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The Impact of Venture Capital and Private Equity on the Clean Tech Industry

by

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Master of Science in Management Studies

Abstract

The goal of this thesis is two-fold. First, we will try to find out if the clean tech industry is a good choice for private equity, in that it generates attractive returns for investors. Second, we will try to assess whether or not private equity and venture capital have had a positive impact for the clean tech industry as a whole.

We will first analyze the performance of clean tech private equity since the beginning of the 21st century. As we will see that it has underperformed other sectors such as high-tech or biotech, we will then try to identify the specific challenges that the clean tech industry poses to private equity investing. Finally, we will do our best to offer solutions to these challenges and highlight the opportunities offered exclusively by clean tech in order to re-galvanize private equity investment in that sector.

Our conclusion will show that there exists a sweet spot for clean tech private equity investing, and that private equity did have a significant positive impact for the industry as a whole. We encourage private equity investors to continue to allocate capital to that industry under certain conditions, as we are on the verge of significant revolutions in the near to medium future.

Thesis Supervisor: Henry B. Weil
Title: Senior Lecturer, Technological Innovation, Entrepreneurship, and Strategic Management
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I wish to thank professor Henry Weil for his support and advice during this endeavor. His guidance was most valuable, and I am very fortunate to have been a part of his Strategic Opportunities in Energy class. I sincerely hope our paths will cross again in the future.

I would also like to thank my professors at MIT Sloan, especially Professor Christopher Knittel for his Energy & Economics class, Professor Nathaniel Gregory for his Advanced Corporate Finance and Mergers & Acquisitions classes, Professor Roberto Rigobon for his Macroeconomics and Big Data classes, and finally Professor Antoinette Schoar for her Entrepreneurial Finance class. I also express my gratitude to the MSMS faculty members for their help this year: Chanh Phan, Prof. Michael Cusumano and Lisa Monaco. I also want to give a very special thanks to Christine Bolzan, whose support and advice has had a huge impact on my year at MIT Sloan and my career.

Last but not least, I would like to thank all my friends who have helped me throughout this year and who will recognize themselves. My family as well, without whom the MIT experience would never have been possible. And finally I want to thank Loubna Berrada who has always been by my side, and who has helped me make it through all these adventures.

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1. Introduction

Since the beginning of 2015, oil prices have reached a historical low, plunging from over $140 a barrel to below $40 for Brent. Many analysts believed that these prices trends, as well as the advances made in fracking technologies would strongly adversely impact the investments made in clean technology.

I such were the case, how do we account for the fact that in 2015 over $330 billion were invested in the clean energy sector, according to Bloomberg New Energy Finance. This proves that even in the current oil price environment, renewable energy remains a dynamic and attractive sector for investors.

However, in her article “Clean Energy Got a Record $330 Billion in Investment Last Year” published January 2016, Katie Fehrenbacher, analyst for Fortune.com, explains that Venture Capital and Private Equity investors only account for a small part of this market. In 2015 they only contributed to about $6 billion of total capital. This is still less than half of what VC/PE invested in 2008, which is considered by most analysts as the golden year for venture clean technology investment.

The article also shows that there are many new dynamics at work in the sector. For instance, private equity investors, which used to focus on energy generation projects, now seem to shift towards companies offering business models at the intersection between software and energy. We are also witnessing the emergence of new players in the private equity sphere that could very well reshuffle the cards for the industry, such as Bill Gates who launched a multi-billion dollar fund focused on clean tech research and development to boost financing for early stage energy start ups.

Given this very particular context, it is only natural to want to examine the impact private equity has had, and continues to have, on the clean technology sector.

1.1. My motivations in choosing this thesis topic

I have always had a passion for the energy sector, which in my opinion shapes most of the world’s geopolitics and geo-economics. More specifically, I have developed a genuine interest for the renewable energy sector. My classes at MIT this year, most notable Strategic Opportunities in Energy and Energy Economics and Policy, with Professor Weil and Knittel respectively, have allowed me to strengthen my understanding and interest for this sector. I am deeply convinced that clean energy is one of the biggest challenges man has to face in the 21st century. I hope that in my career I will be able to contribute to developments and progress in that field. As I intend to pursue a career in private equity, it is only natural that I wanted to comprehend the opportunities venture capital and private equity financing present for the renewable energy sector. This thesis, and the research I did, was a way for me to be aware of the challenges and the issues at stake, and maybe develop frameworks and solutions to address them.

Finally, many articles in the press seem to convey the idea that clean tech venture capital is dead. Through my research, I wanted to verify the veracity of these claims, and hopefully, infirm them.
1.2. Scope of this thesis

1.2.1. Timeframe and geographic focus

Timeframe
Clean tech investing is a relatively new industry that started at the end of the 1990’s and really soared in the 2000’s after the burst of the dot.com bubble. Given that the industry is relatively new, and the fact that private equity funds usually have a maturity of 10 years or more, data available on clean tech private equity investing is relatively scarce. That is why our study will cover data going as far back as 2000.

Geographic focus
At first, the scope of this thesis was supposed to be focused solely on private equity funds based in the United States, given that it is the most active investing market in the world. However, the scarcity of the data available encouraged me to broaden the scope of my research to the whole world. This actually proved to be quite useful, as Europe – with countries such as Germany or Denmark – have a vibrant clean energy market. This also enabled me to include data from China, where solar and wind energy investing has boomed over the past decade.

1.2.2. Definition of Venture Capital and Private Equity (VC/PE)

Currently, the term private equity is used very loosely, and can actually refer to a variety of investment profiles. This makes research and data collection all the more difficult, as sources often do not define what they mean by private equity. This can range from mega buyout funds such as KKR and Blackstone, to the so-called “angel investors”. Private equity can even sometimes refer to corporate investments made in start ups.

If we refer to the European Venture Capital Association (EVCA), they define private equity as the financing that “provides equity capital to enterprises not quoted on a stock market. Private equity refers mainly to management buyouts, management buyins, replacement capital and venture purchase of quoted shares”. Moreover, for the EVCA, venture capital is only a sub category of private equity focused on earlier stage investments. So based on this definition, private equity deals can refer to a broad range of transactions: leveraged buyout (LBO), venture capital, growth capital, angel investing, mezzanine capital and others.

In her thesis on Public Policy and Clean Energy Private Equity Investment (2008), PhD Mary Jean Bürer provides a very good distinction between Private Equity and Venture Capital:

- Venture capital (VC) strictly refers to investment early on in the life of the company, typically seed capital, start-up and expansion stages (see Figure 1)
- Private equity (PE) on the other hand refers to later stage investments, such as replacement capital and buy-outs, and occasionally the latter rounds of the expansion stage (see Figure 1).

These are the definitions we will apply to our thesis. Finally we will refer to the broader definition of private equity (i.e. the one offered by the EVCA) as “private capital” to avoid any possible confusion. Figure 1 provides a summary of the different financing available to companies based on their development stage.
It is also important to understand how these VC and PE companies are structured. VC/PE professionals actually have to raise funds from outside sources, usually pension funds, wealthy individuals, sovereign wealth funds, etc. These outside sources are referred to as Limited Partners (LPs). The funds that have been raised are pooled in a “Fund” under a Limited Partnership. These funds usually have a life time of 10 to 15 years. The VC/PE fund managers, also called General Partners (GPs), then invest in companies to generate returns for their investors. To maximize these returns, the GPs provide support and expertise to the management teams of their portfolio companies (also called target companies). The VC/PE fund exits an investments usually within 2 to 8 years through different options: IPO, sale to a strategic buyer, sale to another PE company, etc. Finally GPs collect fees from their LPs for managing the fund, plus a “bonus” if the returns are above a certain hurdle rate. This incentivizes GPs to create value for their portfolio companies. Figure 2 summarizes the structure of these VC/PE companies.

Finally, by “investors” we will make reference to the GPs, who actually make the final investment decision in the target company.
1.2.3. Definition of Clean Tech

Clean Tech, Green Energy, Renewable Energy? What is the difference between all those terms? Once again the difficulty here is that very often they are used interchangeably by the press and the media. We need to refer to the academia to get a precise definition and distinction.

For this thesis we will refer ourselves to the definition provided by Pernick and Wilder in *The cleantech revolution: The next big growth and investment opportunity* (2007). They define clean tech as “any product, service, or process that delivers value using limited or zero nonrenewable resources and/or creates significantly less waste than conventional offerings”.

This actually covers a very wide range of industries and products. Pernick and Wilder go further and explain that clean tech actually covers four main industries: energy, transportation, water, and materials. Clean tech comprises energy efficient technologies that include but are not limited to recycling, renewable energy (wind power, solar power, biomass, hydropower, biofuels), information technology, green transportation, electric motors, green chemistry, composite materials, and lighting (see Figure 3).
We see that renewable energy in this case is just a sub portion of clean technology. Strictly speaking, renewable energy refers to “energy resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action” (EIA Glossary, Renewable Energy, 2016). Albeit renewable energy represents a large part of clean tech investing, we will consider clean technology as a whole for our thesis.

1.3. Thesis research questions

Now that we have set the scope of our research, we can finally state our thesis topic: The Impact of Venture Capital and Private Equity on the Clean Tech Industry.

Behind that very broad subject, we will focus on the following issues:

* How has the clean tech VC/PE market been performing?
* Can we identify trends and how can we explain them?
* Is clean tech a good investment for PE/VC?
* Is there a “sweet spot” VC/PE investors should aim for when looking for clean tech companies?
* Has VC/PE investing had a positive impact for the clean tech industry?
* Is VC/PE investing adapted to clean tech start ups?
Are there ways to improve the relationship between the investors and the target companies to maximize value for both stakeholders?

