CATÓLICA LISBON SCHOOL OF BUSINESS & ECONOMICS

Can Atmospheric Water Generation be strategic to companies according to the Natural Resource Based View approach?

MSc in Business Administration – Master Dissertation

Author: Joana Vasques da Silva Plácido

Advisor: Professor Paulo Cardoso Amaral

May, 2011

Dissertation submitted in partial fulfillment of requirements for the degree of MSc in Business Administration, at the Universidade Católica Portuguesa, date 2011

Abstract

Title: Can Atmospheric Water Generation be strategic to companies according to the Natural Resource Based View approach?

Author: Joana Vasques da Silva Plácido

This work aims to explore if the use of AWG technology, an environmental technology, can be strategic or not to companies based on the Natural Resource Based View of the Firm theory (Hart, 1995). The work develops a theoretical analysis complemented with two examples that illustrate the theoretical conclusions. The analysis is performed through theoretical demonstrations based on a set of strategic frameworks, theories and concepts: the Natural Resource Based View (Hart, 1995) due to its relation with the natural environment; Contingent Resource Based View *of the natural environment* (Aragón Correa & Sharma, 2003) as it is related with the previous theory also providing important conclusions about dynamic capabilities (Teece et al., 1997); and dynamic capabilities (Teece et al., 1997) themselves, due to their strategic relevance in a changing environment – an assumption of the present work. The theoretical analysis concludes that the use of this environmental technology can provide companies with sustainable competitive advantages (lower costs, competitor's preemption and future position in developing markets) and can also work as a dynamic capability (Teece et al., 1997). To demonstrate how the use of AWG technology can be a dynamic capability to companies, the two illustrative examples are developed, regarding a Brewery and a Pharmaceutical Company; with these examples it is possible to illustrate the theoretical conclusions, demonstrating how the use of AWG technology can be strategic to both companies (as a factor of adaptation) and under which conditions and assumptions is that possible. The work ends up concluding that the use of AWG technology can in fact be strategic to companies, based on the Natural Resource Based View, under a set of assumptions and established conditions: the environment should be tacit and changing (characterized by changes in environmental regulations, growing "green" markets, increasing fresh water scarcity scenarios, unsustainable economic activity growth and by the increasing growth of developing markets, *"markets of the future"*) and companies should be water intensive and should envision to enter and invest in developing countries.

Resumo

Título: Can Atmospheric Water Generation be strategic to companies according to the Natural Resource Based View approach?

Autor: Joana Vasques da Silva Plácido

A presente dissertação pretende explorar se o uso da tecnologia AWG, uma tecnologia ambiental, pode ou não ser estratégico para as empresas, segundo a teoria *Natural Resource Based View* (Hart, 1995). A dissertação desenvolve uma análise teórica complementada por dois exemplos que pretendem ilustrar as conclusões teóricas retiradas. A análise é realizada através de demonstrações teóricas baseadas num conjunto de teorias e conceitos estratégicos: a teoria *Natural Resource Based View* (Hart, 1995) devido à sua relação com o ambiente natural; a teoria *Contingent Resource Based View of the natural environment* (Aragón Correa & Sharma, 2003), por estar relacionada com a teoria anterior e por proporcionar conclusões importantes acerca de *dynamic capabilities* (Teece et al., 1997); e *dynamic capabilities* (Teece et al., 1997) em si, pela relevância estratégica que têm num ambiente em mudança – um pressuposto da presente dissertação. A análise teórica conclui que o uso desta tecnologia ambiental pode criar vantagens competitivas sustentáveis nas empresas (baixos custos, antecipação da concorrência e posição futura nos mercados em vias de desenvolvimento) e funcionar como um factor de adaptação ao mercado em mudança (Teece et al., 1997). Para demonstrar como o uso da tecnologia AWG pode ser um factor de adaptação, são desenvolvidos dois exemplos respeitantes a uma empresa de cervejas e a uma empresa farmacêutica; com o desenvolvimento destes dois exemplos é possível ilustrar as conclusões teóricas retiradas, demonstrando como o uso da tecnologia AWG pode ser estratégico para ambas as empresas (como factor de adaptação) e sob que condições e pressupostos tal é possível. A dissertação acaba ao concluir que o uso da tecnologia AWG pode, de facto, ser estratégico para as empresas, segundo a *Natural Resource Based View*, sob condições e pressupostos estabelecidos: o ambiente deve ser tácito e estar em mudança (caracterizado por mudanças em regulações ambientais, pelo crescimento dos mercados "green", pelo aumento de cenários de escassez de água doce, por um crescimento da actividade económica insustentável e pelo crescimento dos países em vias de desenvolvimento) e as empresas devem depender fortemente de recursos hídricos (água fresca) e visionar entrar e investir nos países em vias de desenvolvimento.

