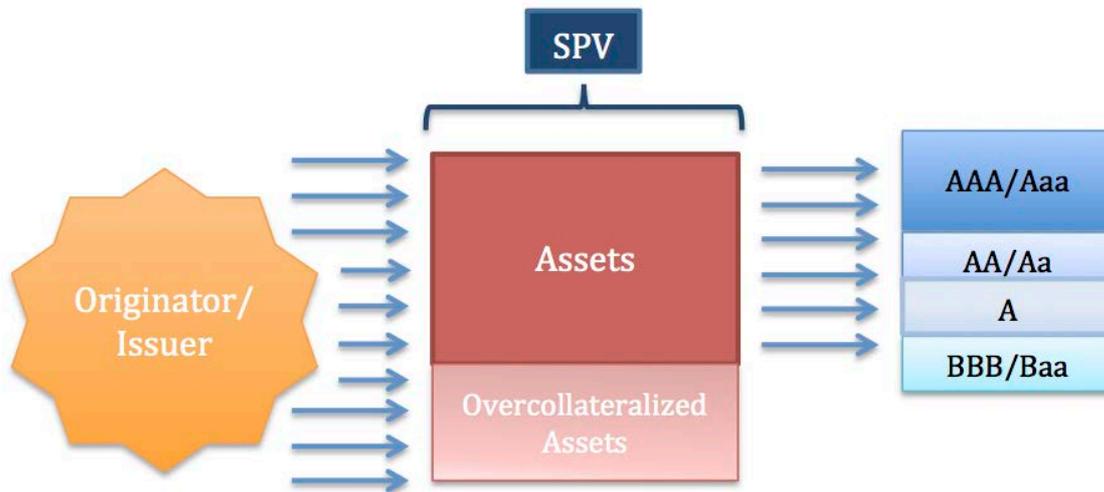


Figure 13: overcollateralisation process (source: Lowder T., Mendelsohn, M., (2013). National Renewable Energy Laboratory)

- Excess spread: it is the “additional revenue created by the difference between the coupon on the underlying assets and the coupon payable on the securities”⁸³. For example, borrowers whose mortgages are in a given collateral pool may be paying 6% interest, while the coupon of the mortgage-backed security may be 3%. The transaction can then use the excess spread to absorb collateral losses or to build overcollateralisation to its desired level.

Furthermore, as said before, there are also other options in the form of the first-loss reserve, a co-investment or a mezzanine investment made by external entities⁸⁴. Anyway, whatever method a transaction uses, credit enhancement allows for more resources or financial backing for a security which would be available from the

⁸³ Standard & Poor’s, (June, 2008). *The Basics Of Credit Enhancement In Securitizations*, RatingDirect, pg.3

⁸⁴ Lowder, T., Mendelsohn, M., (December 2013), *The potential of Securitization in Solar PV Finance*, National Renewable Energy Laboratory,, pg.12

underlying assets alone. In that way, if the pool ends up experiencing losses, the credit enhancements should still provide enough cushion in the transaction to allow for payments. Because it provides a kind of safety net, credit enhancement increases the likelihood that tranches with a higher payment priority will receive their full repayment of principal and also their timely interests. On the other hand, the necessary amount of credit enhancement will be established and calculated by the rating agencies which have the duty to assess the risk and to forecast the potential losses of each financial operation.

3.2.3 Participants in the securitisation process

As outlined before, the securitisation process is characterised by the presence of many different participants. In the following Table it is possible to understand the role of each one and the main tasks that each one has to perform in the context of the securitisation process.

Table 6: actors of a securitisation transaction (source: Lowder T., Mendelsohn, M., (2013). National Renewable Energy Laboratory)

Actors	Role
Obligor	It is the one who makes payments for the securitised assets to the originator. Those payments are pooled all together and, then, they create the basis of the securitisation sale/purchase. In case of a mortgage-based, the obligor is the owner of the lease or loan on the real state property.
Asset originator	It is one of the main actor into the securitisation process. It, indeed, originates and owns the defined cash flows and desires to securitise them.
Issuing agent or special purpose vehicle (SPV)	Is the trust entity into which the assets are sold and kept. Then the assets will be collected and pooled in the SPV and they “will create the collateral basis against which securities are issued”.
Servicer	Its duty is to manage the operations which are linked to the collecting of credits, to related cash flows and to legal and regulatory compliance. Moreover, it receives payment for the duties of monitoring the pool performance, handling non-compliance, defaults and recoveries.
Issuer	Transfers the assets into the SPV and contracts with the legal counsel and with the investment bank to begin the securitisation procedure. Sometimes, the issuer could also be the originator. In other cases, a single body could be, at the same time, issuer, originator and servicer.
Underwriter or investment bank (arranger)	Organises the securitisation process, creates the securities, and executes their sale on the market. Usually, underwriters earn a fee which is also called « underwriter’s discount » because these entities face the risk of holding all the securities on their balance sheet before being sold to the investors. It supervises the securitisation transactions step by step to verify each part of it.

Actors	Role
Trustee	Typically, it is a professional corporate trustee. Its primary objective is to protect the interests of the investors who purchase the securities issued by means of the securitisation and administer the duties of the SPV under the agreements. Moreover, it holds the benefits of covenants and rights in the securities on behalf of the investors.
Credit enhancement company	This figure is not always present in the securitisation process. Anyhow, as said before, it can furnish some form of guarantee, loss reserve or other structure to increase the credit rating's quality which will, then, enhance the securitisation's required yield rate. This procedure will reassure the investors and also protect the issuers. Furthermore, there are also other alternatives for credit enhancement, i.e. there is also the possibility of tranching and over-collateralization
Credit rating body	Makes evaluations on securities offerings using their own methods and practices and then, based on their findings on credit quality, it issues a rating. Higher ratings mean a lower interest rate for the issuers whose aim is to improve the rating's quality. This role has played an essential part into the financial crisis because the rating agencies were not able to assess the reliability of the MBS.
Clearing system	It provides the clearing and it settles trades for the securities. In Europe, the service is managed by Euroclear Bank and Clearstream banking. Instead, in the U.S. the service is provided by DTC.
Capital market investors	Financial institutions, insurance companies, pension funds and other wealthy individuals purchase the securities from the SPV. Generally speaking, the purchase is nothing else than a borrowing transaction, so the investor allocates capital, indirectly, to the originator and receives a fixed rate of return as that originator repays its initial debt.

3.3 Benefits of securitisation

In any case, securitisation has a lot of benefits and advantages in comparison with the other traditional form of equity and debt financing. Typically, securitised assets can include a broader pool of capital because they can better fit with many investor necessities and characteristics. Indeed, investors can choose from a wide range of securitisation investments and products, including prime and subprime mortgages, home-equity instalment loans (or second mortgages), credit card loans and student loans. Furthermore, investors who don't wish to purchase individual securities can also invest in an index with a broader exposure, such as the JP. Morgan ABS Index⁸⁵ and the European Barclays Pan European ABS benchmark Index⁸⁶ or the more specific U.S.

⁸⁵ Lord, J., (November 2015). JP Morgan index launch enhances transparency of US ABS market in *ETF Strategy News*, <https://www.etfstrategy.com/>

⁸⁶ (March, 2010). Barclays Capital Launches Pan European ABS Benchmark Indices in *Business Wire*, <https://www.businesswire.com/>

Mortgage-Backed Securities Index⁸⁷. Therefore, even if the securitisation represents an enormous asset class with many investors, it's necessary that investors consider their goals and risk tolerance levels or seek the advice of a financial expert to understand the benefits of securitisation. Anyway, the advantages of securitisation can be summarised into these broad categories:

- Risk reduction: given the fact that the assets are taken away from the originator's balance sheet, they are isolated from the parent's corporate risk. A specific definition for this risk's detachment is « bankruptcy remote »⁸⁸. Moreover, the process of pooling the assets also reduces credit, geographic and concentration risk. This will also lead to the spreading of costs of all the additional activity as performance management and reporting. Securitisation can also help to enhance credit rating and thus it can reduce the cost of capital. In fact, in the U.S., however, securitisation was primarily a means for financial institutions to comply with regulatory capital requirements.
- Access to a wider capital pool: the vast majority of existing studies on European banks (for instance, Martin-Oliver and Saurina⁸⁹, and Agostino and Mazzuca)⁹⁰, for example, conclude that the main driver of securitising banks in Europe was the need to obtain a greater liquidity. Generally speaking, securitisation can help many companies and businesses to attract many investors who, without this method, would be out of reach. This is a great opportunity for small enterprises and industries to access capital markets and to afford a larger liquidity in order to increase their capacity to produce or expand.
- Improvements for financing: capital markets can often offer more favourable financing terms and costs which otherwise could not be obtained from other forms of

⁸⁷ S&P U.S. Mortgage-Backed Securities Index, S&P Dow Jones Indices, <https://us.spindices.com/indices/fixed-income/sp-us-mortgage-backed-securities-index> [20 September 2018]

⁸⁸ Lowder, T., Mendelsohn, M., (December 2013). *The potential of Securitization in Solar PV Finance*, National Renewable Energy Laboratory,, pg.5

⁸⁹ Martín-Oliver, A., Saurina, J., (September 2017). *Why do banks securitize assets?*, UIB Congress

⁹⁰ Agostino M., Mazzuca, M., (2008). *Why do banks securitize? The case of Italy*, University of Calabria

financing. Obviously, these include longer financing term and lower cost of capital. Indeed, the securitisation can also be an instrument for the small and medium enterprises (SMEs) which do not have the characteristics to ask for other forms of financing (for instance, financing from banks).

- Opportunities for market growth: as said before, the originators remove the assets from their balance sheet and for this reason, they are free to originate more assets, fund expanded operations and thus have more possibilities to create value for themselves. Indeed, the unburdening of the balance sheet, with the creating of a special purpose entity, is an efficient way to monetise assets which before were completely illiquid and so useless. In addition to this, the increased investors' demand for a specific type of securitised assets could create a demand boost which may, in turn, help to develop the upstream market and to create more assets of that type.

3.4 Main risks

To speak about the role of securitisation in the recent financial crisis, it is useful to put that crisis in context. According to the Financial Crisis Inquiry Commission report “the financial crisis of 2007 and 2008 was not a single event, but a series of crises that impacted the financial system first, before contaminating the real economy ... 'While the vulnerabilities that created the potential for crisis were years in the making, it was the collapse of the housing bubble ... that was the spark that ignited a string of events, which led to a full-blown crisis in the fall of 2008’⁹¹. Therefore the well-known crisis was not created by the house bubble itself but by a series of mistakes which were made by the main banks, rating agencies and companies. The instrument itself is not dangerous but its careless and unconscious use is what has created the financial catastrophe. The house bubble was, somehow, just the fuse which has detonated the financial bomb. In spite of all these considerations, the securitisation process remains a delicate instrument which needs to be handled with care and does not have to be underestimated. As many other financial tools, there are many potential risks which can occur both for the issuer and both for the investor himself.

⁹¹ The Financial Crisis Inquiry Commission, (January, 2011). *The Financial Crisis inquiry report*, Pursuant to Public Law 111-21, Official Government edition, pg.27

3.4.1 Risks for issuers

The risks for the issuers of the Asset-Backed securities could be linked to many factors and could be summarised with the following list:

- may decrease issuer's portfolio quality: if the AAA (so the assets with a very high quality) risks, for instance, have been used for a securitisation transaction, this will worsen the credit quality of the remaining risk which was left in the issuer's balance sheet;
- excessive costs: securitisations always lead to several different costs. The costs are, indeed, linked to the daily expenses and the management of the entire operations. In fact, there are several expenses which are related to legal fees, underwriting fees, credit rating costs and to the continuous administration of the transaction. A margin for potential costs is typically necessary in event of a securitisation, above all, if there is an uncommon or esoteric type of ABS which can have hidden expenses;
- size-limited transactions: typically, the securitisation process requires a structure with a large scale, and thus it could not be profitable for a very limited amount of transactions. This could be a limiting factors for the new types of esoteric asset-backed securities which, at the beginning, usually struggle with a small number of transactions;
- additional risks: since securitisation is a complex transaction, it could include credit enhancements which have to face the risk of impairment, such as prepayments. The prepayment, in fact, occurs when the loan/lease owner decides to repay completely the debt and so to close his position. This is translated into the end of the cash flows and the securitisation transactions should take into account this risk when calculating the necessary amount of credit enhancement. In addition to this, there could also be the possibility of default which also affects the entire success of the financial operation;
- complexity of securitisation: the complex system of securitisation are far more complicated and difficult to understand in comparison to other forms of financing. Moreover, this makes difficult for the issuers to monitor the risks and the potential drawbacks. Given the fact that it is a complex instruments, there are many different

hidden risks and, without the right knowledge or experience with the instrument, it can lead to an underestimation of its dangers.

3.4.2 Risks for investors

On the other hand, the risks for the investors are different and manifold than the previous ones and they can be explained in the following way:

- Credit and default risks: default risk is generally accepted as an event in which a company or an individual is unable to meet the required interest payment obligations on time. Defaults in the collateral pool are translated in the loss of the principal and of the related interests. For ABS, a default may occur when maintenance obligations on the underlying collateral are not sufficiently met as detailed in its prospectus. Typically, to understand the security's risk of default, it is necessary to look at the credit rating. Indeed, the different tranches of the ABS are characterised by a different rating which is based on their quality. The senior classes are on the highest point of the ranking and they receive the highest rating, while the subordinated classes receive the lowest credit ratings. In spite of this, the 2008's financial crash has exposed a dangerous conflict or issue in the securitisation procedure, loan originators retain no residual risk for the loans they generate and they do not have any responsibility. This system is what has also caused the worsening of the underwriting standards' quality.
- Reinvestment/prepayment/early amortisation risk: most ABS's investors have also to face another type of risks, i.e. the early amortisation risk. Typically, the prepayment or early amortisation risk is the risk which occurs when there is a premature return of principal in case of fixed-income security. This means that, if the principal is demanded earlier than expected this can change the composition of the pool of loans, typically worsening the credit quality of it. This happens because usually the loan which is paid earlier is the one with a high credit rating quality. For instance, in a mortgage-based security, the owners' mortgages have the right to pay off their debt because they have a improved financial condition or because they have found a way to refinance the loan to a lower interest. However, usually to avoid this problem there are some prepayment penalties in the contract which make less easy to prepay a loan or a mortgage.