We will address these issues in our thesis by first providing an overview of the state of clean tech VC/PE market. Then we will try to evaluate the impact VC/PE investing has had for the clean tech industry. And finally we will focus on future trends and research considerations we can expect from the industry in the years to come.

1.4. Disclaimer

As stated previously, the private nature of VC/PE has made data collection rather difficult. Also, the variety of definitions applied to VC/PE and Clean Tech made the process all the more challenging. This is why the data, especially concerning returns, may vary from one source to the other. But more than the actual numbers, we chose to focus on the trends driving the industry. In that regard the different sources were pretty consistent.
2. The current state of the Clean Tech VC/PE market

2.1. Historical Trends

2.1.1. Fundraising

In this section we will deal with funds that have been raised to invest in clean tech companies. The data shows that trends have been pretty uneven over the past years, with a decrease in the number of funds raised initiated in 2012. This downward trend seems to have been confirmed in 2013, and the years hereafter (see Figure 4). Clean tech fundraising has obviously been affected by the 2008 global financial crisis, as the overall private equity industry has (see Figure 5). Nonetheless, clean tech funds still account for a very small part of overall private equity fundraising in terms of dollar amount (see Figure 5).

Figure 4: Annual private equity clean tech fundraising 2007 – 2014 (Source: Preqin Fund in Market, as of 9/2/2014)
Figure 5: Private equity capital raised since 2007 (based on Bain & Company Global Private Equity Report 2016)

<table>
<thead>
<tr>
<th>Year</th>
<th>Global PE capital raised</th>
<th>Clean Tech capital raised</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>666</td>
<td>352</td>
</tr>
<tr>
<td>2008</td>
<td>681</td>
<td>405</td>
</tr>
<tr>
<td>2009</td>
<td>318</td>
<td>4.9</td>
</tr>
<tr>
<td>2010</td>
<td>299</td>
<td>2.4</td>
</tr>
<tr>
<td>2011</td>
<td>352</td>
<td>n.a.</td>
</tr>
<tr>
<td>2012</td>
<td>405</td>
<td>38% (26%)</td>
</tr>
<tr>
<td>2013</td>
<td>547</td>
<td>35% (9%)</td>
</tr>
<tr>
<td>2014</td>
<td>555</td>
<td>18% (51%)</td>
</tr>
<tr>
<td>2015</td>
<td>527</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>YoY change Global PE</th>
<th>YoY change Clean Tech PE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>2% (53%)</td>
<td>52% (49%)</td>
</tr>
<tr>
<td>2009</td>
<td>(6%)</td>
<td>22% (49%)</td>
</tr>
<tr>
<td>2010</td>
<td>18%</td>
<td>38% (26%)</td>
</tr>
<tr>
<td>2011</td>
<td>15%</td>
<td>(9%)</td>
</tr>
<tr>
<td>2012</td>
<td>35%</td>
<td>(51%)</td>
</tr>
<tr>
<td>2013</td>
<td>1% (5%)</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

Note: Clean Tech funds raised for 2014 were annualized based on Figure 4.

Figure 4 shows that Clean Tech fundraising has experienced a peak in 2009, with $10.4B committed that year. However, this amount has been decreasing ever since (exception of 2011), whereas global private equity commitments as a whole have been steadily increasing since 2011. Preqin fund managers explain that this was partially due to the progress made in fracking technologies. These new developments have diverted the money of large energy private equity players (such as Blackstone or Riverstone) from clean tech back towards oil and gas.

Moreover, clean tech specific funds still represent a very small piece of global private equity money (around 1% over the period). But once again, this doesn’t account for generalist private equity companies that invest in clean tech companies.

As should be expected, clean tech specialized funds are predominantly raised in North America and Europe, as shown in figure 7. It is interesting to note that except for 2009, Europe has almost consistently raised more capital in clean tech than North America. This can most likely be explained by Europe’s more limited access to fossil fuels and to greater public awareness towards renewable energies.
Figure 6: Proportion of annual private equity clean tech aggregate capital raised by primary geographic focus, 2007 – 2014 YTD (Source: Preqin Funds in Market, as of 9/2/2014)

Furthermore, figure 7 shows that, on average, it has been increasingly challenging for GPs to secure commitments for clean tech specialized funds. Except for 2007, more than half of funds have not been able to secure their target commitments at final fund close, the worst year being 2012, where less than 23% of funds were able to reach their target.

Figure 7: Breakdown of target size achieved at final close of private equity clean tech funds (Source: Preqin Funds in Market, as of 9/2/2014)

Nonetheless, LPs investing in clean tech specialized funds seem to have attained some level of sophistication. They have developed over the years a better understanding of the market and can identify the sub sectors within clean tech that they wish to invest in, as shown in figure 8.
2.1.2. Deal activity

*VC/PE only amounts to a small part of total clean energy investments (Figure 9)*

Over the years, VC/PE investments have only accounted for a minor part of total deal value in the clean energy industry. Most of the deal value is captured by asset financing and small distributed capacity projects (accounts for over 90% of deal value). VC/PE on the other hand only accounts for 2-5%. This can be explained by the fact that the energy sector is very capital intensive in its commercialization and expansion stages. VC/PE prefers to invest earlier on to bring the technology to commercial stage, explaining the smaller investments in terms of dollar amount overall. Nonetheless, it is interesting to notice that public market financing has increased its total share in the deal value, contrary to VC/PE, which tends to have decreased in recent years.
Figure 9: New investment in clean energy by asset class (Source: Bloomberg Clean Energy Finance, as of 10/6/2015)

New Investment in Clean Energy by Asset Class (SB, as of 10/6/2015)

<table>
<thead>
<tr>
<th>Year</th>
<th>VC/PE</th>
<th>Public Market</th>
<th>Asset Finance &amp; Small Distributed Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>1.4</td>
<td>5.7</td>
<td>41.1</td>
</tr>
<tr>
<td>2005</td>
<td>2.4</td>
<td>109.6</td>
<td>70.1</td>
</tr>
<tr>
<td>2006</td>
<td>7.9</td>
<td>153.3</td>
<td>109.6</td>
</tr>
<tr>
<td>2007</td>
<td>178.4</td>
<td>235.5</td>
<td>153.3</td>
</tr>
<tr>
<td>2008</td>
<td>173.4</td>
<td>251.3</td>
<td>235.5</td>
</tr>
<tr>
<td>2009</td>
<td>6.7</td>
<td>272.2</td>
<td>251.3</td>
</tr>
<tr>
<td>2010</td>
<td>11.2</td>
<td>263.9</td>
<td>272.2</td>
</tr>
</tbody>
</table>

% of Total

<table>
<thead>
<tr>
<th>Year</th>
<th>VC/PE</th>
<th>Public Market</th>
<th>Asset Finance &amp; Small Distributed Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>95%</td>
<td>5%</td>
<td>95%</td>
</tr>
<tr>
<td>2005</td>
<td>89%</td>
<td>10%</td>
<td>89%</td>
</tr>
<tr>
<td>2006</td>
<td>85%</td>
<td>10%</td>
<td>85%</td>
</tr>
<tr>
<td>2007</td>
<td>79%</td>
<td>10%</td>
<td>79%</td>
</tr>
<tr>
<td>2008</td>
<td>86%</td>
<td>16%</td>
<td>86%</td>
</tr>
<tr>
<td>2009</td>
<td>87%</td>
<td>16%</td>
<td>87%</td>
</tr>
<tr>
<td>2010</td>
<td>89%</td>
<td>16%</td>
<td>89%</td>
</tr>
<tr>
<td>2011</td>
<td>93%</td>
<td>16%</td>
<td>93%</td>
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<tr>
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<td>96%</td>
<td>20%</td>
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<td>20%</td>
<td>93%</td>
</tr>
<tr>
<td>2014</td>
<td>91%</td>
<td>20%</td>
<td>91%</td>
</tr>
<tr>
<td>2015</td>
<td>93%</td>
<td>20%</td>
<td>93%</td>
</tr>
</tbody>
</table>

Note: total values include estimates for undisclosed deals; excludes corporate and government R&D, and spending for digital energy and energy storage projects.

A diverse sector focus (Figure 10, 11 & 12)

Based on Figure 10, if we combine buyout (i.e. private equity) and venture capital deals, it seems like the number of deals are evenly distributed across sectors, with a slight lead of solar.

However if we look at venture capital deals, we see that the mix is a bit different (we would have liked to conduct the same analysis for private equity backed deals, but unfortunately the data wasn’t available to us). For VC deals we can see that there has a strong increase in the proportion of transportation related deals, both in dollar amounts and in number of deals (see Figures 11 and 12). On the other hand, we see that the proportion of solar has decreased and now only represents a minor piece of total VC deals. This is a sign that different private equity players have different industry preferences based on investment stage. As solar panel projects are rather capital intensive, it explains why early stage VCs don’t favor them, contrary to larger late stage buyout funds.
Figure 10: Proportion of buyout and venture capital backed clean tech deals by industry, 2008-2012 (Source: Preqin Deals Analyst Online Service)

Figure 11: Sector shares of clean tech venture capital (number of deals) (Source: i3 Q4/FY 2015 Innovation Monitor, 2016)

Note: excludes smart grid, industrial biotech, wind and others.
Geographically, APAC has supplanted the Americas and EMEA since 2012
Another interesting fact worth mentioning has been the shift in deals from the Americas to APAC in the overall clean energy industry. Indeed, in 2004 APAC only accounted for a third of total deal value, against almost half for the Americas. In 2014, this has totally shifted. The amount invested in clean energy in APAC is almost double the amount in the Americas, and now accounts for just over half of total dollars invested. This can most likely be explained by two factors: China has polarized a lot of the solar panel production and projects over the past couple of years. Solar being one of the most capital-intensive sub sector within clean tech, this can be one explanatory factor for the numbers observed. Secondly, North America still remains very active in the VC sphere, but VC investments are traditionally much smaller than buyout or asset financing deals. It is always important to keep these underlying factors in mind while analyzing these figures.
Figure 13: New investment in clean energy by region (Source: Bloomberg Clean Energy Finance, as of 10/6/2015)

![New Investment in Clean Energy by Region 2004-2014 ($B)](chart)

Note: total value includes estimates for undisclosed deals; includes corporate and government R&D, and spending for digital energy and energy storage projects.