Acknowledgements

I would like to thank those that contributed and helped me developing this work.

Firstly, I would like to thank my father who made me aware of this new technology, as well as, its advantages and potential, which allowed me to choose a theme and develop this Dissertation.

I would also like to thank very much to my Master Dissertation Advisor, Professor Paulo Cardoso Amaral, who gave me an incredible support and motivation during the whole semester. The support and motivation given, along with constructive critics, allowed me to learn and go further in my Master Dissertation. Therefore, I would like to thank Professor Paulo Cardoso Amaral for his dedication and availability that were crucial in the development of my work.

Finally, I would also like to thank my family and friends for the support given during the semester, as well as, my Master colleagues with who I could discuss and share problems, doubts and most of all knowledge.

Table of Contents

1. Introduction:

To achieve an ecological sustainable global economy it is necessary to align businesses and industries with ecological principles, which may imply transformation of companies' products, production systems and management practices (Shrivastava, 1995). In the long run improvements towards ecology will change, among other things, competitive landscape, consumer behavior, industrial regulations and competitive opportunities (Shrivastava, 1995).

This work aims to explore how Atmospheric water generation technology, an environmental friend technology, can be strategic to companies. It is important to address this question when it is known that companies have a major role in achieving ecological sustainability (Shrivastava, 1995) and they can also benefit from it gaining some competitive advantages (Hart, 1995). Atmospheric water generation is an environmental friend technology that extracts water from air and converts it to pure and clean drinking water[1]. Moreover, the atmospheric water generators also cleanse the air as they produce water by using air filters, which removes almost all airborne particles[2]. This technology protects water sources and allows providing water in remote locations, plus, atmospheric water generation allows a huge reduction in costs, not only the water supply costs but also costs of treatment, transportation, storage, etc[3]. This work thus links three base concepts: sustainability, ecology and technology, aligning them with companies' strategies and decisions, as it addresses how companies can benefit strategically from an ecological friend technology and at the same time contributing to an ecological sustainable global economy. Next it is presented some main arguments that make the study of this theme relevant.

Industrial development has brought wealth and prosperity to the world; however, it has been also leading to ecological issues that are responsible for some major problems faced by Earth in the present days, for instance, global warming, ozone depletion, deforestation, industrial accidents, toxic wastes, among others (Brown & the staff of the Worldwatch Institute, 1991, 1992, 1993; Pryde, 1991; Smil, 1994) cited by Paul Shrivastava (Shrivastava, 1995). "*A better balance between economic and ecologic variables is desirable and the time frame to achieve it is the next three decades*" (Gore, 1992) cited by Paul Shrivastava (Shrivastava, 1995), so the present times are the epicenter of this major challenge, which highlights the pertinence of this article.