- Currency interest rate fluctuations (market risk): like all fixed income securities, the prices of fixed rate ABS move in response to changes in interest rates. Fluctuations in interest rates affect floating rate ABS prices less than fixed rate securities, as the index against which the ABS rate adjusts will reflect interest rate changes in the economy. Furthermore, interest rate changes may affect the prepayment rates on underlying loans that back some types of ABS, which can affect yields. Home equity loans tend to be the most sensitive to changes in interest rates in comparison to auto loans, student loans, and credit cards which tend to be generally less sensitive to interest rates.
- Moral hazard: investors usually rely on the deal manager to price the securitisations' underlying assets. Therefore, a conflict of interest occurs when the manager's gains are linked to the performance of the portfolio. Because of that, the manager is, somehow, tempted to inflate the prices of the portfolio assets. Moreover, another case of moral hazard risk occurs with senior note holders when the manager has a claim on the deal's excess spread.
- Servicer risk (counterparty risk): the servicer is the responsible party for the transfer and for the collection of payments. The overall procedure is delayed or put under pressure if the servicer becomes insolvent and he is not able to repay the debt. Even if, sometimes, it is possible to find a substitute, the time which the process will take is crucial for the entire system. Standard and Poor's analysed scenarios where the servicer may be unwilling or unable to perform its duties and a replacement servicer has to be found. The causes which can have an influence on the probability of a replacement servicer's availability and willingness to accept the commitment are: "... the sufficiency of the servicing fee to attract a substitute servicer, the seniority of the servicing fee in the transaction's payment waterfall the availability of alternative servicers in the sector or region, and specific characteristics of the assets and servicing platform that may hinder an orderly transition of servicing functions to another party."⁹² This risk is mitigated by having a backup servicer involved in the transaction.

⁹² Standard and Poor's (2007), Principles-Based Methodology For Global Structured Finance Securities, pg.4

3.4.3 Risk mitigation's strategies

Securities markets have declined significantly since the financial crisis in 2008, even if, as highlighted before, now there is a recovery of the previous market size. Several new regulations deliberated in the Dodd-Frank legislation of 2010⁹³, as well as the Basel III⁹⁴ international banking regulations, have put brakes on some of the reckless practices which cause to the financial crash. Especially, limits on proprietary trading in investment banking in Dodd-Frank and new capital requirements instituted by the Basel III Accord will make it more difficult for banks to leverage beyond their possibilities.

These regulations also attempt to bring the interests of issuers, bankers, and rating agencies in line with those of the investors. Beforehand, the former parties would receive their compensation upon the execution of the deal and had no “skin”⁹⁵ in the securities once they were sold; this was ineffective in guaranteeing due diligence, and many toxic securities consequently were sold off with full impunity. In reaction to new regulations and other effects of the crisis, the financial markets today feature greater transparency of investment information, greater retention of risk by equity holders, sponsors, and/or originators, and more robust investor evaluation of financial instruments⁹⁶. Systemic risk monitoring is an essential activity to prevent the emergence of a new financial crisis and requires control over the systemically significant financial institutions and the risks of instability related to their activity. In Title I of the legislation ("Financial Stability") the establishment of two agencies called Financial Stability Oversight Council (FSOC)⁹⁷ and Office of Financial Research (OFR) who are devoted respectively to supervision and limitation of risks systemic macroeconomics and the

⁹³ U.S. Government, (July, 2010). *Dodd-Frank Wall Street Reform and Consumer Protection Act*, Public Law 111–203, Enacted December 16, 2016,

⁹⁴ Basel Committee on Banking Supervision, (June 2011). *Basel III: A global regulatory framework for more resilient banks and banking systems*, Bank for International Settlements

⁹⁵ Lowder, T., Mendelsohn, M., (December 2013). *The potential of Securitization in Solar PV Finance*, National Renewable Energy Laboratory,, pg.6

⁹⁶ Culp, C.; Forrester, P. (2013). U.S. Structured Finance Markets: Recent Recovery, Post-Crisis Developments, and Ongoing Regulatory Uncertainty in *The Journal of Structured Finance* (18:4).

⁹⁷ Murphy, E., Bernier, M., (November 2011). *Financial Stability Oversight Council: A Framework to Mitigate Systemic Risk*, Report from Congressional Research Service, pg.1

analysis of data stored in time. More specifically, the new rules are laid down for financial institutions involved in securitisation operations: in particular, the obligation is foreseen to retain a portion of the credit risk of the assets sold in the operation. The SEC will have to issue rules for the publication of information on the securitisation by the asset-backed issuer securities and conduct a two year study on the rating process for the structured finance products, potential conflicts of interest and the feasibility of a system in which an independent authority can assign to registered rating agencies the task of determining the rating of products of structured finance.

3.5 Rating of ABS

Most of the sources of uncertainty to which the ABS holders are exposed are attributable to the credit risk associated with the assets sold by the originator and the non-performance of third parties involved in the transaction. In many cases, the credit rating of the ABS is higher than that of the sponsors of the ABS. This is achieved through the use of special investment vehicles and credit enhancements, as well as through the use of supporting tranches. Achieving a top rating for an asset-backed security is very essential because of the fact that the most important purchasers of asset-backed securities are institutional investors (for instance pension funds, mutual funds and other fiduciaries of funds), who usually demand, or are obliged by law, to invest in just investment-grade securities. Failing to reach a top rating would severely restrict the market for the security, so the issuers of asset-backed securities have created some techniques for improving the credit quality of their security. This is done by consulting with the credit rating agency that will rate the security. Rating agencies opine on the future creditworthiness of transactions. MBS and ABS investors generally expect a review by one or more rating agencies. Issuers generally seek ratings that are high enough to attract investors at interest rates lower than traditional bank debt. These lower interest rates have been the principal reason that issuers are attracted to securitisation.

The structural components that make it possible for companies with no or very low ratings to transform unrated assets into highly rated securities have been practised for over forty years. To obtain the ratings desired, assets being securitised must be isolated from the risk of bankruptcy of the Originator. This is done by transferring the assets into

a SPV, which possesses certain structural features that decrease the chance that the SPV will be the subject of a bankruptcy proceeding while the rated debt is outstanding. In addition, to be attractive to institutional investors, the securities should generally be issued in a sufficiently large principal amount to permit multiple institutional investors to invest in them. This creates greater opportunities for buying and selling the securities in the secondary (i.e., post-issuance) market, resulting in greater liquidity. In fact, greater liquidity usually results in lower interest rates on the securities. The function of rating agencies in this process is to assess the risk that any of the securities will not be paid on the schedule specified in the transaction documents. In the rating process, rating agencies do not assist issuers in structuring their deals; an agency will only analyse structures that issuers place before it. Depending on how the rating agencies view the proposed deal, an issuer may need either more or less over-collateralisation (credit enhancement) to achieve the desired rating. Over-collateralisation refers to the “cushion” in the form of either pledged cash flow in excess of debt service requirements or the addition of subordinated classes of debt. In either case, the issuer’s objective is to achieve the lowest cost of funds by minimising the amount of over-collateralisation or subordination levels and to maximise the principal amount of the highest rated securities in the offering.

One problem in this system is related to the fees that the credit rating agencies earn with these consultations, which are typically much higher than the ones which the agencies receive for rating bonds. In fact, there has always been a dispute about this comfortable disposition concerning mortgage-backed securities (MBS) and their related credit ratings. Following the crisis, many of those securities were severely downgraded because of the many defaults on the underlying subprime mortgages⁹⁸. Many criticisms have arisen because of the fact that the rating bodies were gaining excessively with the consultations on the MBS. Because of that, they wanted to have more and more clients in the market area, they were extremely tolerant and permissive in the credit ratings’ analyses and supervisions.

⁹⁸ Baghai, R., Becker, B., (November 2016). *Possible bias in ratings when rating agencies perform consulting services*, VOX CEPR Policy Portal, <https://voxeu.org/article/rating-agencies-consultants-potential-bias>

3.5.1 Key drivers of rating

A rating is an assessment of either expected loss or probability of default. Moody's ratings of ABSs have the aim to estimate the expected losses, which includes the evaluation of both the probability of default and the amount of loss, given the default rate. Moody's defines the ratings of structured finance long-term in the following way:

« Moody's ratings on long-term structured finance obligations primarily address the expected credit loss an investor might incur on or before the legal final maturity of such obligations vis-`a-vis a defined promise. As such, these ratings incorporate Moody's assessment of the default probability and loss severity of the obligations. They are calibrated to Moody's Corporate Scale. Such obligations generally have an original maturity of one year or more, unless explicitly noted. Moody's credit ratings address only the credit risks associated with the obligations; other non-credit risks have not been addressed, but may have a significant effect on the yield to investors. »⁹⁹

With the probability of default approach, the rating assesses the probability of full and prompt payment of interests and the final payment of the principal when is due by the legal final maturity date. This is the approach taken by Standard and Poor's and they try to define their credit rating procedure as:

« It takes into consideration the creditworthiness of guarantors, insurers, or other forms of credit enhancement on the obligation and takes into account the currency in which the obligation is denominated. The opinion evaluates the obligor's capacity and willingness to meet its financial commitments as they come due, and may assess terms, such as collateral security and subordination, which could affect ultimate payment in the event of default. »¹⁰⁰

⁹⁹ Moody's Rating Symbols & Definitions, May 2009, Moody's Investors Service, pg.12

¹⁰⁰ S&P Global Ratings, Issue Credit Ratings, https://www.spratings.com/en_US/products/-/product-detail/issue-credit-ratings [21 September 2018]

Anyway, the rating of ABS is essential to understand the risks which an investor has to face after the purchase of this type of instrument. Therefore, the rating agencies are considered as an impartial and an independent body which could give an objective opinion on the investment process. Obviously, their aim is to safeguard the interests of the investors. Ratings should reflect neutral and influence-free professional opinion on the assessment of credit risks associated with a financial instrument or with a corporation. Rating agencies estimate the likelihood for investors to see their investment satisfied. They have the task of expressing a synthetic judgment on an issuer or an issue through a symbol (for example, AAA) and an accompanying analysis that explains its motivations. The intervention of a rating agency is fundamental as there is the need to have a judgment that allows assessing effectively the relationship between risk and return of the security, in particular, it is an essential element for the investor that through the rating can evaluate if a given security has a level of risk in line with the pre-set investment objectives. Moreover, the services provided by the rating agencies provide a guideline to the investors as to the degree of certainty of payment of the principal and of the interest in the case of a debt instrument. In any case, the different credit agencies provide different techniques and methodologies to assess the creditworthiness of an asset.

The three American main rating agencies, Moody's, S&P and Fitch, which provide ratings for structured transactions are (as in Figure 14):

	Moody's	S&P	Fitch	Meaning
Investment Grade	Aaa	AAA	AAA	Prime
	Aa1	AA+	AA+	High Grade
	Aa2	AA	AA	
	Aa3	AA-	AA-	
	A1	A+	A+	Upper Medium Grade
	A2	A	A	
	A3	A-	A-	
	Baa1	BBB+	BBB+	Lower Medium Grade
	Baa2	BBB	BBB	
Baa3	BBB-	BBB-		
Junk	Ba1	BB+	BB+	Non Investment Grade Speculative
	Ba2	BB	BB	
	Ba3	BB-	BB-	
	B1	B+	B+	Highly Speculative
	B2	B	B	
	B3	B-	B-	
	Caa1	CCC+	CCC+	Substantial Risks
	Caa2	CCC	CCC	Extremely Speculative
	Caa3	CCC-	CCC-	In Default w/ Little Prospect for Recovery
	Ca	CC	CC+	
		C	CC	
		CC-	In Default	
D	D	DDD		

Figure 14: correspondence between Moody's, Fitch and S&P's (source: World Economic Forum, <https://www.weforum.org/agenda/2016/07/what-is-triple-a-credit-rating/>, [10 September 2018])

Anyway, not all the credit rating agencies use the same symbology to define each credit quality. For example, Moody's and S&P ratings have similar but different level of credit risk and different symbols to define each rating class as in the previous table.

In conclusion, the purpose of the analysis of a securitisation transaction by the agencies is that on the one hand to assess the probability that the vehicle makes regular payments of interest and principal on the bonds issued, on the other hand, it allows the quantification and determination of the type of guarantees which ensure the best coverage of the issued security.

CHAPTER IV

Solar Asset-Backed Securities (ABS) Case

4.1 Solar market background

After a detailed analysis of the available financial instruments which can be used in order to make green investments, here we analyse the case of the solar ABS. Before going into the details, it is necessary to briefly contextualise the solar industry and market to understand which are the advantages and challenges of this sun-related technology. Therefore, although the solar market consists of multiple technologies that harness the sun's energy in different ways, here we focus specifically on solar photovoltaic (PV) technology. PV technology is used in three distinct market segments that generate power for three different classes of customers: residential, commercial, and utility-scale photovoltaic solar arrays. Solar PV has traditionally covered just a very small percentage of the total amount of electricity generated, but the PV industry has experienced an incredibly rapid growth in the last few years and is expected to continue this trajectory in the immediate future. Indeed, in the span of only a few years, the solar market has grown from a restricted niche industry into an important global player. Solar installations in the United States grew at an annual rate of almost 70% between 2005 and 2012. Federal tax incentives and state-level aids have largely driven this incredible growth. Moreover, the price of a solar panel has started to decline considerably from 1975 to 2015 where the price is just 0.6% of what was at the beginning. This decline was then followed by the increase in global solar panel installations which started to grow vertiginously at the beginning of the 21st century (see Figure 1).