**Average deal sizes in venture capital deals are pretty flat**

Overall, invested amounts by VCs have remained pretty steady over time, with a slight increase in 2015. This probably accounts for the fact that the industry is maturing and that there is a greater availability of mid-late stage projects to finance. Also the difference of financing amounts between early and growth stage are quite significant (6 to 7 times larger in later rounds), which is consistent with both the private equity industry as a whole and the fact that growth in the clean tech sector is highly capital intensive.

Figure 14: Average round size in clean tech venture capital (Source: i3 Q4/FY 2015 Innovation Monitor, 2016)

![Average Round Sizes in Clean Tech Venture Capital ($M)](chart)

Note: excludes outliers above $350M.
2.1.3. Returns and performance

If we look at the performance since 2003 of the NEX index (figure 15), which comprises several clean tech energy companies, we can see that the clean tech industry has widely underperformed the tech market (against NASDAQ), and the market as a whole (S&P 500). There clearly was a bubble for clean tech companies up until 2008, when it burst along with the global financial crisis. Although recovery seemed to be on its way, the index plunged in 2011 and never fully recovered afterwards. There are many factors that can explain this, and one of the most vastly recognized ones was the crash in the price of PV cells due to Chinese manufacturers who were able to substantially drive down costs with government subsidies and economies of scale.

Figure 15: NEX Clean Energy Index 2003-2015 YTD (Source: Bloomberg New Energy Finance, as of 10/6/2015)

Now, if we benchmark the performance of clean tech venture capital investments against those of other VC/PE sectors, the conclusion isn’t that bleak, but is not all that positive either. From 2002 to 2009, clean tech VC has barely performed better than the overall VC industry (19% vs. 17%), and clearly underperformed the IT industry (28%). This does not even account for the fact that the golden age of clean tech investing came to a halt in 2009, and overall performance would have probably even been worse if additional data were available.

Finally, the data shows that the performance on clean tech VC/PE has been decreasing overall. In his article “Clean tech loses power in energy portfolios” (Pensions and Investments, 2015), Arleen Jacobius writes that the “global clean-tech had a gross internal rate of return of 4.4% on a total of $15.4 billion in investments from 2008 to 2012, down from
11.1% gross IRR from 2004 to 2007 on a total of $9.2 billion in investments, according to the most recent data from Boston-based consulting firm Cambridge Associates LLC.

Figure 16: Venture capital performance from 2002 to 2009 (Source: National Venture Capital Association, and Bain & Company Global Private Equity Report 2016)

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Energy</th>
<th>Information Technology</th>
<th>All VC Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>26%</td>
<td>9%</td>
<td>10%</td>
</tr>
<tr>
<td>2003</td>
<td>47%</td>
<td>17%</td>
<td>12%</td>
</tr>
<tr>
<td>2004</td>
<td>13%</td>
<td>20%</td>
<td>14%</td>
</tr>
<tr>
<td>2005</td>
<td>9%</td>
<td>31%</td>
<td>5%</td>
</tr>
<tr>
<td>2006</td>
<td>7%</td>
<td>21%</td>
<td>9%</td>
</tr>
<tr>
<td>2007</td>
<td>22%</td>
<td>22%</td>
<td>13%</td>
</tr>
<tr>
<td>2008</td>
<td>12%</td>
<td>48%</td>
<td>26%</td>
</tr>
<tr>
<td>2009</td>
<td>14%</td>
<td>54%</td>
<td>37%</td>
</tr>
</tbody>
</table>

2.2. The importance of external factors to explain these trends

2.2.1. The impact of the Dot.com bubble burst

In their research paper titled The Promise and Pitfalls of Venture Capital as an Asset Class for Clean Energy Investment: Research Questions for Organization and Natural Environment Scholars (2012), Alfred Marcus, Joel Malen, and Shmuel Ellis explain how the burst of the dot.com bubble has played a great role in the emergence of clean tech private capital investing. With the burst occurring in 2001, VC/PE managers were looking for alternate sectors to invest LP funds, and started paying attention to clean tech firms. By 2005, clean tech investments started generating returns, over-performing the tech sector. Consequently, the larger pension funds started investing massively in VC/PE funds with a clean tech focus, which explains the increase in the number of clean tech fund raised, with its peak in 2009 (see Figure 4). However, as any bubble, this affluence of capital towards clean tech fueled many deals in technologies that weren’t ready for commercialization, generating poor returns, and ultimately driving investors away.
2.2.2. The correlation with oil and gas prices

It seems rather logical that fluctuations in the price of fossil fuels would have an impact on the amount of capital invested in the clean tech industry. Douglas Cumming, Irene Henriques, and Perry Sadorsky proved this relationship in their paper 'Clean tech venture capital around the world' (2016). The data actually shows that it is the external factor that has the strongest impact on the decision to invest in clean tech – more so than any other economic, legal or institutional variable. Their study concludes that an increase in oil prices leads to an increase in the number of clean tech VC deals, albeit with a slowing rate of increase over time (see figure 17).

We pushed this analysis until Q3 2015, using the Brent Oil Price per quarter (calculated as an average over the period), and the figures provided by Bloomberg Clean Energy Finance 2015 for VC/PE Clean Tech investments. We can see that Cumming et al. findings hold true until Q1 2011. Then there is a decorrelation between fluctuations in oil prices and VC/PE clean tech investments. This can probably be explained by the poorer performance of Clean Tech investments, driving investors away from the sector. This extra data is also biased by the fact that we do not the exact criteria and sample companies retained by Cumming et al.

Figure 17: Clean tech VC/PE investments vs. oil prices ($/bbl) (Source: Bloomberg New Energy Finance 2015)

2.3. The fall from grace of clean tech investments?

To this day VC/PE clean tech invested still is very marginal compared to the overall amounts invested in the clean tech industry.
Figure 18: 2014 Clean energy investment types and flows breakdown (Source: Bloomberg New Energy Finance, as of 10/6/2015)

2014 Clean Energy Investment Types & Flows (SB)

Note: total values include estimates for undisclosed deals; AF = Asset Finance; SDC = Small Distributed Capacity.

2.3.1. Top H2 2015 deals and exits

All in all, 2015 has been a good year for clean tech deals involving VC/PE backing:
- Centerbridge Partners secured the largest PE backing of the year with the acquisition of Senvion for $1.2B
- 2015 has also been a successful year for exits, both through M&A and IPOs:
  - the sale of Nextracker to Flex for $330M (estimated MoM multiple of 10x)
  - the IPO of Sunrun on the Nasdaq for $505M
Figure 19: Top H2 2015 Clean Tech VC/PE acquisitions (Source: i3 and Bloomberg, New Energy Finance, 2015 League Tables)

<table>
<thead>
<tr>
<th>Target</th>
<th>Description</th>
<th>Close</th>
<th>Sector</th>
<th>Value (SM)</th>
<th>Investors</th>
</tr>
</thead>
<tbody>
<tr>
<td>SENVION</td>
<td>German manufacturer of wind turbines</td>
<td>Q1 2015</td>
<td>Wind</td>
<td>1.138</td>
<td>Centerbridge Partners</td>
</tr>
<tr>
<td>NextEra Energy</td>
<td>Developer of an online platform providing ride booking services</td>
<td>Q4 2015</td>
<td>Transportation Services</td>
<td>700</td>
<td>LeTV</td>
</tr>
<tr>
<td>NEXTEV</td>
<td>Manufacturer of high-end electric vehicles</td>
<td>Q3 2015</td>
<td>Electric vehicles</td>
<td>500</td>
<td>Hillhouse Capital Management, Sequoia Capital Operations, Yuyue Capital</td>
</tr>
<tr>
<td>TerraForm Global</td>
<td>Globally diversified owner of clean power generation assets</td>
<td>Q2 2015</td>
<td>Solar</td>
<td>403</td>
<td>Glenview Capital Management, Baron Capital, IBERIABANK Asset Management, Capcicorn Investment Group, Zimmer Partners, General Electric</td>
</tr>
<tr>
<td>Sunnova</td>
<td>Provider of solar installation and services</td>
<td>Q4 2015</td>
<td>Solar</td>
<td>300</td>
<td>Triangle Peak Partners, Franklin Square Capital Partners</td>
</tr>
<tr>
<td>Suzlon Energy</td>
<td>Indian manufacturer of wind turbines</td>
<td>Q1 2015</td>
<td>Wind</td>
<td>289</td>
<td>Undisclosed</td>
</tr>
<tr>
<td>OLA</td>
<td>Developer of a taxi e-hailing application</td>
<td>Q4 2015</td>
<td>Transportation Services</td>
<td>275</td>
<td>Didi Kuaidi, Softbank Capital, Baidu Gifford, Falcon Edge Capital, Tiger Global, DST Global</td>
</tr>
<tr>
<td>ReNew Power</td>
<td>Developer and operator of renewable energy projects in India</td>
<td>Q4 2015</td>
<td>Wind</td>
<td>265</td>
<td>GEF Management Corp, Abu Dhabi Investment Authority, Goldman Sachs</td>
</tr>
<tr>
<td>Greenko</td>
<td>Operator of clean energy projects in India</td>
<td>Q4 2015</td>
<td>Wind</td>
<td>247</td>
<td>GIC</td>
</tr>
<tr>
<td>Anosto</td>
<td>Developer of wind energy projects</td>
<td>Q1 2015</td>
<td>Wind</td>
<td>230</td>
<td>Actis</td>
</tr>
</tbody>
</table>