[1] Source: www.air2water.net; www.airqua.com; www.watermicron.com; www.airtowater.com.au; www.awginternational.com; www.ecoloblue.com; www.planetswater.com
[2] Source: www.air2water.net; www.airqua.com; www.watermicron.com; www.airtowater.com.au; www.awginternational.com; www.ecoloblue.com; www.planetswater.com
[3] Source: www.air2water.net; www.airqua.com; www.watermicron.com; www.airtowater.com.au; www.awginternational.com; www.ecoloblue.com; www.planetswater.com

The increasing population and economic growth have been leading to a growing stress on the availability of fresh water which is enhanced by the effect of climate changes (Hofman et al., 2011). In the more arid regions of the world water scarcity has become a major problem (Seckler et al., 1999). A study by the International Water Management Institute (IWMI) (Seckler et al., 1998) cited by David Seckler (Seckler et al., 1999) estimates that by the first quarter of the 21st century near one quarter of the world's population will experience severe water scarcity. This reality makes water a crucial theme of study nowadays, therefore, Atmospheric water generation seems an important environmental friend technology to be addressed as it can diminish some of these negative trends and contribute strongly to water sources protection. Besides the importance of addressing a water related theme, the study of the strategic impact of AWG technology in companies is also important when is known that by the middle of the 21st century nearly 40% of the world economic production will come from products and technologies strongly related with environmental and energy issues (Japanese Government - Ministry of International Trade and Industry – MITI) cited by Paul Shrivastava (Shrivastava, 1995). Therefore, choice of technologies is one strategic variable that strongly change *"environmental impacts, risks and costs of companies"* (Kotha and Orne, 1989) cited by Paul Shrivastava (Shrivastava, 1995).

Companies have a crucial role on economic development as they have *"financial resources, technological knowledge and institutional capacities"* that allow them to implement *"ecological solutions"* (Schmidheiny, 1992; Welford & Gouldson, 1993) cited by Paul Shrivastava (Shrivastava, 1995). Moreover, companies can also benefit from ecological sustainability, so it is pertinent to analyze it on a corporation context (Stead & Stead, 1992) cited by Paul Shrivastava (Shrivastava, 1995). Environmental technologies, for instance, have important impacts on strategic management at an industry and individual firm level affecting many strategic variables (Shrivastava, 1995). Therefore, it is relevant to study the impact of AWG technology on companies exploring how companies can benefit from it strategically and at the same time contributing to a sustainable development.

The Research question that this work investigates is the following:

> **Can Atmospheric Water Generation be strategic to companies according to the Natural resource based view approach?**

In order to assess the research question it is adopted a methodology that proceeds as follows. First, is directly applied a strategic framework that takes in account constrains imposed by the natural environment – Natural Resource based view (Hart, 1995). This framework assesses at which extent the technology in use can contribute to competitive advantages to companies. Moreover, Natural resource based view allows to conclude if these competitive advantages are

sustainable or not, according to this theory, if the resources and capabilities, behind the competitive advantage, are valuable and no substitutable being also tacit, social complex and rare, and if they are along with social legitimacy, they lead to a sustained competitive advantage. The growing trend of high dependence between business and natural environment (Hart, 1995), as well as, the relevance of Resource Based View (Wernerfelt, 1984; Barney, 1986) as a strategic framework makes Natural Resource Based View one pertinent approach to assess the research question.

Following with some insights of Natural Resource Based View, it is assessed if the utilization of AWG units is along with path dependency, in order to explore at which extent the utilization of this technology can represent or develop dynamic capabilities (Teece et al., 1997) in companies. If the utilization of this technology allows developing tacit, complex and rare capabilities, if it has social legitimacy and if it is along with the path dependence defended by Natural Resource Based View (Hart, 1995), there are strong evidences that this utilization can be translated in a dynamic capability, as it has the main characteristics that define a dynamic capability (Teece et al., 1997), (Eisenhardt & Martin, 2000) cited by J. Alberto Aragón Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003). With some conclusions of the *Contingent Resource Based View* of the natural environment[4] (Aragón-Correa & Sharma, 2003) it is possible to demonstrate that AWG technology implies dynamic capabilities – helping to answer the research question; according to this theory, a proactive environmental strategy is a dynamic capability, thus it is needed to prove that the utilization of AWG leads to a proactive environmental strategy. After concluding, theoretically, the strategic impact of AWG, it is demonstrated specifically, through some illustrative examples, how the use of this technology can be a factor of adaptation along the value chain in continuous changing environments, having the ability to achieve new forms of competitive advantages (Teece et al., 1997). The impact on value chain will be assessed by a VITO elements approach (Shrivastava, 1995; Katz & Kahn, 1968; Churchman, 1963) cited by Paul Shrivastava (Shrivastava, 1995), that takes in account: Vision, Inputs, Throughputs and Outputs. By demonstrating, through examples, the strategic impact of AWG on value chain, as a factor of adaptation, the research question is finally answered.