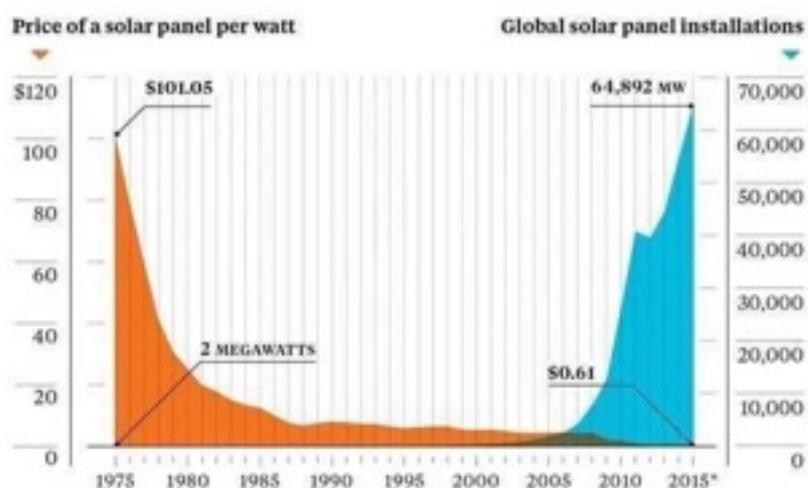


Figure 15: The graph compares the cost of the panel, with the installed capacity (source: Richard, M., Earth Policy Institute, Bloomberg, 2015)

However, for some reasons, these tax incentives and policies will be unable to sustain such rapid growth in the coming years, with major effects in the residential sector. If the solar industry will continue to grow and will become competitive with other renewable or non-renewable energy sources, innovative private financing mechanisms are needed to allow residential solar developers to enter into capital markets and access new classes of investors (e.g., mutual funds, pension funds, and other institutional investors) who are essential to access wider pools of fundings. Without the entrance of these institutional investors the market will not be able to sustain such solar industry growth. On the other hand, the PV industry, generally, is able to access the capital markets by means of two main common ways:

1. Securitisation: as said before, it's the process of transforming illiquid assets into standardised, tradable and liquid products (i.e. the securities). Indeed, security issuers sell "the rights to the underlying assets and the proceeds are used to finance business operations"¹⁰¹. Then, the issuers pay an interest rate to every investor who has purchased the securities. The given percentage of the interest rates is usually calculated in relation to the securities' ratings and to their risk/reward characteristics.
2. Bonding: another alternative is the process of securitising debt and then issuing it into the capital markets by means of bonds. When the investors are purchasing these bonds (and the rights to the cash flows on the underlying debt), they are, in simple words, lending capital to the issuer of the securities. The investors, then, receive an interest rate as a compensation for the investment. The amount of it is determined by the characteristics of the bonds and by their credit rating quality.

Therefore, securities are issued in several different forms, they range from bonds to stocks to different types of asset-backed products. The National Renewable Energy Laboratory (NREL), which is a U.S. body specialised in renewable energy and energy

¹⁰¹ Lowder, T., Mendelsohn, M., (December 2013). *The Potential of Securitization in Solar PV Finance*, National Renewable Energy Laboratory (NREL), pg.V

efficiency research and development, has established that ABS and also collateralised loan obligations (CLO) structures will likely “be the initial vehicles through which residential and commercial solar assets could be securitised”¹⁰². Bond finance has already been utilised by some solar developers on an industrial scale to finance projects’ development and operations. Despite the fact that the securitisation of solar leases presents a promising solution to the problem of entering into capital markets, there are still a variety of barriers which currently prevent solar companies from securitising these assets successfully and profitably. In fact, there are many challenges to face in order to create a reliable and profitable market for these instruments. Here we identify and assess these barriers and recommend strategies to promote low-cost securitisation of residential solar leases while minimising the potential risks that such securitisation process poses.

4.2 Overview on solar securitisation

Given the solar industry’s premises, it is important to explore a promising recent development in green finance: the securitisation of solar assets. Typically, securitisation is well-known by the general public as the cause of the massive recession in 2008, when the subprime mortgage bubble burst and investors realised that securitising bad loans did not magically make vanish all the risk. Diversification is one of the most famous strategies to reduce the risk of an investment or a project. An idea which could also be applied to our daily life, for instance, when someone should not concentrate all his efforts and resources in one area because he could lose everything. Basically, the concept can also be summarised very well by the famous sentence « do not put all your eggs in one basket ». Anyway, diversification is not the solution to every risky problem because the risk of one asset could highly be correlated with the other assets’ risk and this could lead to a disaster. Fortunately, solar securitisation so far looks much secure, in fact, the underlying loans are given to individuals or companies with much higher credit quality. In spite of the fact that securitisation itself has been around since the 1970s, the solar adaption of it is comparatively new and, from 2013 to 2016, solar companies

¹⁰² Lowder, T., Mendelsohn, M., (December 2013). *The Potential of Securitization in Solar PV Finance*, National Renewable Energy Laboratory (NREL), pg.16

(mainly SolarCity and Sunrun) have only carried out seven series of securitisation¹⁰³. The result from them is very promising because they have been offered with a yield of 4-6% which can be translated into a general confidence of the investors in this financial instrument. However, all of these series look very similar to securitisations for other asset typologies, like credit cards, home mortgages, or student loans. Varun Sivaram, an expert on energy technology and climate change stated that «the solar ABS transactions to date adhere to the general framework of most securitisations, with some important exceptions. Solar ABS use a standard legal structure, the special purpose entity, to combine thousands of rooftop solar systems generating monthly cash flows.

Importantly, the special purpose entity is a limited liability company, which is designed to mitigate bankruptcy risk between the solar provider (the originator) and the issuer of the solar ABS. The special purpose entity then issues new debt securities based on the cash flows from the solar leases/PPAs or loan payments¹⁰⁴. In the end, the ultimate goal of solar ABS is to match new investors with renewable energy assets in order to generate returns for the former and lower the cost of capital for the latter. We do, however, reflect on the current challenges and future opportunities of solar securitisation. Debt markets should in theory supply lower-cost capital for solar providers and drive a greater deployment of renewable energy. The structure of the transactions, the size of the markets, and the recent uptick in investors' interest seem all to converge to make solar ABS promising and profitable in the close future. In the U.S. companies SolarCity (acquired by Tesla in 2016), Mosaic and Sunnova controlled more than the half of the market in 2017, with an overall value of almost 1.3\$ billion of solar ABS raised¹⁰⁵ (see Figure 16).

¹⁰³ Sivaram, V., “Securitization: The Next Big Thing in Solar Energy Financing”, July 19, 2016, Council on Foreign Relations

¹⁰⁴ Gorton, Gary, and Nicholas S. Souleles. “Special Purpose Vehicles and Securitization.” NBER Working Paper 11190, March 2005. <http://www.nber.org/papers/w11190>.

¹⁰⁵ Eckhouse, B., “Tesla Returns to Securitization Market With More Solar Contracts”, 4 December 2017, Bloomberg



Figure 16: solar ABS divided by issuers (source: Eckhouse, B., (2017). Bloomberg New Energy Finance)

The important information that it is possible to capture from the Bloomberg's table is the fact that more and more companies are seeing solar securitisation as a profitable opportunity and the market's forecasts seem to predict a positive trend in U.S. PV installations in the next years¹⁰⁶. In fact, in the U.S. total solar production has increased over fifty times since 2005, and residential solar installed capacity has grown seventy-seven times. Furthermore, from 2014 to 2015, the sector witnessed capacity growth by over 60 per cent. All these data show that capturing the sun energy and investing in it is promising to be very good investments because of a constantly improving technology and a continuous plummet of costs. Looking into the future of 2040, and "solar power is estimated to represent almost a third of installed global generating capacity"¹⁰⁷.

4.3 Structure of solar ABS

Even before its first issuance, the idea of securitising solar assets was not completely new. Since 2010 and even before, researchers, experts and interested esoteric ABS investors have tried to find ways to pool together solar loans and leases and, then, sell

¹⁰⁶ GTM Research / Solar Energy Industries Association (SEIA) U.S. (2018) *Solar Market Insight Report 2018 Q2*, US PV Installation Forecast, 2010-2023E

¹⁰⁷ Bloomberg New Energy Finance, (2015). *New Energy Outlook*, pg.4

the related securities on the market. In a study, Theresa Alafita and Joshua Pearce¹⁰⁸ were evaluating the feasibility of asset-backed solar (ABS) securities which could be a low-priced approach of financing, the research was also able to suggest policies that could simplify the realisation of the securitisation and discover that securitisation is a vital way for improving project funding. In fact, in 2012, the U.S. Department of Energy, overseen by the National Renewable Energy Laboratory (NREL), gave birth to the Solar Access to Public Capital (SAPC) project whose objective was to evaluate the securitisation prospects and its potential benefits for issuers and investors¹⁰⁹. The group working on this 3-years project was composed by lawyers, rating agencies, banking professionals, tax consultants and other experts in order to create a “mock securitisation”¹¹⁰. Its aim was to focus on the standardise practices which were complete with cash flow analyses under different stress tests and with the identification of friction points. Eventually, the group developed a standard residential lease and commercial power purchase agreement (PPA) contracts which were a very precious instrument in the hands of solar developers, common customers, and also third-party finance suppliers¹¹¹.

The solar ABS transactions so far follow the general framework of most of the existing securitised products but with a few important differences which differentiate them for the other asset classes. Generally, solar ABS use a standard legal structure, the special purpose vehicle (SPV), to combine thousands of rooftop solar systems which are producing monthly cash flows. It is important to remember that the special purpose entity is a limited liability company, whose structure has been created to protect the solar suppliers and the issuers of solar ABS from any probability of bankruptcy or

¹⁰⁸ Alafita, T., Pearce, J., (2014). *Securitization of residential solar photovoltaic assets: Costs, risks and uncertainty*, Michigan Technological University, Department of Materials Science and Engineering

¹⁰⁹ DeMarzo, P., (2005). The Pooling and Tranching of Securities: A Model of Informed Intermediation in *The Review of Financial Studies*, Oxford University Press, Vol. 18, No. 1

¹¹⁰ Mendelsohn, M., Lowder, T., (December 2015). *The Solar Access to Public Capital (SAPC) Mock Securitization Project*, National Renewable Energy Laboratory

¹¹¹ O’Sullivan, F., Warren, C., (July 2016). *Solar Securitization: An Innovation in Renewable Energy Finance*, An MIT Energy Initiative Working Paper, pg.4

default risks. Furthermore, the special purpose entity issues new debt securities based on the cash flows from the solar customers who make payment on their leases or on their PPA contracts. Then, the investment banks give a price and market the securities to the interested investors. Following this, potential investors can purchase the solar asset-backed securities in order to receive the interest payments (see Figure 17).

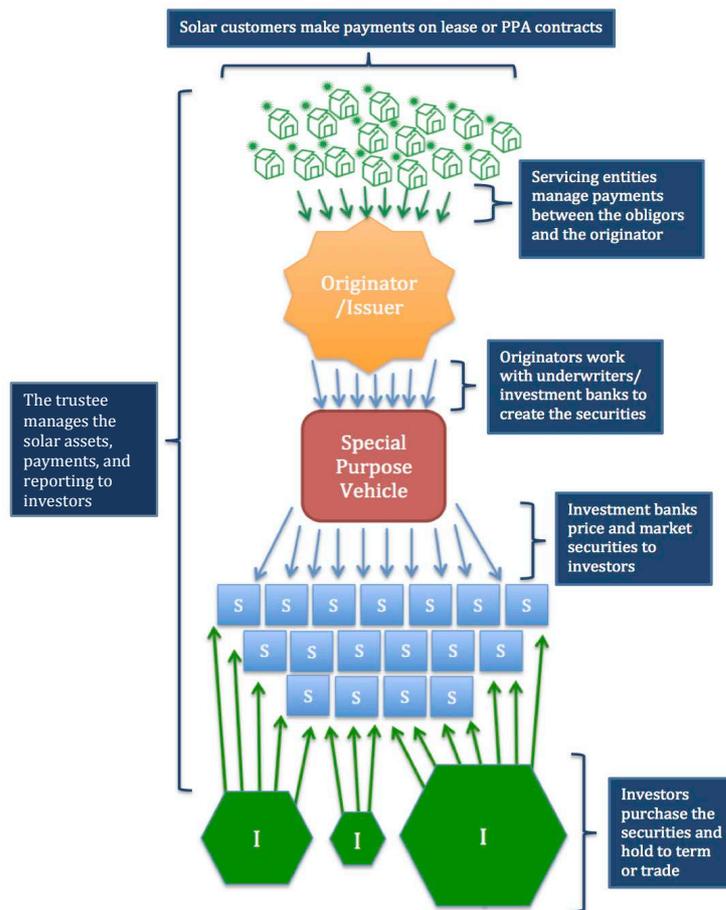


Figure 17: solar ABS structure (source: Mendelsohn, M., Lowder, T., (2015). National Renewable Energy Laboratory.)

The solar suppliers in turn can receive debt financing at lower costs. With cheaper financing from securitisation, solar providers hope to generate better cash flows and deploy more systems than would otherwise be difficult to arrange. As highlighted before, while solar securitisation shares many affinities with other ABS, the framework has two particular subtle nuances¹¹². First of all, tax equity investors are critical because

¹¹² Sivaram, V., (July 2016). Securitization: The Next Big Thing in Solar Energy Financing, Council on Foreign Relations, <https://www.cfr.org/blog/securitization-next-big-thing-solar-energy-financing>

of the fact that solar suppliers have to cash in on the solar investment tax credit (ITC) which is a system to support the deployment of solar energy in the U.S¹¹³. Whilst tax equity investors have usually the senior claims on the cash flows from the projects, securitisation involves another group of investor who are looking for similar predictable returns: the fixed-income ones. Here we can see a simple distinction between these two types of investors:

- Tax equity investors: are used to invest in solar projects using a financing approach called project finance. Project finance is the way most energy generating assets are financed in the US today. A successful project finance transaction is based on predictable, reliable cash flows that are more than sufficient to service operational expenses and financing costs. Tax Equity investment returns are based on a combination of cash flow from the project and federal tax benefits (tax credits and tax deductions).
- Fixed-income investors: investors in fixed-income securities are typically looking for a constant and secure return on their investment. For example, a retired person might like to receive a regular dependable payment to live on like gratuity, but not consume principal. This person can buy a bond with their money, and use the coupon payment (the interest) as that regular dependable payment. When the bond matures or is refinanced, the person will have their money returned to them. The major investors in fixed-income securities are institutional investors, such as pension plans, mutual funds, insurance companies and others.

Therefore, solar asset-backed securities (ABS) are being explored as a promising possibility for issuers and for investors. If there is a way to access the an incredibly wide pool of wealth managed by institutional and other investors, solar ABS will have the great potential of decreasing financing costs, and also to open many doorways to financing possibilities¹¹⁴. This could be particularly convenient for the development of smaller scale solar projects, where the fundings' research is extremely arduous. Even if

¹¹³ Solar Energy Industries Association (SEIA), *Solar Investment Credit (ITC)*, <https://www.seia.org/initiatives/solar-investment-tax-credit-itc> [15 September 2018]

¹¹⁴ Mendelsohn, M., Feldman, D., (2013). *Financing U.S. Renewable Energy Projects Through Public Capital Vehicles: Qualitative and Quantitative Benefits*. National Renewable Energy Laboratory, Technical Report NREL/TP-6A20-58315.

securitisation has allowed other asset classes to successfully attract financial capital, there are several challenges limiting its widespread utilisation within the solar industry¹¹⁵. Therefore, in order to facilitate the development and the spread of this new asset class, legislators and lawmakers must take into account the risks associated with the specific characteristic of the assets, and find regulations and policies to reduce these risks and to foster the development of this energy. For example, California, in 2011, made a law which requires that the 33% of all the electricity consumed in the state by the 2020 has to be produced from sustainable energy sources¹¹⁶. Despite this and many other initiatives to promote the renewable energies, the path ahead is still long and requires a great commitment from the governmental institutions. Therefore, solar securitisation is an innovative asset class which is still developing and is facing growing pains due to the long tenor and unstable nature of the assets as well as a limited presence in the market¹¹⁷.