Figure 20: Top 2015 Clean Tech M&A exits (Source: i3 Q4/FY 2015 Innovation Monitor, 2016)

<table>
<thead>
<tr>
<th>Acquirer</th>
<th>Target</th>
<th>Deal Size (SM)</th>
<th>PIC (SM)</th>
<th>Implied MoM</th>
<th>Venture Backers</th>
</tr>
</thead>
<tbody>
<tr>
<td>flex</td>
<td>NEXTracker</td>
<td>330</td>
<td>33</td>
<td>10.0x</td>
<td>DBL Investors, Sigma Partners, SJF Ventures, Temenbaum Capital</td>
</tr>
<tr>
<td>SFCE</td>
<td>LatticePower</td>
<td>263</td>
<td>198</td>
<td>1.3x</td>
<td>GSR Ventures, Mayfield Fund, Crescent HydePark, AsiaVest, Temasek, Keystone V</td>
</tr>
<tr>
<td>Acuity Brands</td>
<td>DIS TECH Controls</td>
<td>222</td>
<td>33</td>
<td>6.7x</td>
<td>Aster Capital, Demeter Partners, TechFund Europe, Lazard Asset Management, others</td>
</tr>
<tr>
<td>ENGIE</td>
<td>solairedirect</td>
<td>222</td>
<td>33</td>
<td>6.7x</td>
<td>Aster Capital, Demeter Partners, TechFund Europe, Lazard Asset Management, others</td>
</tr>
<tr>
<td>OLA</td>
<td>OXITEC</td>
<td>70</td>
<td>36</td>
<td>1.9x</td>
<td>Scottish Equity Partners, Intel Capital, Braemar Energy Ventures, others</td>
</tr>
<tr>
<td>INTREXON</td>
<td>OXITEC</td>
<td>161</td>
<td>33</td>
<td>4.9x</td>
<td>East Hill Management, Oxford Capital Partners, Asia Pacific Capital</td>
</tr>
<tr>
<td>dyson</td>
<td>SAKT13</td>
<td>90</td>
<td>44</td>
<td>2.0x</td>
<td>Beringea Ventures, GM Ventures, Khosla Ventures, ITOCHU</td>
</tr>
<tr>
<td>ROHM</td>
<td>poweration</td>
<td>70</td>
<td>37</td>
<td>1.9x</td>
<td>SSE Ventures, Intel Capital, Venture Tech Alliance, Braemar Energy Ventures, others</td>
</tr>
<tr>
<td>BOSCH</td>
<td>SEED</td>
<td>Undis.</td>
<td>44</td>
<td>n.a.</td>
<td>Samsung, GSR Ventures, Khosla Ventures, Presidio Ventures</td>
</tr>
<tr>
<td>Kuaidi Dache</td>
<td>Undis.</td>
<td>818</td>
<td>n.a.</td>
<td>GSR Ventures, Tencent, CITIC Private Equity, Temasek, DST Global</td>
<td></td>
</tr>
</tbody>
</table>

Note: PIC = Paid in Capital, totally capital that was drawn down in the investment; MoM = Money on Money multiple (Deal Value/PIC)
<table>
<thead>
<tr>
<th>Target</th>
<th>Description</th>
<th>Mkt Cap (SM)</th>
<th>Pre-IPO Investors</th>
</tr>
</thead>
<tbody>
<tr>
<td>TerraFrm</td>
<td>YieldCo for solar projects of SunEdison</td>
<td>550 NASDAQ</td>
<td>n.a.</td>
</tr>
<tr>
<td>8point3</td>
<td>First Solar &amp; SunPower joint YieldCo for solar projects</td>
<td>981 NASDAQ</td>
<td>n.a.</td>
</tr>
<tr>
<td>Sunrun</td>
<td>Home solar sales and installation</td>
<td>505 NASDAQ</td>
<td>Foundation Capital, Accel Partners, Sequoia Capital, Madrone Capital Partners, Firsthand Technology</td>
</tr>
<tr>
<td>SolarEdge</td>
<td>Manufacturer of solar system power components</td>
<td>1,150 NASDAQ</td>
<td>GE Ventures, Lightspeed Venture Partners, Norwest Venture Partners, Genesis Capital, others</td>
</tr>
<tr>
<td>Alarm.com</td>
<td>Smart home services provider</td>
<td>716 NASDAQ</td>
<td>ABS Capital Partners, NJTC Venture Fund, Technology Crossover Ventures, Equis Capital</td>
</tr>
<tr>
<td>Enviva</td>
<td>Producer of woody biomass pellets and fuels</td>
<td>417 NYSE</td>
<td>Riverstone/Carlyle Renewable Energy Partners</td>
</tr>
<tr>
<td>Arcadia</td>
<td>Climate resistant crop trait developer</td>
<td>116 NASDAQ</td>
<td>Vilimorin, BASF Venture Capital, Saints Capital, Mandala Capital, Exeter Life Sciences</td>
</tr>
</tbody>
</table>

### 2.3.2. Top 2015 VC/PE Investors

This year’s top investor in terms of committed dollars was Centerbridge Partners with its mega $1.2B buyout of Senvion. However in terms of total deal closed, 350 Investment partners came first with no less than 14 deals. Finally in terms of the sector within clean tech that received the most investment, it was an even split between solar and wind who received 36% and 35% of the total deal value respectively.
The data suggests that VC/PE investors have slowed down their capital allocations to clean tech over the past couple of years. Figure 9 shows that investment in clean energy has been pretty stagnant in terms of dollar value.
This slowdown is even more apparent if we compare it to investments made in the IT/software sector. In his article “Top 10 Venture Capital-Backed Green Companies” (2015), Jeremy Quittner compares the amount of dollars invested between the two industries from 2012 to 2014:

- On the one hand, the clean tech industry has received almost $2B dollars in VC investments in 2014, which represents a 41% increase compared to 2013, but a 30% decrease compared to 2012 and even a 50% compared to 2011.
- On the other hand, software companies received $21B in VC funding in 2014, which is almost double the amount they received in 2013, and three times the amount compared to 2011.

Overall, this seems to confirm that it has become increasingly difficult for clean tech companies to attract VC/PE funding. The risk-return profile of the asset class just doesn't seem to appeal to investors, which have found better alternatives to generate returns for their LPs. Why aren’t clean tech investments performing as well? What are the factors explaining these trends?
3. What impact does VC/PE investing have on the clean tech industry?

3.1. Clean Tech investors must face a series of challenges specific to that industry

First, it is important to understand that the clean tech industry has a very specific life cycle, which necessarily has its impact on the financing of such projects. The research paper ‘Cleantech’ venture capital around the world (2016), by Douglas Cumming, Irene Henriques, Perry Sadorsky, provides a very good break down in 4 phases of this life cycle:

1. Technology research
2. Technology development
3. Manufacturing and scale-up
4. Roll-out

The paper explains that different types of funding are required for the different phases:

- Government funding for stage 1
- VC/PE funding for late stage 1, stage 2 and early stage 3
- Public equity markets and M&A focus on stage 3 and 4
- And finally debt financing is used for stage 4

Given this specific life cycle, Cumming, Henriques and Sadorsky (2016) were able to identify the specificities of clean tech venture capital as opposed to biotech or high tech VC. These specificities were summarized in figure 25, and will be further explained in this section.

**Figure 25: What differentiates clean tech from other venture capital? (Source: ‘Cleantech’ venture capital around the world, Cumming, D., Henriques, I., & Sadorsky, P., 2016)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Clean Tech venture capital</th>
<th>Biotechnology or high tech venture capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accrual of Benefits</td>
<td>Although there are private benefits to production, the benefits to society are significant due to the public good nature of the service or good.</td>
<td>Private benefits are significant as property rights tend to be well defined (copyrights, patents) and there may or may not be benefits to society.</td>
</tr>
<tr>
<td>Assessment of risks, returns and market growth opportunities</td>
<td>Operates on the production side of the economy making it difficult to evaluate the risks, returns and market growth opportunities.</td>
<td>Operates on the consumption side of the economy making it easier to evaluate the risks, returns and market growth opportunities.</td>
</tr>
<tr>
<td>Ability to exit</td>
<td>Tends to be very capital intensive and faces greater technology risks associated with the functioning of the technology, scalability and exit requirements</td>
<td>Capital intensity is lower than clean tech and exit requirements are lower given that incumbents are more likely to purchase the investment.</td>
</tr>
</tbody>
</table>

3.1.1. A highly capital intensive industry

This is perhaps the biggest challenge of clean tech compared to the high tech and biotech industries. Take for instance, Solyndra, a company that manufacturers photovoltaic systems using thin – film technology, has had to raise $970M in equity finance in addition to a $535M loan guarantee from the Department of Energy, prior to its planned IPO in mid 2010. This is truly a considerable amount, when you compare it to the average round sized we discussed in Figure 14 for later VC rounds of c.$30M. The number of VC funds that are able to raise such amounts of capital are fairly limited. Moreover, having to raise such large amounts of capital presents additional execution risk for private capital investors. Let’s now take a look at the
The valley of death dilemma

First of all, this greatly increases the technology risk taken on by private capital investors. Indeed, clean tech projects require much more capital in order to prove the viability of the technology, and even more to prove its marketability. This is the so-called “valley of death” dilemma, which is further explained in ‘Cleantech’ venture capital around the world. The valley of death, which is a term used by the VC industry as a whole, refers to the shortage of funding experienced at the technology development stage and also the shortage of funding that occurs once you have to prove the viability of a new technology for commercialization. The paper explains that for clean tech start ups, the valley of death is “longer” than for other sectors — namely high tech and biotech — both in terms of time to develop the technology and in the amounts of funding required. This is a dilemma for investors because it is much harder for them to assess if the technology is going to be successful before actually reaching commercialization stage. Contrary to pharma where there are some clear milestones at which investors can choose to cut funding if results are inconclusive — phase 1 trials, FDA approval, etc. — clean tech is more of an all-in or out bet. This way, investors lose the benefit of real option valuation, i.e. the value of having the ability to cut funding — and thus losses — over the lifetime of their investment.