4.3.1 *The role of YieldCos*

SunEdison, one of the world-leading American company in the design and construction of solar systems, services and solutions to simplify access to solar energy on the global market, is one of the example of a company which is interested in the creation of YieldCos, which are entities which are created in order to own the operating assets which generate steady cash flows. Indeed, SunEdison created the first YieldCo in 2014 which was then followed by another one in 2015¹¹⁸. In order to be clear, this new long-term financial instrument, which although it does not guarantee high returns, guarantees certain, will, in fact, provide protection for investments and business activities in the photovoltaic sector. Keeping in mind that this is not a new concept. In fact, it is years that many financial experts and professionals talk about this financial instrument in the

¹¹⁵ Herndon, A., (July 2012). First Solar Bonds Financing \$4.6 Billion U.S. Panel Boom in *Bloomberg News*

¹¹⁶ Nolan, A., Michels, D., (February 2013). Securitisation as a means to finance distributed solar projects in *Financier Worldwide Magazine*, <https://www.financierworldwide.com/securitisation-as-a-means-to-finance-distributed-solar-projects/#.W6X3UmQzZQI>

¹¹⁷ Brandt, T., Garry, T., (March 2016). *The Solar Securitization Opportunity*, Marathon Capital, LLC and Marathon Capital Markets

¹¹⁸ Foley, S., Crooks, E., (April 2016). SunEdison: Death of a solar star in *Financial Times*

world of renewables, but it is certainly true that this topic has become more interesting now that the policy of incentives to renewables is, in many ways, uncertain and ambiguous (with tendencies) also retroactive) in many European countries and not only. In essence, therefore, a YieldCo is a "publicly-traded" company, whose goal is to possess assets capable of producing cash flows to be shared among investors in the form of dividends (see Figure 19).

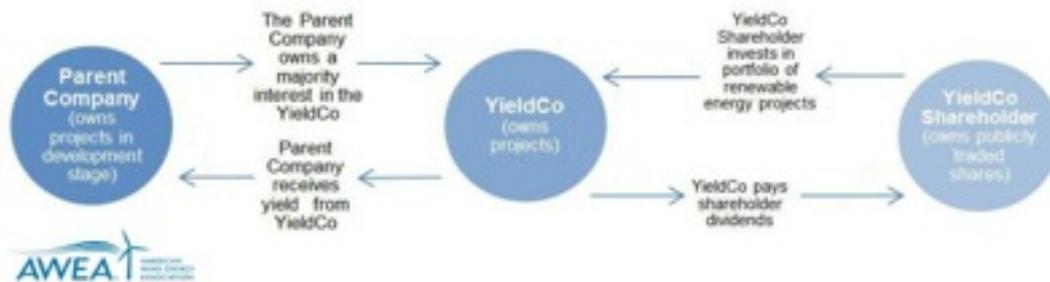


Figure 19: YieldCos structure (source: American Wind Energy Association, (2015). *You can be an investor in a wind farm through new "YieldCos"*)

In concrete terms, it will be a matter of creating new photovoltaic parks connected to power plants of companies with which energy purchase contracts have been signed or, in any case, of sources of long-term income. YieldCos also provide another possibility: instead of dividing the entire gain among investors, reinvest a part of it in the photovoltaic sector, without the impediments and the rules to which they are, instead, subject investments like those of MLP (Master Limited Partnerships) or REITs, real estate investment funds, two forms of investment (even these long-term and safe) to which many investors have been oriented over the last twelve months. Compared to these, however, the YieldCos are, in fact, bound by fewer rules and interventions by local governments. They also offer the possibility of being easily bought, like normal shares or bonds, but compared to these they do not run the risk of being influenced by the fluctuating market prices. Anyway, for different motives the YieldCos are not able to reach the institutional investors. Indeed, there have been some issues which are related to the transparency and the governance of these entities and sometimes there were also conflicts of interests because the developer sometimes could also be the owner of the institution.

4.4 Potential risks

Even though asset-backed securitisation has become well-established in the economy (mainly in the American one), reaching everything from credit card receivables to auto lease payments, the mortgage-related practices which contributed to the financial crisis of 2008 raise many questions about the wisdom and reliability of securitisation itself. The financial crisis followed a remarkable increase in the securitisation of consumer debt, especially subprime mortgage debt. By 2006, in U.S. subprime mortgage assets accounted for about half of all asset-backed securities issuances. These mortgage loans were granted to borrowers who had little ability to repay them and were then quickly packaged, securitised, and also often re-securitised. Under this “originate-to-distribute” model, brokers had an incentive to increase the number of loans they sold by incredibly lowering credit quality standards, and banks had the incentive to take on more subprime assets because they used to pay higher interest rates¹¹⁹. A very low attention was paid to the riskiness of the mortgages, in part because of the perceived stability of the residential real estate market, which approximately everyone forecasted to continue to increase in value and size. After the well-known tumultuous crisis, while regulators are still trying to figure out exactly which were exactly the triggers which caused the financial disaster and how to prevent it from happening again, it is important to assess the risks of this new esoteric asset class. This is especially necessary because, during the crisis, rating agencies and investors were inadequately aware of risks that the subprime mortgage assets posed.

4.4.1 Solar-specific risks

There are a number of risks that are specifically related to solar leases, which must be addressed before a successful, low-cost securitisation can take place. Indeed, the securitisation of these assets has to face many challenges which may be related to the complicated technology which is behind them or also to the complexity of the instrument itself. Moreover, the complexity of the system makes the ratings' procedures even more difficult because they are linked to the solar PV technology which makes the assessment of risks and exposure a very challenging job. Facing this risks and finding

¹¹⁹ Zestos, G., (October 2015). *The Global Financial Crisis: From US subprime mortgages to European sovereign debt*, Routledge, pg.33

solutions to fully or partially avoid them could help to attract new investors and make this niche market more profitable in the future.

4.4.1.1 Technology risks

As said before, the first challenge is related to the technology behind the photovoltaics panels which are used to absorb the sunlight in order to create electric energy. Therefore, solar securitisations' cash flows depend principally on the production of electricity from the rooftop solar panels which have been installed by the customers. PV panels and their related technology improve constantly, but the residential business model assumes twenty-year contracted cash flows from the installed systems¹²⁰. During that time horizon, huge developments in technology could present themselves. This could lead to the subsequent “obsolesce” issue, i.e. the solar installations could become worthless at some point in the future and this problem is real but the loss is difficult to calculate. Other asset's securitisation has comparable technology issues as the solar ABS. For example, car leases (with an average life 3 years) have similar concerns about the fast-changing technology, but there is an active secondary car market which is essential to sell the old automobile and to recover some of the initial asset's value. In fact, valuation of vehicles and homes are also not very unusual in order to take some of the initial value back.

On the other hand, in the case of default, solar supplier cannot effortlessly take back the panels because they have little to almost zero value after the initial installation. Moreover, if the PV panels are useless, there is also a concern about the recycling of their materials which have to be worked off in a sustainable way. Indeed, the PV modules “contain substances such as glass, aluminium and semiconductor materials that can be successfully recovered and reused, either in new photovoltaic (PV) modules or other products”¹²¹. Another issue is also born out in the “transfer risk” underlying the third-party ownership business model¹²². For example, when a customer leaves the

¹²⁰ O'Sullivan, F., Warren, C., (July 2016). *Solar Securitization: An Innovation in Renewable Energy Finance*, An MIT Energy Initiative Working Paper, pg.4

¹²¹ Larsen, K., (August 2009). End-of-life PV: then what? - Recycling solar PV panels in *Renewable Energy Focus*, <http://www.renewableenergyfocus.com/>

¹²² Kroll Bond Rating Agency (KBRA), (October, 2012). *Evaluating Credit Risks in Solar Securitizations*, <https://www.krollbondratings.com/announcements/108>.

home, he needs to transfer the solar contract to the new property's owner. The process can be complex, mainly in the case of death or divorce of the owners. This risk may be further increased in the future if, at the time of transfer, "new panel technology in the market will be more efficient and far cheaper than the existing rooftop assets in the contract lease"¹²³. Moreover, if solar power continues to fall in cost, solar installations will have low "salvage" value in the case of a consumer loan default. For many people, this does not seem a real risk, but it is, in fact, an important factor which has to be taken into account when comparing solar asset-backed securities to other other classes of ABS.

4.4.1.2 Ratings complexity

First, to have a successful securitisation that will attract investors, a potential buyer must be able to rely on the originator to "reasonably predict the aggregate rate of default"¹²⁴. This will enable credit rating agencies to accurately assign ratings to each security and allow potential investors who rely heavily on credit ratings in their due diligence efforts to make more informed and reasonable decisions. In the solar lease context, potential investors would need data showing the likelihood of customer default over the life of the assets, which usually last for more than twenty years. The issue with this type of assets, however, is that existing solar leases have been present in the market just for a very limited amount of time. The lack of historical data about the likelihood of default of the solar leases is one of the most critical issues in this context. The still short life of solar ABS is not giving us enough data from which to draw conclusions about aggregate default rates going forward for twenty years or more. This amount of time is necessary for rating agencies and potential investors who want to understand the riskiness and the behaviour of these instruments. Another issue is that, even with a considerable higher amount of data, many credit agencies, in the past, were inadequately assessing the risks of these instruments and they were also responsible for the blast of the crisis and for the consequences arising therefrom.

¹²³ Arreola, G., Treadwell, T., Hoen, B., (2015). *Survey of Buyers, Sellers and Realtors Involved In San Diego Third-Party Owned Solar Home Transactions, A Qualitative Assessment*, Lawrence Berkeley National Laboratory, <https://emp.lbl.gov/sites/all/files/lbnl-1003917.pdf>

¹²⁴ Schwarcz, S., Markell, B., & Broome, L., (2004). *Securitization, structured finance and capital markets*, Caroline Academic Press, pg.201

4.4.1.3 Net metering

When you have a rooftop solar system, it can often generate more electricity than you need during the daylight hours. The homeowner is only billed for the “net” energy used each month, which is the difference between the energy produced by the solar power system and the energy consumed by the house over the monthly billing period. Net metering is a state-level policy which permits to the households to sell the additional created energy. Indeed, the rooftop installations’ owners have the opportunity to sell the electricity in surplus to the distribution grid and at the prevailing tariff rate. Anyway, volumetric retail tariffs involve not only energy charges but also the costs for the maintenance of the distribution grid. In other words, the cost shifting from the households with solar installations to the other ratepayers is creating a heated debate¹²⁵. In spite of the controversy around net metering costs, its impact on the residential solar business model is indisputable. Solar panels’ owners keep this into account in the calculation of the monthly lease payments which then influence the present value of each lease¹²⁶. On the other hands, this system could also create issues because the change of net metering policies could, then, invalidate and worsen the quality of the assets tranches. Forecasting specific metering policy changes, indeed, is almost impossible. Another risk is related to the geographical concentration of securitisation. In fact, if the solar securitisation is strongly concentrated in a geographical area there will be a surplus of produced electric energy. Therefore, a higher supply of energy means a lower prevailing tariff rate for the electricity and so lower profits for the PV owners.

4.4.2 Broader market and regulatory risks

In addition to the first type of risks, other broader market and regulatory risks have taken place after the effects of the recent financial crisis. Unluckily, these risks are much more difficult to calculate and to face than the solar-specific ones. One of the most important questions is whether residential solar leases, which are physically related to

¹²⁵ Roberts, D., (May 2015). *California will require solar panels on all new homes. That’s not necessarily a good thing. More solar is not always and everywhere better*, <https://www.vox.com/energy-and-environment/2018/5/15/17351236/california-rooftop-solar-pv-panels-mandate-energy-experts>

¹²⁶ Feldman, Boff, and Margolis, (January, 2016). SunShot Initiative Q3/Q4 2015 Solar Industry Update,” U.S. Department of Energy,

homes, might be subject to broader real estate market risk as in the case of the past housing bubble. From this point of view, solar leases may seem similar to mortgage-backed securities, with default rates on both types of instruments tied closely to foreclosure rates. Moreover, solar lease contract lives, typically twenty years, are approximately similar to mortgage terms nature, which is usually equal to thirty years. Moreover, solar securitisation depends heavily on the policies and on the regulations of each state or country and they could change anytime. In the end, there are many broader and regulatory factors and issues which characterised this instrument making it very risky and unstable..

4.4.2.1 Public policies could change and lack of independent green certifications

As we can see from the data, state and federal policies have allowed U.S. residential solar to flourish in the last years. However, these same incentives and subsidies, if removed or altered, could pose challenges to existing and future securitisations because they could eliminate the advantages for the investors and could also raise the costs. In addition to the state policy uncertainty, federal policy could change as well, especially if “the Internal Revenue Service (IRS) makes it more difficult for tax equity investors to invest alongside ABS debt investors”¹²⁷. On the other hand, there is also a problem with the harmonisation of common standards which, if improved, could boost green securitisation in the U.S. and in Europe. Despite several competing and voluntary standards, investors strongly require independent and objective certifications which could help in avoiding any confusion. China's entry into the market with their own standards has not necessarily helped the issue. For instance, it's difficult to agree with the issuance of Chinese bonds linked to the “clean coal” projects and even if they are classified as green¹²⁸.

4.4.2.2 Lack of companies which offer securitisations

¹²⁷ Sivaram, V., (July 2016). *Securitization: The Next Big Thing in Solar Energy Financing*, Council on Foreign Relations, <https://www.cfr.org/blog/secritization-next-big-thing-solar-energy-financing>

¹²⁸ Standaert, M., (January 2018). China support for Clean Coal given green bonds touch of gray in *Bloomberg News*

Another characteristic of solar securitisations market is a critical lack of liquidity which creates numerous problems. This is related to the low number of companies which can or want to offer securitised solar products. Until now, in the US, only a few companies have performed securitisation transactions. These companies have the scale and diversity of projects to do so on their behalf because securitisation needs to be done in large bunches to be appealing for institutional investors who tend to avoid transactions with a limited size¹²⁹. Indeed, even if the number of issuance is increasing over time, there is very little trading of existing solar ABS, meaning a static “buy and hold” strategy from institutional investors. It is difficult to know the precise number of investors in solar ABS, but we know that the number is still low for the potential of solar ABS products. This is due to the fact that understanding the residential solar asset class is not a straightforward task and takes time, so that opportunity cost may dissuade new investors from buying the securities.

4.5 Solar ABS’s rating

The credit characteristics of residential solar loans, a relatively new consumer financial product, are similar to those of other types of loans, Moody's Investors Service says in a new report. Asset-backed securities (ABS) backed by residential solar loans, therefore, share many of the same risks as ABS backed by other types of collateral, though in some cases they may be more pronounced. « The credit risks associated with US residential solar loans are not new to ABS investors, since most, though not all, are in line with those of the collateral in well-established ABS asset classes»¹³⁰ says Moody's analyst, Daniela Jayesuria. « For solar loans, the credit strengths include the relatively strong credit quality of borrowers and the ongoing utility of rooftop solar panels, while the negatives include the risk of contractor fraud, regulatory risks related to net metering and the potential impact of technological advancements ». Indeed, the solar ABS involve different types of risks in comparison to mortgage or automobile loans.

¹²⁹ Sivaram, V., (July 2016). *Securitization: The Next Big Thing in Solar Energy Financing*, Council on Foreign Relations, <https://www.cfr.org/blog/securitization-next-big-thing-solar-energy-financing>

¹³⁰ Moody’s Investor Service, (July 2017). *Moody's: US residential solar loans present ABS investors with familiar risks*, https://www.moody's.com/research/Moodys-US-residential-solar-loans-present-ABS-investors-with-familiar--PR_369271

The rating agencies need to take into account the different kinds of risk and the dangers whom the investors may face. For instance, the risks related to the technology need to be taken into account because are very specific and solar panels are developing very quickly, changing the value of the current installations. Anyway, the credit quality of solar loan borrowers has generally been strong, given the fact that they must be homeowners and are incentivised to repay their loans since the installation of solar panels will reduce their energy costs. Jayesuria says in "ABS - US: Solar loans: a new ABS collateral type with familiar risks." Additionally, solar financing companies have so far focused on prime borrowers. These factors make the credit risks associated with solar loans similar to those of closed-end, second-lien mortgages.

4.6 Measurement of the cost of capital

The concept of cost of capital plays a vital role in the decision-making process of financial management and so, in the evaluation of an investment or a project. The measurement of the cost of financial capital raised by means of securitisation begins with the cash flow analysis. In some way, the cost of capital is a measure of the sacrifice made by the investors in order to get a fair return from their investments. In our case, the Power Purchase Agreements (PPAs) for solar consumers will be taken into account to understand how to calculate this economic measure in the context of solar securitisation. In fact, the originator's, cash flows depend on the performance of its related PPAs. The originator can hold these contracts for their maturity, ensuring a long-term annual income stream, or it can sell PPAs to a special purpose vehicle or entity (SPV) to raise easy and fast capital. Here, the measurement of the cost of capital and the related formulas will be taken by a research made by T. Alafita and J. Pearce¹³¹. Indeed, the present value of developer's cost of capital can be calculated by means of the following equation:

$$\text{Developer's cost of capital} = \text{cash flows to the originator} - \text{sale price of the PPAs}^{132}$$

¹³¹ Alafita, T., Pearce, J., (January 2014). *Securitization of Residential Solar Photovoltaic Assets: Costs, Risks and Uncertainty*, Michigan Technological University, Department of Materials Science and Engineering

¹³² Stone, C., Zissu, A., (2005). *The Securitization Markets Handbook: Structures and Dynamics of Mortgage-and Asset-Backed Securites*. Bloomberg Press, NY

4.6.1 Value of Discounted Cash Flow for the Originator

We start by assuming that a solar power developer originates mo number of PPAs. To understand better the process, assume that these contracts are identical, have been created at the same time, and have a twenty-years duration¹³³. The characteristics and the criteria specified by the PPAs established an anticipated value for the contracted receivables, in a third-party ownership entity. Despite the fact that these PPAs contracts are very complicated in their structure and composition, it's possible to summarise them by their fundamental elements:

- amount of electric energy stipulated in the contract
- price per unity for the electricity (calculated in dollars)
- recovery methods and practices in the case of contracts' termination

With the PPA, the consumer pays the system owner for 100% of the electricity produced by the installed photovoltaic system¹³⁴. When they are all installed, every system is capable of producing an annual output of eo kWh of electricity per year, even if over time this production tends to decline slightly. Anyway, the annual energy output in kilowatt-hour can be defined by the following formula:

$$e(t) = (1-\alpha)^{t-1}e(0)$$

where α represents the constant annual decline rate and t represents the number of years of use. Anyway, during the first year there is not degradation rate and so the system operates at its full capacity. As it is possible to see from the equation, the contract's default rate is the primary source of cash flow uncertainty, and it also undeniably affects the revenues because it lowers the amount of energy output in the contract. In case of bankruptcy, house's sale or of purposeful termination, the financial responsibility will certainly relapse on the consumers¹³⁵. Because of the uncertainty about the length of recovery processes and of their success, liability payments have not been taken into

¹³³ Cory, K., Canavan, B., Koenig, R., (2009). *Power Purchase Agreement Checklist for State and Local Governments*. National Renewable Energy Laboratory, Golden, CO, pg.5

¹³⁴ Alafita, T., Pearce, J., (January 2014). *Securitization of Residential Solar Photovoltaic Assets: Costs, Risks and Uncertainty*, Michigan Technological University, Department of Materials Science and Engineering

¹³⁵ Futuregen Industrial Alliance, Inc., (2012). Unit Contingent Power Purchase Agreement, <http://www2.illinois.gov/ipa/Documents/FutureGen-Alliance-Power-Purchase-Agreement.pdf>

account for evaluating the cash flows. Indeed, for simplicity, a recovery rate of zero is assumed. Whenever a contract's owner fails to repay its debt, the stream of associated payments is removed, and it is canceled out from the asset pool. To describe this phenomenon we use β which represents the annual rate at which the contracts default. Certainly, the termination rates reflect the owner's features, economic situation, and also the current market state. Even if these factors vary constantly over time, for reasons of simplification, the contract termination rate is assumed to be constant over the life of the asset-backed security under consideration. Anyway, the total number of contracts at time t can be expressed in the following way:

$$m(t) = m(0)(1 - \beta)^{t-1}$$

where m_0 represents the amount of contracts which are part of the pool at the beginning. Keeping in mind that all the contracts are assumed to be operating during their first year of life. Given the previous two formulas, it is possible to state that the total amount of energy under contract is expressed by the formula:

$$E(t) = [(1-\alpha)^{t-1}e(0)][(1 - \beta)^{t-1}m(0)]$$

As we know, electricity prices are crucial for the last determination of the CFs. Here, p_0 is considered the unique price for all contracts. Anyway, the price raises by a constant annual escalation rate of γ . This makes the dollar/kilowatt-hour price of electricity in a given period as:

$$p(t) = (1 + \gamma)^{t-1}p(0)$$

Moreover, using the last two equations, annual cash flows are expressed by the formula which multiplies the previous two equations related to the price and the amount of energy produced:

$$c(t) = p(t)E(t) = [(1 + \gamma)^{t-1}p(0)][(1-\alpha)^{t-1}e(0)][(1 - \beta)^{t-1}m(0)]$$

In the end, the total real value of the contracts for the originator is equal to the sum of the cash flows for the 20-years nature of the contracts and discounted at the risk-free rate:

$$C = \sum_1^{20} \frac{c(t)}{(1 + \delta)^t}$$

From this formula, it is possible to understand the value of the contracts under consideration over their length of time and by discounting them by means of the risk-free rate.

4.6.2 Value of discounted Cash Flow for the Investor

While there are many potential forms of credit enhancement, for simplicity of the analysis, the over-collateralisation method is used in this case to evaluate the effect of this parameter on the value of the contracts. Under this method, the par value of issued securities is lower than the value of the collateral. Indeed, the more over-collateralisation required, the less capital can be raised from the asset pool. Consider θ be the amount of over-collateralization required and θ the percentage of contracts set aside each year to be protected from potential contract defaults. Typically, it is assumed that over-collateralisation is always sufficient to ensure payment of investor obligations. However, credit rating agencies are not always perfectly right in forecasting actual default rates and this could create many issues. Consequently, if θ is the amount of over-collateralisation which is necessary, the difference between this value and the actual rate of early contract termination (β) can be expressed in the following way¹³⁶:

$$\sigma = \theta - \beta \geq 0$$

where σ represents the surplus over-collateralisation. The excess collateralisation is distinguished by the other components to understand the impacts of contract issuance and accurate risk evaluation by the credit rating agencies. Credit enhancement is

¹³⁶ Alafita, T., Pearce, J., *Securitization of Residential Solar Photovoltaic Assets: Costs, Risks and Uncertainty*, Michigan Technological University, Department of Materials Science and Engineering, pg.6

incorporated in the model in a manner similar to β . $c(t)^s$, the annual cash flows included in η the securitisation, are given by the equation:

$$c^s(t) = p(t)E(t) = [(1 + \gamma)^{t-1}p(0)][(1-\alpha)^{t-1}e(0)][(1 - (\beta + \sigma))^{t-1}m(0)]$$

where the number of contracts is influenced by: $\theta = \beta + \sigma$. Next, servicing fees are deducted from the cash flows. The servicing fee will be calculated as a percentage of annual revenues, τ , so that the annual fee which is paid to the servicing agent, F_t , is given by:

$$F(t) = \tau c^s(t)$$

and this value is deducted from the annual cash flows. At last, the cost of investor return is incorporated in the cash flow analysis. Before the total real value of contracts was discounted at δ , the risk-free level. Instead, the investors demand a higher rate of return as repayment for the risk which they are facing. If the additional risk or premium risk is expressed by μ , so the rate of return to the solar ABS is composed by $r = \delta + \mu$ ¹³⁷. When investor returns are accounted for, the present value of the income stream generated by the PPAs included in the securitisation pool is given by the formula:

$$C(abs) = \sum_1^{20} \frac{(1 - \tau)c^s(t)}{(1 + r)^t}$$

Because of the fact that Cabs should cover all ABS payment obligations, it must be true that the present value of the expected cash flows from the underlying collateral net all securitisation costs is equal to the present value of the income stream from the ABS.

¹³⁷ Alafita, T., Pearce, J., *Securitization of Residential Solar Photovoltaic Assets: Costs, Risks and Uncertainty*, Michigan Technological University, Department of Materials Science and Engineering, pg.7

And following this reasoning, this value must also be equal to the market price of the securities¹³⁸.

4.7 Analysis of UpscaleSun case

In order to see a practical application of the previous formulas, we will analyse the structure of a fictional company, called UpscaleSun, which has issued solar ABS over the 2013-2016 period and how the changes in some of the main parameters can change the entire result of the operation, sometimes making it completely unprofitable. As SolarCity, the company founder of the first U.S. solar ABS in 2013¹³⁹, the fictional company has operated mainly in California because it is a country with many incentives for consumers who want to invest in PV panels. Moreover, because of its perfect climate, it is also one of the countries which produces the most energy for each installed panel. Indeed, one of the main example of the development of this system in California is the case of the agreement between SolarCity and Walmart in 2011. The deal was made in order to install the solar systems on over 60 Walmart stores and to produce over 70GWh per year¹⁴⁰. Because of this project, the related PPAs could deliver revenues for almost \$9.1m/year.

The analysis will be based on a study and on a model of the Michigan Technology University¹⁴¹, which has performed a similar analysis, evaluating the viability of the PPAs' pools used for securitisation purposes. As in the study, the securitisation transaction will be composed by purchase power agreements which are arrangements through which a third-party owns, operates and maintain the solar system while the host has to install the panels on his property and has to buy the energy produced for a certain

¹³⁸ Zhang, Z., (2012). *The Risk-Isolating Paradox in China's Asset Securitization*, University of Macau, pg.70

¹³⁹ International Financing Review, (November 2013). SolarCity brings first US solar ABS in *International Financing Review*, <http://www.ifre.com/solarcity-brings-first-us-solar-abs/21118648.fullarticle>

¹⁴⁰ Bloomberg New Energy Finance, (2012). *Re-imagining US solar financing*, US Solar-White paper, pg.22

¹⁴¹ Alafita, T., Pearce, J., *Securitization of Residential Solar Photovoltaic Assets: Costs, Risks and Uncertainty*, Michigan Technological University, Department of Materials Science and Engineering

period of time¹⁴². Our analysis will use data from the 2013-2016 period to understand which are the main parameters which can affect the success of an fictional securitisation in California and which are the factors that can trigger a complete default of a solar ABS. Given the structure of the securitisation, there are three points in the process which are of particular interest and importance:

- the probability of default for the PPA's owner
- the amount of necessary over-collateralisation to cover for the potential losses
- the required rate of return for investor

To assess the extent to which a securitisation's outcome is influenced by these moments, three variables are analysed, the rate of early contract termination, β ; excess over-collateralisation required by rating agencies bodies, σ ; and the rate of return required by investors, r . Moreover, the number of contracts included in the considered pool is 100 in order to simplify the analysis. All the other values are considered as fixed for ease, even if, in practice, they can change due to many factors (for example, improvements in technology, increased efficiency of the panels, change in electricity prices and treasury rates). On the other hand, the remaining parameters, β , σ , and r are each given a range of possible values and a sensitivity analysis is performed (see Table 7).

Table 7: reference values for UpscaleSun fictional securitisation

Variable	Meaning	Measuring system	Value
m_0	Number of contracts included in pool	Thousands	100
t	Life of the contract	t	20 years (NREL, 2016)
e_0	Annual level of electricity output of installed PV system	kWh/year	14.500 (American Physics Society, NREL, 2016, Solar Power Rock, 2018)
α	PV system degradation rate	%/year	0,8% mean and 0,5% median (Jordan, 2016)

¹⁴² United States Environmental Protection Agency (EPA), *Solar Power Purchase Agreement*, <https://www.epa.gov/greenpower/solar-power-purchase-agreements>, [10 September 2018]

Variable	Meaning	Measuring system	Value
γ	Price escalation rate	%/year	2 (EIA, 2012)
P	Initial price of electricity	\$/kWh	0.16 (EIA, 2015) in California
δ	Zero coupon treasury rate	%	2 (Wall Street Journal, 2013. Damodaran 2016)
τ	Management/Servicing Fee	%	1 (Furletti, 2002)
r	Rate of return	%	$6 < r < 12$
β	Rate of early contract's termination	%/year	$0 < \beta < 15$
σ	Difference between actual and expected rate of early termination	%/year	$0 < \sigma < 8$

However, for the β , the rate of early termination there are some difficulties in calculating its value. Given the fact that there are a few years of data collection on default rates in the residential PV market, it's very difficult to define a value for β which is critically for the calculation of the expected annual cash flows of the securitisation transaction.