Reduced portfolio diversification

Firstly for the investor, if we assume that the size of a given fund is fixed, this means that by increasing its per deal capital commitments, the investors will consequently have to reduce their number of investments. This strongly increases their risk exposure, as they are losing the benefits of portfolio diversification. In their working paper titled Venture Capital Investment in the Clean Energy Sector (2010), Ghosh and Nanda show that even a Tier 1 VC company only generates positive returns on 36.8% of its invested capital (see figure 26). Furthermore, it is actually only 4.3% of its invested capital that generate 61.7% of its total return value for the fund — the famous “home run”. Thus, by reducing the numbers of deals and increasing capital commitments, VCs have a greater chance of falling in the “<1x” category, which will strongly affect the overall performance of their fund, and will endanger their capacity to raise future funds.
Figure 26: Breakdown of a Tier 1 VC’s portfolio (Source: *Venture Capital Investment in the Clean Energy Sector*, HBS Working Paper 11-020, Ghosh, S., & Nanda, R., August 2010).

**Breakdown of a Tier 1 VC’s portfolio**

- **63.2%** of Cost: <1x
- **20.5%** of Cost: 1x to 3x
- **13.6%** of Cost: 3x to 6x
- **9.2%** of Cost: 6x to 10x
- **4.3%** of Cost: >10x

- **61.7%** of Value

*Dilutive for founders and early investors*

Finally, this high capital intensity, forcing private capital investors to refinance repeatedly also becomes an issue for entrepreneurs and early stage investors. The more capital they have to raise, the more diluted the founders’ stake will be.

### 3.1.2. Time horizon

All these issues around capital intensity are directly linked to the issues related to the time horizon of VC/PE investments. The lifespan of a typical VC/PE fund, i.e. the period between which the GP raise the fund and when they actually need to return the money to investors, is usually 10 years. This explains why VC/PE investments usually have a maturity of 2 to 5 years, because, assuming an investment period of 5 years, it allows GPs to lock in returns over the life of the fund, thus reassuring investors. The problem with clean tech projects is that they have a much longer lifespan, more often in the 7-8 year range. This is a significant challenge for GPs, first because it means that they need to find their investment targets early on in the life of the fund, or they won’t be able to close the fund on time. This also makes raising new funds much more difficult, as the GPs do not have performance metrics to show yet. Moreover, this increases uncertainty for LPs who basically have to wait the very end of the life of the fund to know what their investment will return.

### 3.1.3. Restricted exit opportunities

Another point made by Ghosh and Nanda in *Venture Capital Investment in the Clean Energy Sector* (2010), is that clean tech VC/PE investors have much more limited exit options than other VC/PE favored sectors such as high tech or biotech. The reason for that is that in the energy industry, large companies are large users of fossil fuels (oil and gas companies, electric utilities given that most of our electricity in the United States still comes from coal). Energy efficiency technologies, for instance, have a paradoxical relationship with electricity suppliers, because their goal is ultimately to reduce energy consumption. The fact is that these
large energy companies actually see many clean tech companies as a threat to their business models — reduced output, cannibalization, etc.

The situation is actually different for high tech and biotech. These industries actually rely on start ups as their innovation pipeline. This fosters a very strong M&A market with high valuations (given the strong competition between strategic buyers), and incentivizes VC/PE players to back these companies.

### 3.1.4. A very geographical industry

Every market has some form of geographic component. Nonetheless, this is even more prevalent for the clean tech industry. Take any project to generate electricity for instance. In the case of coal or oil, transportation costs of the resource are pretty low, which allows the extraction location to be far from the production site. On the other hand it is much harder to transport electricity once it is produced, and clearly the yield of solar panels will not be the same in Texas than in Michigan. The same remark can be made for wind-, geothermal-, and hydropower.

Eric R.W. Knight further develops this concept of the geographical focus of clean tech in his paper *Five Perspectives on an Emerging Market: Challenges with Clean Tech Private Equity* (2012). He shows that this geographical component has impacted over time VC/PE investors’ ability to generate high quality deal flow. He explains that “particular regions have [developed] technology strengths that capitalize on their physical environments. For example, Denmark has a cluster of wind companies (e.g., such as Vestas), the United States has strength in energy efficiency and solar companies (e.g., First Solar, Bright Source, and Solyndra), and the U.K. has strength in tidal and wave technologies (e.g., Polaris)”. This has also led PE funds to develop specializations and contacts based on their location. This isn’t the case for software start ups that basically all converge to the Silicon Valley where the private capital is, because it is indifferent for them to develop software in California or Massachusetts. On the contrary for clean tech, it is the investors that must go to the technology, and not the other way around.

### 3.1.5. Specificities of the energy industry

In *Five Perspectives on an Emerging Market: Challenges with Clean Tech Private Equity* (2012), Eric R.W. Knight comes back on certain of the particularities of the energy industry as a whole that pose additional challenges to clean tech companies and investors.

*Clean Tech companies are price takers*

As we said previously, clean tech is particular in the sense that new companies are viewed as competitors that could very well disrupt the traditional business models of the established firms, rather than as an innovation pool. The other peculiarity is that clean energy producing firms are invariably price takers. Contrary the biotechs that can come up with a new drug and thus be price makers, clean tech firms will never have such level of pricing power. This is directly linked to the fact that energy (for clean tech electricity) is a commodity, and has very little differentiation. Knight explains that this is why regulations have a crucial role for early stage companies, which leads us to a second issue...
Regulatory risk
The clean tech sector is very exposed to regulatory risks, which have direct impact on the pricing of their product. First of all, this requires investors to have a good understanding of the regulatory space. This indirectly excludes generalist funds that will not have a sufficient level of knowledge, unless they have had repeat experience in the sector.
Moreover, it has happened in several cases that with a change in regulation many clean tech start ups went bankrupt. The example chosen by Knight is Spain in 2008 that suppressed feed-in tariffs, which literally led most of the solar panel industry to tank. It is only natural that investors don’t want to expose themselves to this kind of risk.

3.2. VC/PE investors have adapted to these challenges over time

Given all the challenges we mentioned earlier, how can we explain that clean tech is still attracting private capital? Well, in The Promise and Pitfalls of Venture Capital as an Asset Class for Clean Energy Investment: Research Questions for Organization and Natural Environment Scholars (2012), Alfred Marcus, Joel Malen, and Shmuel Ellis have found evidence that private capital investors still see opportunities in the clean tech sector. Over the years, the most successful ones have been adapting their investment strategies to accommodate the specificities of the industry.

3.2.1. Investments stages and technological risk

The authors have compared VC investments made in clean tech VC against investments made in the VC industry as a whole from 1995 to 2009 (see figure 27). They have found that clean tech VC has invested much more in late stage rounds:
- Late stage financing: average round in clean tech has been $31.2M, against only $10.7M for VC in general. Furthermore, in terms of total number of deals, later stage rounds account for 25.4% of them (against 19.2% for VC), and 56.3% if you consider the total dollar amount (against 26.5%)
- Expansion stage financing: average round in clean tech has been $16.4M, against only $9.4M for VC in general.
- Seed financing: consistent with our findings, we see that average deal sizes are much smaller at the seed level for clean tech deals ($0.94M vs. $3.43M)

Figure 27: A comparison of all venture capital funding and clean energy venture capital funding by stage: 1995-2009 (Source: The Promise and Pitfalls of Venture Capital as an Asset Class for Clean Energy Investment: Research Questions for Organization and Natural Environment Scholars, Marcus, A., Malen, J., & Ellis, S., 2012)
The paper goes one by explaining the reasons behind this “late stage bias” (Marcus et al. 2012). As we said previously, exit options for clean tech VC/PE are much more limited when it comes to sales strategies. That is why clean tech investors have decided to put more capital over a longer period of time to bring their companies to commercialization stage (rather than just prove the technology). Once the portfolio companies have reached that stage, VC/PE get better exit options, and at more attractive valuations. This trend has been confirmed over the recent years (see figure 28).

This suggests that VC/PE has also made the choice to invest at a later stage in order to limit its exposure to technology risk. This allows them to focus more on the go to market strategy, which is where they can create the most value for the entrepreneurs.

Figure 28: Clean tech funding by stage quarterly 2011-2014 (Source: PwC Cleantech Report MoneyTree Report, Q3 2014)

![Clean tech funding by stage quarterly 2011-2014](image)

3.2.2. Specialized vs. Diversified funds

We have mentioned previously that the VC/PE clean tech industry initially launched in the 2000s with a handful of specialized funds focusing solely on such investments. Afterwards, there was a transition to high profile generalist funds, mostly due to the push of LPs – notably large pension funds – who wanted exposure to clean tech. However, given the complexity of the industry, it seems we are going back to specialized funds that are able to better align their objectives to the requirements of the clean tech industry.

Specialization has proven to actually boost returns for funds in the clean tech space. A study led by Andrea Masini and Emanuela Menichetti on renewable energy investment called *Energy Policy. The impact of behavioral factors in the renewable energy investment decision making process: Conceptual framework and empirical findings* (2010), proved that attitude towards technological risk and the share of renewable energy companies in the portfolio positively impacts the performance of the portfolio.
So who in the private equity world invests in clean tech today? According to data collected by Preqin, as of July 2015, there are over 2,000 fund managers that say they invest in the clean tech sector. Among these funds, Preqin has selected those focused solely on clean tech investments. The data shows that they are mostly located in North America and Europe (51% and 36% of all fund managers respectively). This can be explained by the fact that these regions provide better subsidies and tax credit for renewable energy investing. Moreover, these funds are still predominantly Venture Capital funds (71%), followed by Growth Equity (12%) (see figure 29).

Figure 29: Solely clean tech focused private equity fund managers by main investment strategy (Source: Preqin Fund Manager Profiles, July 2015)

3.2.3. Shifting from energy supply to energy demand technologies

We said that one of the major challenges for clean tech investments is the capital intensity and the life cycle of the technology. Are there ways to work around those issues?

Private capital investors have actually been pretty ingenious in doing so. Once again, our analysis will be based on Ghosh and Nanda’s research paper, *Venture Capital Investment in the Clean Energy Sector* (2010). The literature shows that over the past couple of years, investors have been moving away from energy production projects, which are the most capital intensive, to the longest time frame. This new capital has been redeployed towards technologies focusing on energy demand. Ghosh and Nanda identify certain of these technologies: energy efficiency, monitoring software, energy storage and transportation (of energy or transportation as a whole with electric vehicles or vehicle sharing companies).
They explain that this has had a double benefit. First of all, it has mitigated their exposure to clean tech specific risk. But this shift has also allowed them to focus on companies that have business models that traditional VC/PE investors are more familiar with – such as component manufacturing, or software solutions. This way, they are once again able to capitalize on the experience and all the best practices the industry has to offer.

This shift has started as early as 2009. Indeed “the share of energy efficiency deals done by VCs rose from 24% in 2008 to 32% in 2009 while energy production investments fell from 30% to 18%, and investments in alternative fuels fell from 13% to 8%” (Ghosh and Nanda, 2010).

3.3. Overall, VC/PE has a history of success and significant impact for the clean tech industry

3.3.1. The takeoff of the clean tech industry was made possible by VC/PE investing

In his article “Cleantech Venture Capital: Why Are These Investors Smiling?” published in 2015, Eric Wesoff shows that the takeoff of the clean tech industry was achieved thanks to VC/PE investing. He provides numerous examples of successful PE-backed companies that became public, generating substantial returns for its investors, and who have become some of the heavy weights of the clean tech industry today.

He takes the example of solar hardware, one of the most capital intensive branches of clean tech, and lists companies that have had VC backing and that have contributed to making solar a solid asset class in the clean tech market. Some of these companies include SolarCity, Solar Universe, Sunrun, Sungevity, Enphase and Clean Power Finance.

Wesoff estimates that “without the innovation and breakneck pace of these VC-funded downstream firms, the U.S. solar market might have taken another five years to reach its current levels, if it took off at all” (2015).

Another emblematic example he gives is the impact that VC-backed Tesla has had in the electric vehicle market, making electric cars no longer just a nerdy ecological initiative, but a trendy and luxurious object.

3.3.2. All in all, does VC/PE backing actually make a difference?

For this section we will base ourselves on a study conducted by Carol Marie Boyer in 2011 called Early Stage Financing of Clean Technology Industries: Does Private Equity Backing Matter?.

For the purpose of this study, Ms. Boyer interviewed 66 clean technology firms, which had the following characteristics (figure 30):
Figure 30: Boyer's study panel firms

<table>
<thead>
<tr>
<th>Early Stage Financing for Clean Technology Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you firm Receive early stage financing?</td>
</tr>
<tr>
<td>No (40; 61%)</td>
</tr>
<tr>
<td>Yes (26; 39%)</td>
</tr>
<tr>
<td>If yes, what type?</td>
</tr>
<tr>
<td>Angel Investors (11*; 41%)</td>
</tr>
<tr>
<td>Venture Capital (9*; 33%)</td>
</tr>
<tr>
<td>Private Equity (3; 11%)</td>
</tr>
<tr>
<td>Public Shareholders (1; 4%)</td>
</tr>
<tr>
<td>Bank Debt (1; 4%)</td>
</tr>
<tr>
<td>Self-financed (2; 7%)</td>
</tr>
<tr>
<td><strong>What percentage of ownership did the firm exchange?</strong></td>
</tr>
<tr>
<td>Average = 56%</td>
</tr>
<tr>
<td>High = 80%</td>
</tr>
<tr>
<td>Low = 34%</td>
</tr>
</tbody>
</table>

*One company used venture capital and angel investors.

Then, she explains that to determine the impact of private equity financing, she separated the results of those that had had PE backing and those that hadn’t.

The results of the study show that "private equity-backed firms had worse one-year and three-year returns, but the difference is not statistically significant. However, the private equity-backed firms had a higher five-year return of 11.29% annualized versus a 0.75% return for non-private equity-backed firms" (Boyer, 2011) (see figure 31). This can probably be explained by the fact that PE professionals will have better experience in deal making and monetization of investments, thus allowing to maximize value upon sale, which typically occur after a holding period of more than 3 years.

In terms of financial ratios, we also see that PE-backed companies outperform their non PE-backed counter parts (see figure 31):

- "Private equity-backed firms have a price-to-earnings ratio of 28.43 versus 15.99 for non-private equity-backed firms"

- "Private equity-backed clean technology firms have a higher sales-to-asset ratio of 0.94 versus 0.58 for non-private equity-backed clean technology firms"

- "Private equity-backed clean technology firms are making more capital expenditures relative to total assets with 38.20 versus 17.28 for non-private equity-backed clean technology firm". One of the explanations for this result is the fact that non PE-backed companies maybe just didn’t have sufficient financing available. Nonetheless that’s an argument in favor of PE-backing, knowing the capital intensity of the industry.

- "The research and development relative to sales of private equity-backed clean technology firms is higher than that of non-private equity-backed clean tech firms: 46.75% versus 4.61%, respectively" (Boyer, 2011). The same comment can be made here.
Figure 31: Boyer’s study: PE vs. non-PE backed firms

<table>
<thead>
<tr>
<th></th>
<th>PE backed</th>
<th>Non PE backed</th>
<th>T Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-year return (July 2008 - July 2009)</td>
<td>31.83%</td>
<td>28.29%</td>
<td>0.50</td>
</tr>
<tr>
<td>3-year return (July 2006 - July 2009)</td>
<td>8.87%</td>
<td>8.79%</td>
<td>0.99</td>
</tr>
<tr>
<td>5-year return (July 2004 - July 2009)</td>
<td>11.29%</td>
<td>0.75%</td>
<td>2.23**</td>
</tr>
<tr>
<td>Price-to-Earnings Ratio</td>
<td>28.43</td>
<td>15.99</td>
<td>3.15**</td>
</tr>
<tr>
<td>Sales to Assets</td>
<td>0.94</td>
<td>0.58</td>
<td>2.50**</td>
</tr>
<tr>
<td>Capital Expenditures to Assets</td>
<td>38.20</td>
<td>17.28</td>
<td>2.27**</td>
</tr>
<tr>
<td>Capital Expenditures ($M)</td>
<td>4,638.72</td>
<td>262.92</td>
<td>1.09</td>
</tr>
<tr>
<td>Corporate Governance Quotient</td>
<td>60.41</td>
<td>52.02</td>
<td>0.92</td>
</tr>
<tr>
<td>R&amp;D Expenditures to Net Sales</td>
<td>46.75</td>
<td>4.61</td>
<td>2.15**</td>
</tr>
<tr>
<td>Dividend Yield</td>
<td>0.99%</td>
<td>2.08%</td>
<td>2.09**</td>
</tr>
<tr>
<td>Employees</td>
<td>17,471</td>
<td>15,757</td>
<td>0.15</td>
</tr>
</tbody>
</table>

**Significant at 5%

*Significant at 10%

However, we must also mention the fact that PE-backed firms outperform non PE-backed firms in every aspect – especially from a returns perspective – after a 5-year period, even if it isn’t the case if you look at a 1-year and a 3-year holding period. This shows that PE investors must be patient to unlock the value of their clean tech investments.

So basically, this study does prove that VC/PE backing does have a positive impact for clean tech companies, and that entrepreneurs should seek out these types of investors to maximize the performance of their companies when in need of financing.
4. Expected developments and further research considerations

4.1. Rethinking our definition on the success of clean tech investments

4.1.1. The concepts of externalities and marginal social benefits in economics

To better assess the performance of clean tech investments, it is important to first go back to certain key concepts of economics theory.

**Externalities**

"In Economics, externality describes the cost or benefits of any activity experienced by an unrelated third party" (Udemy.com).

It is pretty evident that every economic transaction today has externalities, be they positive or negative. It is all the more true for the energy industry, the main externality in our case being pollution and all its consequences. There is an evident cost for society from fossil fuels. This is why, symmetrically, there should be a benefit for society to use renewable energies and clean technologies.

**Marginal social benefit**

"Incremental benefit of an activity as viewed by the society, and expressed as the sum of marginal external benefit and marginal private benefit" (businessdictionary.com).

This allows us to get to the concept of marginal social benefit. This notion suggests that society as a whole would benefit from additional investments in clean technologies.

4.1.2. How to include benefits for society in returns analysis

If we refer back to Figure 25 and the ‘Cleantech’ venture capital around the world (2016) study, once again we see that there is a public good nature associated to clean tech. This should be taken into account by investors and impact in some way the performance assessment of their investments.

The whole question is how. This idea of valuing green isn’t new, and there have been consistent signs of LPs’ appetite to invest in clean technology, either for public image reasons, or because they genuinely believed there was an economic opportunity in clean tech. There has been some attempts to value the social benefit of clean technology – for example carbon rights, the notion of a triple bottom line, which includes some form of social impact. But it remains very difficult nonetheless to assess these benefits in terms of dollar value. And in all cases, this would make sense only if such criteria would be adopted by the entire clean tech VC/PE community, and to a further extent their LPs.