Using the formula for the numbers of contract affected by the default rate, in fact, it is possible to see a very decreasing number of un-defaulted contracts after the 20-years of the lifespan of the securitisation deal and with different values of β which ranges from 0 to 15 (see Figure 20). It is possible, indeed, to see that with a default rate of 0% the un-defaulted loans, after 20 years, are equal to the 100% of the initial amount but, instead, with a default rate of 15% the number decreases to just 4.5% which is extremely low in comparison to the number of the pool's loans at $t=0$.

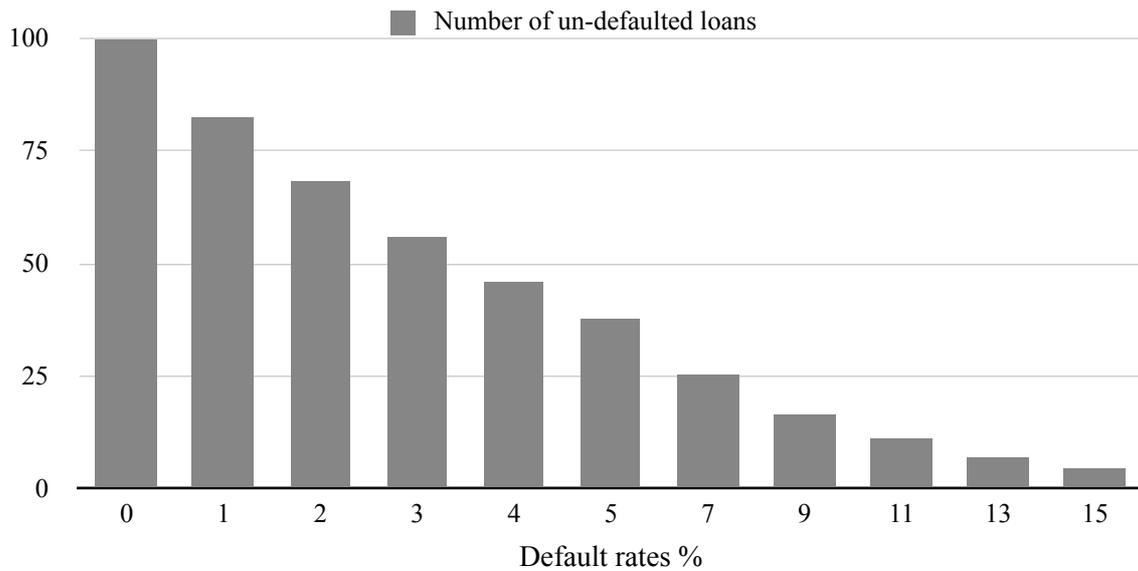


Figure 20: Percentage of un-defaulted loans with different default rates (after 20 years)¹⁴³

The effect of the increase in the default rate is also visible in the total real value of the contracts during the 20-years lifespan. The value of the annual cash flow with a 15% default rate is almost less than one-third of the value with a 0% default rate (see Figure 21). This shows the strong effect of the default rate on the total value of the contracts for the originator which has been discounted at the risk-free rate.

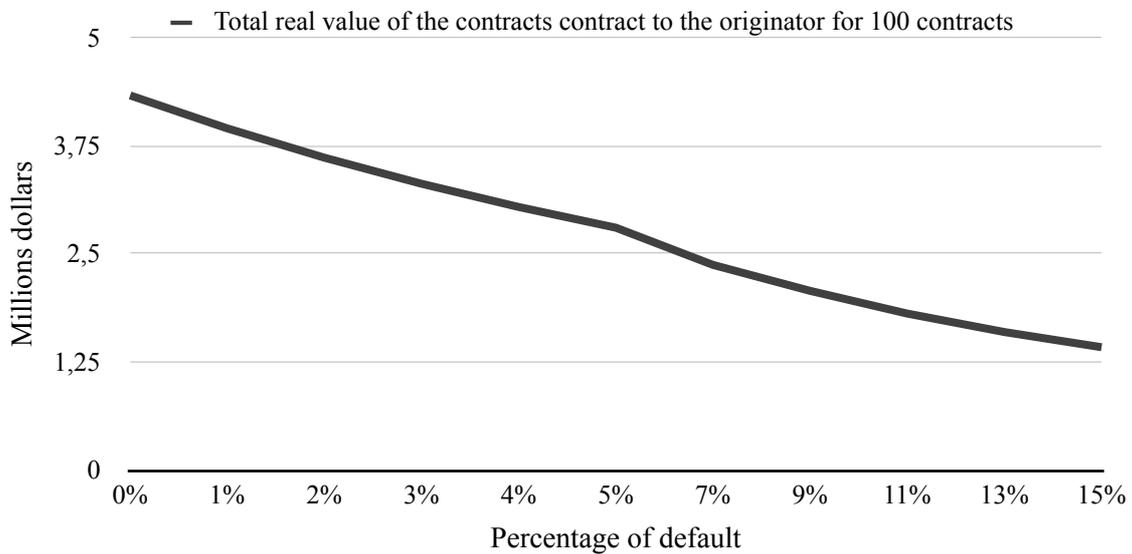


Figure 21: total discounted value of the contracts over 20-years lifespan with different default rates

¹⁴³ This graph and the following ones have been made with data from the previous table and using the formulas of Michigan Technological University (2014), *Securitization of Residential Solar Photovoltaic Assets: Costs, Risks and Uncertainty*

On the other hand, the calculation of σ , which depends on the confidence of the credit rating bodies in their capability to forecast the rate of early termination, is also an issue for securitisation's evaluations. This rates' uncertainty has also the effect of increasing the perceived riskiness of the underlying assets which, then, results in a higher rate for the level of credit enhancement.

However, the lack of historical data about this value makes very difficult to calculate it and, for this reason, the analysis takes into account different values for σ . Despite that, it is clear that the combination of β and σ has the effect of decreasing even further the value of the annual cash flow at the beginning ($t=2$) and at the end of the 20-years contract. Indeed, as it is possible to see from the second table, when the amount of $\beta+\sigma$ amounts to 23% (which is the highest level calculated in our study) the value of the annual cash flows at $t=20$ is equal to 2,35k\$ which is incredibly lower than in the case of $\beta+\sigma$ equal to 0 (see Figure 22).

	Overcollateralisation σ								
Default rate β	0	0,01	0,02	0,03	0,04	0,05	0,06	0,07	0,08
0	\$337.993	\$334.613	\$331.233	\$327.853	\$324.473	\$321.093	\$317.713	\$314.333	\$310.953
0,01	\$334.613	\$331.233	\$327.853	\$324.473	\$321.093	\$317.713	\$314.333	\$310.953	\$307.574
0,02	\$331.233	\$327.853	\$324.473	\$321.093	\$317.713	\$314.333	\$310.953	\$307.574	\$304.194
0,03	\$327.853	\$324.473	\$321.093	\$317.713	\$314.333	\$310.953	\$307.574	\$304.194	\$300.814
0,04	\$324.473	\$321.093	\$317.713	\$314.333	\$310.953	\$307.574	\$304.194	\$300.814	\$297.434
0,05	\$321.093	\$317.713	\$314.333	\$310.953	\$307.574	\$304.194	\$300.814	\$297.434	\$294.054
0,06	\$317.713	\$314.333	\$310.953	\$307.574	\$304.194	\$300.814	\$297.434	\$294.054	\$290.674
0,07	\$314.333	\$310.953	\$307.574	\$304.194	\$300.814	\$297.434	\$294.054	\$290.674	\$287.294
0,09	\$307.574	\$304.194	\$300.814	\$297.434	\$294.054	\$290.674	\$287.294	\$283.914	\$280.534
0,11	\$300.814	\$297.434	\$294.054	\$290.674	\$287.294	\$283.914	\$280.534	\$277.154	\$273.774
0,13	\$294.054	\$290.674	\$287.294	\$283.914	\$280.534	\$277.154	\$273.774	\$270.394	\$267.014
0,15	\$287.294	\$283.914	\$280.534	\$277.154	\$273.774	\$270.394	\$267.014	\$263.634	\$260.255

	Overcollateralisation σ								
Default rate β	0	0,01	0,02	0,03	0,04	0,05	0,06	0,07	0,08
0	\$337.993	\$279.239	\$230.252	\$189.483	\$155.618	\$127.543	\$104.313	\$85.130	\$69.323
0,01	\$279.239	\$230.252	\$189.483	\$155.618	\$127.543	\$104.313	\$85.130	\$69.323	\$56.324
0,02	\$230.252	\$189.483	\$155.618	\$127.543	\$104.313	\$85.130	\$69.323	\$56.324	\$45.658
0,03	\$189.483	\$155.618	\$127.543	\$104.313	\$85.130	\$69.323	\$56.324	\$45.658	\$36.925
0,04	\$155.618	\$127.543	\$104.313	\$85.130	\$69.323	\$56.324	\$45.658	\$36.925	\$29.791
0,05	\$127.543	\$104.313	\$85.130	\$69.323	\$56.324	\$45.658	\$36.925	\$29.791	\$23.976
0,06	\$104.313	\$85.130	\$69.323	\$56.324	\$45.658	\$36.925	\$29.791	\$23.976	\$19.248
0,07	\$85.130	\$69.323	\$56.324	\$45.658	\$36.925	\$29.791	\$23.976	\$19.248	\$15.412
0,09	\$56.324	\$45.658	\$36.925	\$29.791	\$23.976	\$19.248	\$15.412	\$12.309	\$9.804
0,11	\$36.925	\$29.791	\$23.976	\$19.248	\$15.412	\$12.309	\$9.804	\$7.787	\$6.168
0,13	\$23.976	\$19.248	\$15.412	\$12.309	\$9.804	\$7.787	\$6.168	\$4.871	\$3.836
0,15	\$15.412	\$12.309	\$9.804	\$7.787	\$6.168	\$4.871	\$3.836	\$3.011	\$2.356

Figure 22: Value of the annual cash flows at $t=2$ and $t=20$ and with different values of β and σ

Another important scenario analysis is related to the behaviour of the present value of the income stream over the 20-years of the contract with the change in the rate of return to the investor and with the change in the required amount of credit enhancement Θ which has been calculated with the sum of β and σ . The calculations have also considered the amount of the management or servicing fees to deduct from the total value in order to a result as realist as possible in our analysis. Moreover, the rates of return used range from 6% to 11% because this is the numerical interval which captures the realistic values of r . In fact, a high value of 12% makes the entire operations unprofitable. The lowest level of the range is, instead, what is desired by the non-bank financial institutions (for instance, pension and mutual funds, and insurance companies).

As it is possible to see from the examination, the present value of the income cash flows over 20-years is decreasing as the necessary amount of credit enhancement is increasing. It is also interesting to note that the change in the value of the rate of return is not affecting the present value of the portfolio when the value of Θ increases (see Figure 23). Therefore, there is not a great advantage in increasing and improving the rating quality of the pool because then, it is possible to raise more capital from it.

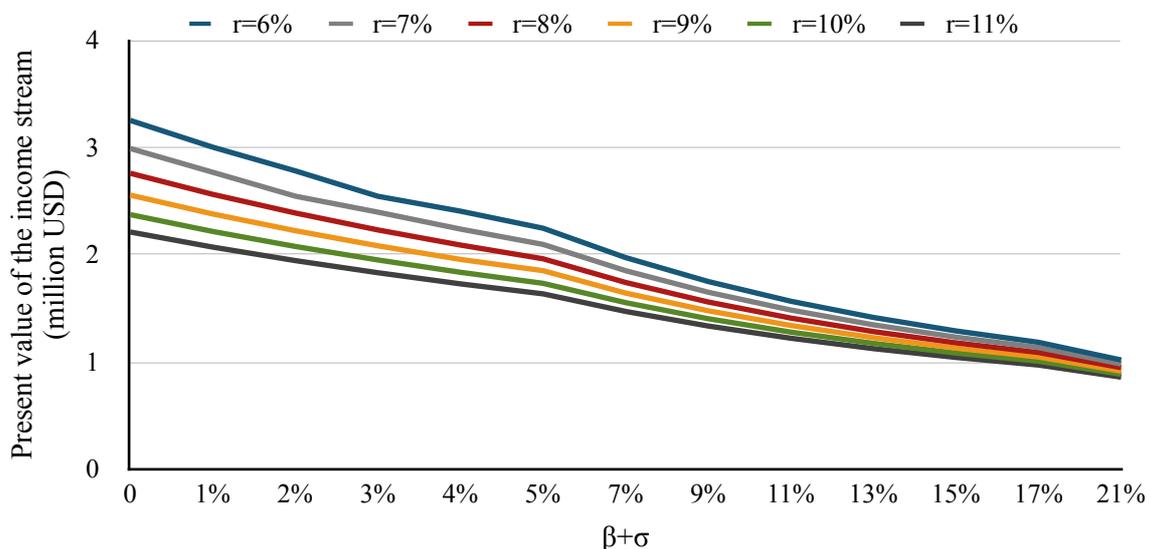


Figure 23: change in present value of the income stream generated by the PPAs included in the securitisation pool with different value of r and $\beta+\sigma$

4.7.1 The Internal Rate of Return

In addition to the previous analysis, it is also possible to calculate the internal rate of return (IRR) in order to evaluate which is the originator's cost of capital. This value is a financial instrument which is used to measure and calculate the profitability of an investment or project, it follows a similar reasoning as the Net Present Value (NPV) method because it uses the discount rate which makes the NPV of all the project equal to zero.

Therefore, in our case, it is important to evaluate if a long-term investment in a photovoltaic system makes sense from a financial point of view. For example, a value of IRR of 8% means that the investor gains 8% per year on the capital invested in the initiative. In our analysis, the formula for the IRR can be expressed in the following way:

$$0 = C(abs) - \sum_1^{20} \frac{c(t)}{(1 + IRR)^t} + \frac{\sum_1^{20}(c(t) - c^s(t))}{(1 + IRR)^{20}}$$

It is important to note that the inflation has increased the price of the electricity over time and this is a factor which consequently increases the value of IRR. Anyway, using our data and by means of calculations, it possible to find which is the Internal Rate of Return (IRR) for our system. For instance, with a zero value for $\beta + \sigma$ the results give IRR values which are not very different from the rate of return (see Table 9).

Rate of return	6%	7%	8%	9%	10%	11%
IRR	6,118%	7,123%	8,128%	9,134%	10,14%	11,146%

Table 7: Internal rate of return with β and σ equal to zero

In fact, when the rate of return increases by 1% the IRR increases by 1,005/1,006% when the amount of necessary over-collateralisation is equal to zero. Moreover, the value of 6,1188%, calculated with a rate of return of 6%, is the lowest potential cost of financing which can be attained by the company under consideration. Anyway, it is important to note that when the amount of σ (the difference between the actual and expected rate of early termination) is equal to zero the last part of the previous internal

rate of return formula disappears because ct and ct^s are equal and so they cancel out. On the other hand, when σ has a positive value together with β , the returns tend to change and they show higher amounts of IRR. In the following example, the model is calculated with a value of σ equal to 4% and a value of β equal to 7%. The two values have been chosen in order to see what happens to the value of the internal rate of return when the value of the over-collateralisation $\beta+\sigma$ increases considerably with respect to the previous example. Indeed, from the analysis, it is possible to see that the amount of IRR increased largely and in the last two cases its amount also exceeds the 12%.

Rate of return	6%	7%	8%	9%	10%	11%
IRR	8.357%	9,563%	10,747%	11,911	13,058%	14,19%

Table 8: Internal rate of return with $\beta=7\%$ and $\sigma=4\%$ equal to zero

The result of the previous table is not a complete surprise because, as we already know, an increase in the amount of over-collateralisation always leads to higher costs. In fact, an imprecise amount of σ is translated in a waste of resources because it increases the financing costs and also the prices of the ABS. Indeed, the values of IRR of the last Table are very different from the previous one, and it can also help to understand how much is critical for the solar ABS issuers to calculate as precise as possible the rate of default and the necessary amount over-collateralisation (which should be equal to the real default rate) in order to avoid an improper use of resources.

4.8 Potential improvements

Asset-backed securitisation benefits the originators of financial assets for a number of reasons. As in the case of general securitisation the main common motivating factors for creating solar asset-backed securities include:

1. creation of vehicles that do not impact the balance sheet of the originator because they do not appear so it is a form of bankruptcy protection
2. obtaining a lower cost of capital to generate greater value
3. obtaining regulatory capital relief, for example banks can pass the risks of lending to other parties

4. obtaining a varied investor base
5. obtaining financing when unable to do so in any other practicable manner and achieve profitability and bankability of projects
6. align with the recent focus on environmental and sustainable issues

All these potential benefits would apply to solar lease providers. In addition to these advantages, it is important to be aware of the ability of the underlying assets to generate electricity, a fact which has nothing to do with equity and debt markets. This feature makes them very much attractive for the investors. Anyway, from the previous analyses, it is possible to understand the effects of changes in the value of β , σ , and r . The understanding of the behaviour of these parameters can help to identify which are the areas of improvements for the solar ABS model and which are the main risks which have to be faced. From this knowledge, it is also possible to create specific regulations and policies to support the development of this financial instrument and of the solar market as a whole.

4.8.1 Creation of asset pools

As we have seen, the originator has the responsibility to create a sufficient credit enhancement amount. His aim is to reduce the rate of β (default rate) because it is extremely important for raising more capital from the pool of assets (as in Figure 21) and the total value over the 20-year lifespan of the deal decreases very quickly as the default rate increases. Therefore, the solar developers have all the interests to implement and follow all the necessary credit evaluations procedures. Another important issue is the standardisation of the contracts in order to create a widely-used and accepted structure which can help the spread of this technique. In the last years, the Solar Access to Public Capital (SAPC) working group, has analysed the residential leases and also the commercial PPAs contracts available in the market in order to spur a standard structure in the market. Their reports have the objective to spread transparency, reduce the additional expenses and fees in the solar energy market and also to help to make the process of pooling easier for all the users. Through the SAPC working group, the National Renewable Energy Laboratory (NREL) is succeeding in gather together an large number of companies, (from example Bank of America, SolarCity to SunRun,

Clean Power Finance and Recurrent Energy), which almost amount to 60 institutions¹⁴⁴, and which should help to identify the best strategies to securitise this solar industry. Another NREL and SAPC's aim is to give birth to a database in order to assess properly assets' performance and credit-default risk which, as highlighted before, it is critical for the analysis of the solar ABS models' behaviour in the long-term.

An additional issue which is important to keep into account when performing an analysis on solar ABS is the amount of geographic diversification. In fact, as said before when talking about the net metering issue, this problem occurs when the solar panels are all located in the same limited area (in our analysis the area is California state) and so there is a higher risk of significant increase in default rates and of disasters made by the nature or man-made. Moreover, a change in policies or regulations could also affect the usefulness of this instrument because these changes can invalidate the benefits of the ABS deals. Furthermore, the usefulness of the solar panels is correlated on the sunlight which can, in turn, lead to more volatile cash-flows in securitisation. Therefore, it is necessary to expand the system to other countries in the U.S but it seems a very complicated task because of the very different regulations and policies which are present in the other American countries. Many states still prefer to invest and focus themselves on traditional forms of energy productions instead of favouring new types of energies which are still obscure and unknown to many¹⁴⁵.

4.8.2 Amount of necessary over-collateralisation

Typically, the default rates are calculated on the basis of historical data but the same type of information is not available for residential PPAs. Therefore, credit rating agencies use proxy data and also the default rate of other types of ABS in order to find a value which is as realistic as possible. However, a similar default rate is not able to capture the complexity and the specific characteristics of the solar ABS which are strongly affected by changes in technology, changes in policies and changes in energy

¹⁴⁴ Clean Energy Authority, (2013). *Securitization could reduce cost of solar energy by 16%*, <https://www.cleanenergyauthority.com/solar-energy-news/securitization-could-reduce-cost-032913>

¹⁴⁵ Alafita, T., Pearce, J., (2014). *Securitization of Residential Solar Photovoltaic Assets: Costs, Risks and Uncertainty*, Michigan Technological University, Department of Materials Science and Engineering, pg.17

prices¹⁴⁶. This, in conclusion, affects the performance of this instrument and also limit its full potential because the amount of over-collateralisation increases together with the uncertainty of the default rates. The SAPC working work is also trying to help the collection of the data in order to facilitate the assessment of the default rates in the long-term. Anyway, another option is to create a public entity which can guarantee for the underlying assets and so it can decrease the amount of necessary credit enhancement and the cost of financing in general. Both the strategies can play an important role in reducing the costs of financing and in increasing the spread of this system.

Moreover, the needed level of credit enhancement also depends on the credit rating agencies which have the duty to predict potential losses. The problem which has been created by the 2008's crisis is that this amount has increased in percentage because of the fear created during the financial catastrophe.

4.8.3 Investor rate of return and lack liquidity

The last important topic which it is necessary to address is the rate of the return for the investors in solar asset-backed securities. As we have seen before in Figure 23, this factor is critical for achieving a successful securitisation. Reducing the rate of return is the objective pursued by the solar developers in order to improve the performance of solar securitisation. On the other hand, the lack of liquidity in the market for solar ABS is a very important problem because it limits the trading of securities. Unlisted, non-standard securities which are passively traded in any market will ask for a liquidity premium, and usually will not be bought by institutional portfolio managers. Increasing the demand for these ABS will help to reverse this static market and to boost the related market. The final development of a liquid secondary market for solar ABS will provide liquidity to permit the solar energy market to expand in a way which is similar to the one that occurred in the mortgages' market.

4.9 Observations

From the previous analyses, it is possible to conclude that the potential of solar ABS is huge even if there are many challenges and difficulties to face. In fact, acquiring the

¹⁴⁶ Colmer, N., (2013). *When Will Solar ABS Finally Catch Fire?*, Asset Securitization Report, pp. 20-21

financing for solar lease providers is completely inexpensive, partly because of the tax equity constraints and the intrinsic risks in the solar business. Although the two broad categories of challenges for creating residential solar lease securitisations (solar-specific and the broader market risks) do present serious limitations which must be faced before successful solar-backed securitisation can fully achieved, they are not completely unbeatable in the medium or long term.

On the other hand, the industry have the opportunity to take advantage from trying to attract new typologies of investors, such as pension funds and other institutional investors which can improve the reputation and the efficiency of this niche of market. Until now, the most part of investments has arrived from big banks, a few insurance companies, and a few non-traditional investors, for example Google. Solar power in 2017 attracted far more investments than any other technology and it attracted flood of investors¹⁴⁷. Moreover, since 2009, the total installed costs of solar systems have decreased by almost 70 percent around the world, reaching a price which is lower than the cost of a new natural-gas plant.¹⁴⁸ In fact, it's clear that asset-based securitisation could play a critical role in the solar energy industry and also in Green Finance which is completely as transformative as the role that securitisation played a few decades ago in changing the mortgages' finance and in the process of increasing the simplicity to buy a property and boosting the economic growth for a long-period before the fateful year of 2008.

Anyway, securitisation has the characteristics and the potential to play a similar role in the economy by financing the spread of the solar energy and by accelerating the utilisation and implementation of solar projects and initiatives. One of the most important characteristics of securitisation is the creation of rated structures which are completely isolated from the credit risk of the solar project sponsor and this could help the solar power industry to develop from a bilateral financing model that depends strongly on tax equity, to a capital markets model that is funded from the deep pool of a

¹⁴⁷ MINING.com, (2018). *Solar Attracted More Investment Than Any Technology In 2017*, <https://oilprice.com/Alternative-Energy/Solar-Energy/Solar-Attracted-More-Investment-Than-Any-Technology-In-2017.html>

¹⁴⁸ Frankel, D., (2016). *How solar energy can (finally) create value*, article, McKinsey&Company, Sustainability & Resource Productivity

liquid secondary market in solar-backed securities. Despite all the difficulties and the challenges highlighted above, securitisation of solar power receivables can be a powerful tool to allow capital markets to provide a strong force for a drastic change in energy consumption. Furthermore, converting solar energy into a securitisable asset class will strongly ask for a change in public policy regulations, regulatory standards and the legal consequences of bringing sunlight into 21st century energy policy. Obviously, as said before, asset-backed securities could also be part of the big transformation in the Green Finance market. Indeed, being a key driver in the solar market is an essential help in the development of this new type of finance. The focus on sustainable products, in fact, has also hit the financial markets and so a successful instruments as solar ABS can help to unite together the lost trust of the investors (after the financial crisis) and the concerns about the health of the environment.

Conclusion

This thesis has tried to answer several questions and issues which are related to the birth of a new type of finance and to the different concerns of the investors, company and governments about the environment and the reduction of global warming. During the course of the discussion we wanted to highlight the fundamental aspects of the Solar ABS, such as the technical characteristics and the functions that this financial instrument should possess; the structuring and issuing process put into practice by many companies; the analysis of the solar industry market and the relative positioning of the solar ABS in comparison with the other forms of ABS; and the analysis of an empirical study based on actual data. Indeed, the new possibilities to invest in a conscious and eco-friendly way have created many issues for an investor in distinguishing and understanding all the different options and also all the different related risks. Moreover, the problem of greenwashing has the power to make it impossible to identify the real eco-performing companies from the ones which are just falsely praising environmental practices and products. Because of this new financial and economic context, different instruments can reply to the necessities and demands of the investors who are looking for a way to gather together financial motives and environmental concerns. Among all the possible financial instruments, securitisation of solar power receivables represents an incredibly powerful tool to permit capital markets to provide the motive for a revolution in the renewable market.

However, some challenges and issues in developing and defining this typology of finance arose from the thesis. Indeed, in order to develop a stable and profitable market, there is the need to boost the flow of private capital for green investments. First of all, it is very important to design an enabling environment facilitating green finance, including the business climate, rule of law and investment regime. Secondly, the definition of green finance needs to become clearer and more precise because, up to date, there is not a generally accepted definition. Third, standards and regulations for transparency have the possibility to help the growth of green finance assets. Indeed, for all asset classes (bank credits, bonds and secured assets) voluntary principles and guidelines for green finance have to be applied and supervised. Moreover, in the context

of solar securitisation, the conversion of solar energy into a securitisable asset class will require a broad-based consensus-driven process which has to be focused on public policies and regulations. Furthermore, if the voluntary guidelines do not seem to be sufficient, they have to be accompanied by financial and regulatory incentives. Many investors around the world are chasing the sun and looking to solar securitisations as a sustainability-friendly method of growing their portfolio. As seen highlighted in the thesis, there are other possible tools to invest in eco-friendly projects and financings but, in the solar energy case, its securitisation could be the answer to the still static solar energy market. While sympathetic government policies will certainly be able to boost opportunities for such investments, particularly for financial institutions, raising several trillion dollars to finance renewable projects over the next 20 years is almost certainly also going to require a capital market mechanism that enables direct investment in projects and assets, rather than the companies that sponsor and develop them. Before it can become the vehicle through which private capital will finance many investments across an array of climate change projects, however, securitisation will have to throw off the stigma that still hangs over it from 2008. Indeed, there are still many doubts and uncertainties because of the 2008 crisis and the following serious effects in the U.S. and in Europe. Given the fact that the financial meltdown started in the U.S., there are many European investors who still look at this financing system with a lot of suspicions.

Obviously, Europe lags behind the US in this market, though. If green securitisation is on the cusp of emerging from a state of infancy in the US, it is still at the ante-natal stage in Europe. The relative lack of progress so far on this side of the Atlantic largely reflects a continuing investor scepticism towards ABS in general, which has meant the flow of primary market activity in established asset classes remains a small part of what it was before the financial crisis. On the other hand, in the empirical case on solar securitisation performed in this thesis, it is possible to see the effect of the changes in the main parameters on the value of the securitisation and later on the value of the Internal Rate of Return. Indeed, a fictional securitisation has been carried out in order to understand the potential of this instrument and also in which way it can be affected by different values of its main parameters. From the results of the empirical application, it

is possible to see that a solar securitisation is a valuable option for environmentally investing and also to help the development of the solar energy industry which is continuing to increase, but this instrument can give an additional help in proceeding in this direction. Because of the current suspicion in the European markets, this instrument is still under-performing and is not delivering the hoped results. Anyway, the solar industry is continuing to grow in several countries which have set goals to ensure most households become energy self-sufficient, mainly through the use of solar panels and the sale of any surplus via the grid. Despite this initiatives, the same objective is still far from being achieved in Europe, and so securitisation is continuing to remain limited and small in size. Investors in Europe are starting to enter into the broader solar securitisation market, however, by purchasing the issuances in the US. On the other hand, there have been always more initiatives to revive, at least at the pre-crisis level, the European securitisation. Indeed, a key driver behind these initiatives is the recognition that ABS could take a lead role in raising the vast sums that will be needed to meet the region's commitment to transform itself into a low-carbon economy which has to be subject to the terms of the Paris Agreement. In this context, in fact, the solar securitisation can help to collect more capital and at the same time meet the goals of the Paris Agreement. Therefore, it can have a dual objective which is essential in the financial and economic context which we are facing in this period. Given these premises, solar securitisation is a very useful instrument and it cannot be excluded by the growth of the Green Finance and also by the many initiatives which have been made in order to recover from the financial crisis.