I believe the academia has a large role to play in educating investors to these concepts. They will be key in increasing the investors’ awareness to these topics. We can also be very creative in building new performance metrics to evaluate how “green” our investment is. For instance why not institute a multiple giving the number of cubic meters of CO₂ emissions saved per dollar invested? I am confident that great developments will be made in the years to come in that field, and I am eager to see how they will be applied. But once again, I am convinced
that such performance assessment must be at some point translated into dollar value to be fully measured by the investment community.

4.2. The role of public policies

Many studies have shown the importance public policies have for private equity investors in the clean tech industry, the most renown one being the study from Mary Jean Bürer and Rolf Wüstenhagen titled *Which Renewable Energy Policy Is a Venture Capitalist's Best Friend? Empirical Evidence from a Survey of International Cleantech Investors* (2009). The study shows the preference of investors for feed-in tariffs, which is basically a type of contract guaranteeing pricing based on production costs. This shows that investors have acquired a degree of sophistication and understanding of the policies, which could allow them to enter in a dialog with public institutions to push for policies that would incentivize clean tech VC/PE investment. So I believe governments must also be a proactive stakeholder in the whole process, and hold regular discussions with professionals and academics from the VC/PE industry to better understand their needs and objectives. Given the concept of marginal social benefit that we have introduced previously, public institutions have a lot to win in encouraging such dialog.

There has already been some successful example of government intervention of public-private partnerships between the government and PE-backed companies. Eric Knight provides the example of BrightSource Energy Inc. in *Five Perspectives on an Emerging Market: Challenges with Clean Tech Private Equity* (2016). Back in 2010, the US Department of energy offered $1.4B in loan guarantees to BrightSource, a California based solar company, to expand its manufacturing facilities. Since then the company has been a real success generating high returns to investors. It was originally financed at the seed stage by VantagePoint Venture Partners, and has attracted many high profile investors afterwards, raising $160M by 2010 (source: *Wikipedia*). Some key investors include: Google, KKR, and Chevron.

However, in her research paper called *Public Policy and Clean Energy Private Equity Investment* (2008), Mary Jean Bürer reminds us that VC/PE investors would – and should – never back a company if it relied solely on policies and subsidies to generate profit.

4.3. The importance of Social Legitimacy

Another key challenge the clean tech industry must achieve to attract more VC/PE backing is the so-called “Social Legitimacy” defined by Alfred Marcus, Joel Malen & Shmuel Ellis in *Conferring Legitimacy: The Takeoff in Clean Energy Venture Capital Investment* (2013). The concept behind “Social Legitimacy” is pretty transparent, and means that the industry is deemed at useful, attractive, or basically worth investing in for society. Their research shows that there is a social construct that actually confers social legitimacy to a specific asset class. These social/market factors can be summarized as:

- successful repeat entrepreneurs starting a clean tech venture attracted investors
- importance of showing that the industry has a track record of generating returns
- importance of the media in spreading that image.
The paper shows that today high tech and software companies have more social legitimacy because of the number of high profile companies that have been VC backed – such as Facebook, Twitter, Amazon, Google, etc. We can only hope that with the emergence of certain mega players in the clean tech space that have received PE financing, like Tesla, the industry will gain that much needed momentum to achieve Social Legitimacy.

4.4. More than a competitor, a partner: the relationship with corporate ventures

In the clean tech industry, corporate VC, i.e. VC “funds” working under the umbrella of large corporations such as GE, have often been considered as an alternative for entrepreneurs. In her article titled “Strategic or VC Investors? Where Cleantech Startups Are Finding Funding” (Green Tech Media, 2014), Julia Pyper goes over the pros and cons of corporate ventures for clean tech companies.

4.4.1. The advantages of corporate ventures compared to VC/PE funding

Corporate venture teams do have some distinct advantages over private capital funding, especially when it comes to generalist funds. First of all, they have a better understanding of the market and the technologies at stake. They also have a longer timeframe than most VC/PE funds. In some sense, corporate ventures is closer to R&D, so they don’t always expect direct returns because they attribute strategic value to the access to information and IP, contrary to traditional financial investors. Finally corporate ventures don’t have to deal with the issue of restricted exit possibilities. When they invest in a clean tech start up, they can always choose to integrate the company afterwards. This obviously depends on each corporate venture funds’ strategy.

4.4.2. “Not all startups are sold on the corporate partnership route, however” (Pyper 2014)

However, the article goes on by saying that “Partnerships are not a panacea” (Pyper 2014) either. Depending on how the corporate ventures’ department is organized and managed, the companies might not actually get all the attention they would if they were PE-backed, where the performance incentive for PE managers is much stronger. Moreover, there is always the risk that the large corporation runs its portfolio companies like subsidiaries. The start up might lose a lot of its autonomy, which would hinder its innovative potential. Finally, large corporate structures can have a lot of inertia, especially regarding the decision making process, which can be both frustrating and ill-adapted to start ups.

4.4.3. Towards a VC/PE – Corporate venture partnership?

During one of his interviews with fund managers, Eric Knight actually noticed a very interesting situation: “In one case, a small UK venture capital firm approached a European multinational corporation as a syndicating co-investor in a portfolio company” (Knight, 2012). The venture fund explained that there was a double intent behind that decision. First, that brought another investor on board, easing the capital intensity dilemma. Second, “syndication with corporations builds relationships between the start-up and larger company, which can be valuable when the time for exit arises. If the larger company and start-up are in the same sector, there are also ancillary benefits through shared knowledge and contacts” (Knight, 2012).
This might let us think about a new symbiotic investment structure specific to the clean tech sector that would bring together VC/PE firms and corporate venture funds. But as we said previously, this would be dependent on the energy industry developing this dynamic a acquiring clean tech start ups as a means for innovation. This might become the case as some clean tech firms are greatly increasing in scale (Tesla, SunPower), and the industry in general is also attracting outside investors (Google, Amazon, etc.).

Moreover, this implication of corporate venture funds in the clean tech PE space isn’t unheard of. Data provided by i3 shows that the amount of VC deals with corporate participation have been increasing in 2015, along with the overall size of the rounds involving corporate ventures (see figure 32). The figure shows that over the past 5 years, corporate ventures have consistently participated to 20-30% of clean tech venture capital deals. And we can already identify certain key players in the market who have become active at backing clean tech ventures, the most prominent one being GE Ventures with over 19 deals closed in 2015 (see figure 33).

Figure 32: Corporate participations in VC deals (Source: i3 Q4/FY 2015 Innovation Monitor, 2016)
4.5. Expectations and areas for further research

I will now address some of the areas I believe would be beneficial to investigate in the future to understand the options we have to adapt the VC/PE’s approach to clean tech investing.

4.5.1. Fund investment thesis

Redefining the investment holding period and the life of the fund

First of all, it is clear that funds wishing to invest in the clean tech industry must lengthen their fund life over the usual 10-year time frame, and also their average investment holding period, which currently is around 5 years. If GPs weren’t constrained by these short-term requirements, I believe the industry would regain a lot of its appeal. But in order to change this mindset, it is up to the fund managers to better understand the needs of their different LPs and accept funding from those whose interests align with their investment strategy, i.e. find those who are willing to commit their capital over a longer timeframe.

Diversification through specialization: redefining investment strategies

Another aspect I would like to investigate is a strategy I would call “diversification through specialization”. The logic is the following: we have seen previously that specializing in clean tech when investing in clean tech increases returns. However this has the adverse effect of reducing the diversification of the portfolio, which LPs tend not to like given their risk-return profile. So why not, while solely investing in clean tech, diversify the sub sectors we invest in and the stage at which we come in? I am curious to see how a portfolio investing in both early stage energy efficiency software companies (with early stage VC yields) and a stake in a wind power farm (yielding more infra-like secure returns) would perform and affect the numbers...
we saw in figure 26. By the way, this has been the strategy of the company that has deployed the most capital in the clean tech private equity space over the past 10 years according to Preqin. Hudson Clean Energy Partners invest exclusively in renewables, and “typically takes controlling positions in high-growth firms with minimal technology development risk” (Preqin, 2015). “The firm is currently managing the $1.2bn it raised through Hudson Clean Energy Partners Fund, which closed in 2009. The firm also has a separate infrastructure arm that raised a $150m solar photovoltaic (PV) power generation fund in 2013” (Preqin, 2015). It would be interesting what the returns are for companies following such strategies from a blended perspective.

More investment syndication
Another, more simple way to simply tackle the issue of high capital needs would be to really more on investment pooling, and fund syndication. But the first question that comes to mind – other than “Is it easy to bring all these players to talk around the same table, and will they accept to share profits?” – is the impact a broader investor base might have on performance for the company. Indeed, more investors also means more potential dis-alignment of interests and a slower decision process, which are all factors that tend to negatively affect a start up’s performance.

4.5.2. The opening of the exit market
Another trend I am curious in is the increasing interest non-energy companies have in buying clean tech start ups. For me, there are two main reasons I see in that trend: either they do so because they are concerned by their energy costs and how these might evolve in the future. A perfect example are data center companies, which are always looking for new ways to reuse the heat generated by their servers to counterbalance the massive amounts of electricity needed to operate their centers. Another potential explanation is that these companies are doing so for opportunistic reasons or because they see potential synergies with the target company. One of the examples in this case might be the acquisition in 2014 of Nest by Google, the thermostat and home energy management company.

In any case, this will hopefully lead to an opening in the M&A market, thus providing more exit opportunities for fund managers.