BIBLIOGRAPHY

- Adamo., R., Federico, D., Notte, A., (2014). Performance and risk of green funds in *Investment Management and Financial Innovations*
- Adelson, M. (2012). “ASF 2012 Conference Report.” *The Journal of Structured Finance* (18:1)
- Alafita, T., and J.M. Pearce. (2014). *Securitization of Residential Solar Photovoltaic Assets: Costs, Risks and Uncertainty*. *Energy Policy* 67: 488–98.
- Alexander, K. (2014). *Stability and sustainability in banking reform. Are environmental risks missing in Basel III?*, Cambridge: University of Cambridge, Institute for Sustainability Leadership
- Altarescu, H., Joshi, J. (March 2013). *Securitization: Lessons Learned from Other Industries*. SAPC Internal Presentation.
- Ben Hadj, S., De Mulder. J., Zachary, M., (2017). *Sustainable and green finance : exploring new markets*. NBB Economic Review
- Blanc, D., Plus, E., Bonnin, M., (2017). *The European green funds market - March 2017*, Novethic Research Centre
- Bloomberg New Energy Finance (BNEF), (February 2013). *PV Market Outlook Q1 2013*.
- Bloomberg New Energy Finance, (2016). *Mapping the Gap: The Road from Paris*, [https:// about.bnef.com/blog/mapping-the-gap-the-road-from-paris/](https://about.bnef.com/blog/mapping-the-gap-the-road-from-paris/)
- Bolinger, M., (2009). *Financing Non-Residential Photovoltaic Projects: Options and Implications*. Lawrence Berkeley National Laboratory, LBNL-1410E, Berkley, CA. <<http://eetd.lbl.gov/ea/ems/reports/lbnl-1410e.pdf>>.
- Borod, R. (2016) *The A -> Z of Solar Deals Done to Date*. Sunshine Backed Bonds Conference, April 21, 2016.
- Borod, R.,. *The Devil in the Details of Solar Securitization*. Practical International Corporate Finance Strategies 2013
- Campiglio, E., Dafermos, Y., Monnin, P., Collins, J., (2018). *Climate change and finance: what role for central banks and financial regulators?*, Bank Underground News, Bank of England, <https://bankunderground.co.uk/2018/08/30/climate-change-and-finance-what-role-for-central-banks-and-financial-regulators/>
- Ceres, (2016). *New report: \$12.1 trillion must be invested in new renewable power generation over next 25 years to limit climate change*, Press Releases, <https://www.ceres.org/news-center/press-releases/new-report-121-trillion-must-be-invested-new-renewable-power-generation>

Cheng, M., Andrew C., Xilun Chen, and Eli K. (June 2014). *Solar Securitizations Panel Discussion*

Citigroup Inc., (January 2014). *Green Bond Principles Created to Help Issuers and Investors Deploy Capital for Green Projects*, Citigroup News, <https://www.citigroup.com/citi/news/2014/140114a.htm>

Colmer, N., (2013). *When Will Solar ABS Finally Catch Fire?*, Asset Securitization Report

Cory, K., Canavan, B., Koenig, R., (2009). *Power Purchase Agreement Checklist for State and Local Governments*. National Renewable Energy Laboratory, Golden, CO

Council of European Union, (October 2015), Inter-institutional file: 2015/0226 (COD), Brussels

Damodaran, A., (2016) Discount rates: the D in the DCF, <http://people.stern.nyu.edu/adamodar/pdfiles/eqnotes/dcf rates.pdf>

De Castries, H., (May 2015). *Climate Change: it's No Longer About Whether, it's About When* in AXA Newsroom, <https://www.axa.com/en/newsroom/news/about-whether-about-when>

Della Croce, R. D., C. Kaminker and F. Stewart (2011), *The Role of Pension Funds in Financing Green Growth Initiatives*, OECD Working Papers on Finance, Insurance and Private Pensions, No. 10, OECD Publishing. <http://dx.doi.org/10.1787/5kg58j1lwdjd-en>

Deutsches Institut für Entwicklungspolitik, (2016), *Green Finance: Actors, Challenges and Policy Recommendations*, Briefing Paper

DW, (2010). *Heat wave could cost Russia almost 1 percent of GDP*, DW News, <https://www.dw.com/en/heat-wave-could-cost-russia-almost-1-percent-of-gdp/a-5887442>

Engblom, A. (April 2013). *Analyst: Solar's Growth to Shift from Utility-Scale to Distributed Generation*. SNL.

Fabozzi, F. J. and Kothari, V. (2008) *Introduction to Securitization*, John Wiley and Sons, Inc., Hoboken, New Jersey.

Foley, S., Crooks, E., (April 2016). SunEdison: Death of a solar star in *Financial Times*

Frankel, D., (2016). *How solar energy can (finally) create value*, article, McKinsey&Company, Sustainability & Resource Productivity

Furletti, M., (2002). *An Overview of Credit Card Asset-Backed Securities*. Discussion Paper, Federal Reserve Bank of Philadelphia, http://www.philadelphiafed.org/consumer-credit-and-payments/payment-cards-center/events/workshops/2002/creditcardsecuritization_012002.pdf.

Giddy, I., (2001), *Financing with Asset-Backed securities*, New York University, pages.stern.nyu.edu/~igiddy/.../SIM%20Asset%20Backed.ppt

Gorton, G., Souleles, N., (March 2005). *Special Purpose Vehicles and Securitization*. *NBER Working Paper 11190*, <http://www.nber.org/papers/w11190>

Hale, J., (2018). What Are Sustainable Funds and How Have They Performed? - A view of the sustainable investing landscape in the U.S. in *Morningstar blog*, <https://www.morningstar.com/blog/2018/01/31/sustainable-funds.html>

Hegedus, L. (20 June 2013). *What Would a Solar Asset-backed Security Look Like?* Renewable Energy World. Accessed June 20, 2013

Heltberg, R., Bennett Siegel, P., (2009). *Jorgensen, Addressing human vulnerability to climate change: Toward a 'no-regrets' approach*, in *Global Environmental Change*

Herndon, A., (July 2012). First Solar Bonds Financing \$4.6 Billion U.S. Panel Boom in *Bloomberg News*, 28.

International Capital Market Association, (2018). *Green Bond Principles Voluntary Process Guidelines for Issuing Green Bonds*, The Green Bond Principles

Jordan, D.C., Smith, R.M., Osterwald, C.R., Gelak, E., Kurtz, R.S. (2011). *Outdoor PV Degredation Comparison*. National Renewable Energy Laboratory, Conference Paper NREL/CP-5200-47704.

Joshi, J. (March 2009). *Viewpoint: Restarting the Securitization Markets*. Total Securitization.

Kann, S. (February 2013). *U.S. Residential Solar PV Financing: The Vendor, Installer and Financier Landscape, 2013-2016*. Greentech Media Research.

King AA, Lenox MJ, (2001). Does it really pay to be green?, in *Journal of Industrial Ecology*

Koh, A., (February 2018). Will a lack of transparency hurt the green bonds? in *Eco-Business*, Singapore

Kroll Bond Rating Agency (KBRA). (October, 2012). *Evaluating Credit Risks in Solar Securitizations*, <https://www.krollbondratings.com/announcements/108>.

Larsen, K., (August 2009). End-of-life PV: then what? - Recycling solar PV panels in *Renewable Energy Focus*, <http://www.renewableenergyfocus.com/>

Lindenberg, N. (2014). Definition of Green Finance in *Social Science Electronic Publishing*

Lowder, T., and Mendelsohn, M. (December 2013). *The Potential Securitization of Solar PV Finance*, www.nrel.gov/docs/fy14osti/60230.pdf.

Luxembourg for finance, (2018). *Luxembourg continues to rank among the top 3 financial centres in the EU*, <http://www.luxembourgforfinance.com/en/news/luxembourg-continues-rank-among-top-3-financial-centres-eu>

McGarry, C., (April 2018) *Set to be the Breakthrough Year for Green Loans and Green Securitisations*, <https://www.whitecase.com>

Metropolitan Transportation Authority (MTA), (2016). *MTA to Issue Its First 'Green Bonds'*, [http://www.mta.info/news-bonds-green-bonds-mta/2016/02/10/mta-issue-its-first- %E2%80%98green-bonds%E2%80%99](http://www.mta.info/news-bonds-green-bonds-mta/2016/02/10/mta-issue-its-first-%E2%80%98green-bonds%E2%80%99)

MINING.com, (2018). *Solar Attracted More Investment Than Any Technology In 2017*, <https://oilprice.com/Alternative-Energy/Solar-Energy/Solar-Attracted-More-Investment-Than- Any-Technology-In-2017.html>

Moody's Investor Service (2008), *Revising Default/Loss Assumptions Over the Life of an ABS/RMBS Transaction*, International Structured Finance, Rating Methodology

Moody's Investor Service (2009), *Refining the ABS SME Approach: Moody's Probability of De- fault assumptions in the rating analysis of granular Small and Mid-sized Enterprise portfolios in EMEA*, International Structured Finance, Rating Methodology

Morgan Stanley, (October 2017). *Behind the Green Bond Boom*, Research, <https://www.morganstanley.com/ideas/tax-reform-framework>

Novethic Research Centre, (2018). *The European Green Funds Market +49%*, Paris, Novethic Report

OECD, (2012). *Defining and measuring green investments: implications for institutional investors' asset allocations*, OECD Working papers on finance, insurance and private pensions, no.24

O'Sullivan, F., Warren, C., (July 2016). *Solar securitisation: An innovation in Renewable Energy Finance*, An MIT Energy Initiative Working Paper

Pelusi, D., (April 2016). *The New Morningstar Sustainability Rating: a new lens for investors*, Morningstar SRI Breakfast, Morningstar

Pension Fund Service, (2017). *Green Bonds*, The World Bank

Porter, M., Van der Linde, C. (1995). *Green and competitive in Harvard Business Review*

Randjelovic. J., O'Rourke. A., Orsato. R., (2003). *The Emergence of Green Venture Capital*, INSEAD R&D, Fontainebleau, France

Rahus Institute, (2008). *The Customer's Guide to Solar Power Purchase Agreements*. Available at: <<http://www.californiasolarcenter.org/sppa.html>>

- Rennings K. (2000). Redefining innovation - eco-innovation research and contribution from ecological economics in *Ecological Economics*
- Robards, M., (March 2014). Exxon Valdez: what lessons have we learned from the 1989 oil spill disaster? in *The Guardian*, <https://www.theguardian.com/environment/blog/2014/mar/24/exxon-valdez-oil-spill-disaster-arctic>
- Sinclair, G. (2012), *Indexes. In: Evolutions in Sustainable Investing. Strategies, Funds and Thought Leadership*. Ed. By C. Krosinsky. Wiley, Hoboken, New Jersey.
- Sivaram, V., and Norris, T., (May/June 2016). The Clean Energy Revolution: Fighting Climate Change with Innovation in *Foreign Affairs Magazine*
- United States Securities and Exchange Commission, (2015). *SolarCity Corporation - Form 10-K 2015*. San Mateo, CA,. https://www.sec.gov/Archives/edgar/data/1408356/000156459016012549/scty-10k_20151231.htm.
- Securities Industry and Financial Markets Association, (April 2016). *SIFMA Issues 2015 Securitization Year in Review*, Press release, <http://www.sifma.org/newsroom/2016/sifma-issues-2015-securitization-year-in-review/>
- Segoviano, M., Jones, B., Lindner, P., & Blankenheim, J., (Apr. 2015). *Reviving securitization*, Banque de France Financial Stability Review No. 19
- Standard and Poor's (June 2017), *Standard and Poor's Credit Rating Definitions, RatingsDirect*, www.spglobal.com/ratingsdirect
- State of California, (2014). *Third Annual Report, 2014 Green Bonds*, <https://www.treasurer.ca.gov/publications/2014green.pdf>
- Stone, Austin, C., and Zissu, A. (2012). *The Securitization Markets Handbook: Structures and Dynamics of Mortgage- and Asset-Backed Securities*, Second Edition. John Wiley & Sons
- Turkenburg WC, (2000). In World Energy Assessment: Energy and the Challenge of Sustainability in *Renewable energy technologies*, UNDP, New York
- Va'zquez, M., Rey-Stolle, I., (2008). *Photovoltaic Module Reliability Model Based on Field Degradation Studies. Progress in Photovoltaics: Research and Application*, Wiley InterScience
- Wang, Y., Zhi, Q., (2016). *The role of green finance in environmental protection: Two aspects of market mechanism and policies*, CUE2016-Applied Energy Symposium and Forum 2016: Low carbon cities & urban energy systems
- Winston, A., (2010). *Avoiding Greenwash and its Dangers*, Harvard Business Review
- World Bank, (2012), *Carbon Finance for sustainable development*, Annual Report

World Economic Forum, (2011). *Reducing the Cost of Financing*, Green Investing

Zhang, Z., (2012). *The Risk-Isolating Paradox in China's Asset Securitization*, University of Macau

Zider, B., (1998), How Venture Capital works in *Harvard Business Review*, <https://hbr.org/1998/11/how-venture-capital-works>

Zokaei, K., (2013). Environmentally-friendly business is profitable business in *The Guardian*, <https://www.theguardian.com/sustainable-business/environmentally-friendly-sustainable-business-profitable>

WEBOGRAPHY

<https://about.bnef.com/>

<http://www.bloomberg.com/>

<http://climatemundial.com>

<https://www.ebf.eu/>

www.eib.org/en/index.htm

<https://energy.mit.edu/>

<https://www.foreignaffairs.com/>

<https://www.globalcapital.com/>

<https://www.icmagroup.org/>

<https://www.ifc.org/>

<https://www.marketwatch.com/>

<https://www.mtu.edu/>

<http://www.nber.org/>

<https://www.nrel.gov/>

<http://www.oecd.org/cgfi/>

<https://pensionfundservice.com/>

<http://people.stern.nyu.edu>

<https://www.renewableenergymagazine.com/>

www.spglobal.com/ratingsdirect

<http://treasury.worldbank.org>

www.un.org/en/

<https://www.worldbank.org/>