4.5.3 Alternative private equity investors
The other option we haven’t explored in this thesis (because it wasn’t within the scope of our research) were the alternative private capital sources the clean tech company could call upon to finance itself. There are many types of investors we haven’t considered: high net worth individuals, foundations, family offices, pension funds investing directly in companies, or maybe a combination of several? But this would probably make the deal structures more complicated, and we would need extensive research to assess the viability of this strategy, based on the goals and requirements of every investor type, and the alignments of these with the interest of the target company.
5. Conclusion

5.1. Is there an ideal target for VC/PE Clean Tech investing?

5.1.1. Low capital intensity and high technology risk

Is there such as thing as a perfect target company for a VC/PE investor in today’s market? One that would both maximize returns for investors and value creation for the company? Under the current market conditions and financing rationale broadly used by the industry, Ghosh and Nanda (2010) do suggest that such a sweet spot exits.

In their research paper, *Venture Capital Investment in the Clean Energy Sector* (2010), they classify clean tech companies along two main criteria, which are capital intensity and technology risk (see figure 34).

Figure 34: Sub-sectors within clean energy (Source: *Venture Capital Investment in the Clean Energy Sector*, HBS Working Paper 11-020, Ghosh, S., & Nanda, R., August 2010)

<table>
<thead>
<tr>
<th>High technology risk</th>
<th>Low technology risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High capital intensity</strong></td>
<td><strong>Low capital intensity</strong></td>
</tr>
<tr>
<td>Wind farms</td>
<td>First commercial plants for unproven solar cell technologies</td>
</tr>
<tr>
<td>Utility-scale solar</td>
<td>Advanced biofuel refineries</td>
</tr>
<tr>
<td>‘First-gen’ biofuel refineries</td>
<td>Offshore windfarms</td>
</tr>
<tr>
<td>Fabs for solar cells using established technologies</td>
<td>Carbon sequestration</td>
</tr>
<tr>
<td>Wind and solar components of proven technologies</td>
<td>Energy efficiency software</td>
</tr>
<tr>
<td>Internal combustion engines</td>
<td>Lighting</td>
</tr>
<tr>
<td>Insulation / Building materials</td>
<td>Electric drive trains</td>
</tr>
<tr>
<td>Energy efficiency services</td>
<td>Fuel cells / Power storage</td>
</tr>
<tr>
<td>Wind and solar components of unproven technologies</td>
<td></td>
</tr>
</tbody>
</table>

*The left side of the chart: low risk projects*

The box in the top left hand corner refers to the manufacturing and deployment of more mature energy production technologies. These types of projects are perfect candidates for debt financing, given the low technology risk, and the fact that the amounts considered would be highly dilutive to entrepreneurs anyway.

The box in the bottom left hand corner designates mostly the manufacturing of components for existing technologies used for energy production. However, such projects are often undertaken internally within larger companies. They are part of an incremental innovation process that the larger companies invest in to lower the cost of their other products.
The right side of the chart: enter venture capital
Projects located on the right side of the chart are typically too risky for debt financing, or for corporations to undertake them internally – outside of their R&D or corporate ventures department. This is when VC/PE backing comes into play.
At first VCs were backing projects at both end of the spectrum (top and bottom). However, there has been a clear shift towards the lower right hand corner of the chart.

We have found our sweet spot!
These projects have all the components to make VC/PE backing successful. The high-risk profile offers the possibility for high rewards and high returns. Moreover the type of products sold are closer to what the VC/PE sector traditionally invests in: energy efficiency software, component manufacturing. This way investors come in with some sort of references as to what tools to use to create value, and entrepreneurs can really benefit from their investors' experience.
Nonetheless, given the complexity of the energy industry as a whole, investors must still have a good understanding of the stakeholders and the trends inherent to the industry. They cannot just force fit frameworks used in any kind of industry. That's why I believe the entrepreneurs should still be looking for clean tech specialized VCs rather than generalist funds.
And the main questions remains how sweet is our sweet spot. Even if VC/PE focuses on that specific niche within clean tech, will it generate higher returns than other investment options such as high tech or biotech?

5.1.2. More than an industry sweet spot, the importance of the geo-economic and geo-politic context
We have alluded earlier to certain external factors, which impacted the amount of investment going towards clean tech, most notably oil & gas prices. I believe we can push that analysis even further and define a series of scenarios that, if they occurred in the future, could positively or negatively stimulate VC/PE investment in clean tech.

The level of oil & gas prices
As mentioned previously clean tech investment will follow closely the variation in oil and gas prices. The higher the gas prices will go, the more clean tech will attract investments, including from VC/PE, which will see an opportunity for higher exit valuations. Unfortunately, in the current context of extremely low oil prices, perspectives still seem pretty bleak for clean tech investing.

The motivation for public policy
We also mentioned the importance public institutions will have to play in setting policies to incentivize investments in the clean tech industry. However I believe that the motivations for these policies can be two-fold. On one end of the spectrum they can be purely political, and motivated by the desire to satisfy the public opinion. I believe that public policies instituted for such reasons will have limited impact in the medium to long run, because they are too dependent on political cycles and do not address a clearly defined need. On the other hand of the spectrum, I see economic motives, which in my sense will have a much more durable impact. Indeed, if these public policies are applied because of the potential economic benefit they might induce, – energy savings, job creations, increased output – I believe their legitimacy will become much more apparent.
Another way to see this issue of the effectiveness of public policies is to consider whether they are the result of “grassroots movements” vs. imposed in a top down approach by
governments and public institutions. Obviously, it will be a mix of both. However I believe that the impact of these public policies will be much greater if they are pushed by civil society and the business community, following the bottom approach I just mentioned. This will be a sign that sustainability – and to a larger extent clean tech and renewable energies – will have reached the level of “social legitimacy” we mentioned earlier necessary to attract VC/PE capital.

We also mentioned the geographical nature of clean tech VC/PE. Going back to that aspect, I believe that this industry will grow faster in countries – or regions in the case of the European Union – where the civil society and the business community implement public policies as a result of economic motivations supported.

*The security of energy supply*

Finally, I am convinced that the strategic dimension of the security of energy supply will become a determining factor to stimulate clean tech VC/PE investments. This is also tied to the geographical nature of the energy industry. Countries that are highly dependent or imports for their energy supply will dedicate much more importance in finding sustainable energy sources. This trend can already be hinted by the superior amount of capital invested in clean tech in Europe compared to North America since the shale gas revolution, where most of the capital went back to oil and gas investments. That is why I am convinced that we will see private capital clean tech investing ramp up much faster in regions of the world with very low access to hydrocarbons.

To conclude, even if we were able to identify a sub sector sweet spot for VC/PE investments in clean tech (figure 34), I also believe that context is critical. We highlighted importance of geo-economic and geopolitical factors – influence of oil prices and energy supply. And we showed how these conditions needed to be analyzed on a country per country basis, given the impact of public policies. So I am sure that the take off clean tech VC/PE investing will be seen in locations where all three criteria are met, which will require a combination of timing and geographical location. I represented this new sweet spot in figure 35 below.
5.2. Key takeaways

I am convinced that the clean tech industry can be attractive to both venture capital and private equity. As a VC/PE investor here are the 3 main takeaways I would absolutely have in mind when identifying targets:

1. As a venture capital investor: target companies that focus on the demand side rather than on energy production. Such companies are less dependent on technology risk, and are less capital intensive. They also generate more “quick wins”, given their shorter adoption cycle. There are several examples of clean tech firms that follow this strategy, such as Nest or Enernoc.

2. For private equity investors, mature energy supply side assets present significant opportunities. We are beginning to see the emergence of large renewable energy producing companies in solar and biofuels. Such companies have not yet gone through major restructuring. There are numerous poorly managed assets, with opportunities for operational improvements and cost reduction. This is ideal for large buyout firms, which can identify the so-called “low hanging fruit” for primary LBOs and thus generate substantial returns for investors.

3. Finally, I would recommend VC and PE investors alike to leave the very high technology risk companies to corporates, such as utilities or oil and gas companies. These companies’ investment life cycle are much more adapted (closer to R&D projects). Moreover, as they allocate strategic value to gaining access to IP, their return requirements are lower than those of financial firms, which makes such early stage firms all the more attractive.
5.3. Emergence of new trends and expectations for the future

As I said, there are many dawning trends developing in the clean tech VC/PE space: the shift of sector focus within the clean tech industry, the emergence of certain mega funds with a broader investment strategy, etc. I am very eager to the impact these trends will have for the clean tech investing market. I also hope these trends will spawn more academic research that will help the investment community better understand the challenges and specificities at stake in clean tech.

Some of the trends I will be following most closely are:

- The emergence of new financing schemes – more syndication, more partnerships with corporate venture funds. Hopefully this will allow to both increase capital commitments and lengthen the overall investment periods.
- I am curious to see the role mega players of the clean tech industry (Tesla, SunPower) will play in the years to come, and if the clean tech industry will transition to a model similar to the ones adopted for several years now by large pharma companies and biotechs.
- Will we be able to correctly value the price of “going green”, and will this concept impact valuation in the VC/PE sphere?
- Finally, I wonder what the impact of the current low oil prices will have on clean tech investment.

To conclude, we have shown that VC/PE has had a great impact on the clean tech industry since its take off in the 2000’s. I am deeply convinced VC/PE still has a great role to play in the development of the clean tech industry, and that its implications will have an impact not only on the energy industry, but for the world economy as a whole. And it is my goal to be a part of this change.
References


Hoffman, D. M. & Huisman, R. (2012). Energy Policy, Did the financial crisis lead to changes in private equity investor preferences regarding renewable energy and climate policies?


Bürer, M.J. (2008). *Public Policy and Clean Energy Private Equity Investment, DISSERTATION of the University of St. Gallen, Graduate School of Business Administration, Economics, Law and Social Sciences (HSG) to obtain the title of Doctor Oeconomiae.*