The work follows with a literature review related to the theme which explores the water problematic in nowadays world and AWG characteristics; briefly reviews the concept of environmental technology (Shrivastava, 1995) and VITO elements approach (Shrivastava, 1995; Katz & Kahn, 1968; Churchman, 1963) cited by Paul Shrivastava (Shrivastava, 1995); and finally reviews Natural resource based view and Contingent Resource Based View of the natural

[4] The original name of the theory developed by J. Alberto Aragón Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003) is "*A Contingent RBV of Proactive Corporate Environmental Strategy"*. However in the article the authors also refer to this theory as "*Contingent Resource Based View of the natural environmen*t" - this will be the named used throughout the present work.

environment; some concepts as dynamic capabilities and knowledge management are also addressed. The literature review gives bases to a proper discussion and the establishment of intermediate conclusions about the strategic role of AWG technology. The work ends answering the research question, establishing some pertinent conclusions and proposing some future research.

2. State of Art:

As referred previously, this chapter presents the state of art, a brief literature review, which allows understanding better some major themes implied in the discussion of the research question.

It starts with an explanation about water resources, the threat of water scarcity that Earth is facing and major consequences and problems related. After approaching this major issue, it is presented the technology in study – Atmospheric water generation[5] – its main characteristics and applications, how it works, and the vast advantages that governments, companies and individuals can have by using it. Then, it starts a more theoretical part, in which is addressed generally the concept of environmental technologies (Shrivastava, 1995), their role in sustainability and how they can be strategic to companies that can benefit a lot from them, contributing, simultaneously to a sustainable development (Shrivastava, 1995). In this section of the state of art, is also addressed the VITO elements analysis (Churchman, 1963; Katz & Kahn, 1968; Shrivastava, 1995) cited by Paul Shrivastava (Shrivastava, 1995), as it is part of the study of environmental technologies' impact on companies.

Then, a brief summary of Natural Resource Based View (Hart, 1995) is done, it is explained the conceptual framework, as well as, the conclusions and implications of this framework, that differentiate itself by including the natural environment in the Resource based view framework. Still related with Natural resource based view and also with contingency theory (Burns & Stalker, 1961; Lawrence & Lorsch, 1967) cited by J. Alberto Aragón-Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003), it is presented the Contingent resource based view of the natural environment (Aragón-Correa & Sharma, 2003) which provides important conclusions about proactive environmental strategies and dynamic capabilities (Teece et al., 1997). Thus, then it is done a summary about dynamic capabilities and their importance in constant changing environments (Teece et al., 1997), plus, it is addressed the concept of knowledge and its relation with dynamic capabilities, as well as, the importance of exploitation and exploration – learning activities – on companies' adaptation and performance (He & Wong, 2004).

Finally, and to highlight the importance of dynamic capabilities, it is presented some facts and information that shows constant and actual changes on environment, for instance, regulations' changes, the increase of green markets and changes in consumers' pattern of choices, technology evolvement, climatic changes, among others.

[5] Source: www.air2water.net; www.airqua.com; www.watermicron.com; www.airtowater.com.au; www.awginternational.com; www.ecoloblue.com; www.planetswater.com

2.1. Water resources - the problematic of water scarcity

Because the technology in study, Atmospheric water generation, is a water related technology, that allows to make clean drinking water from the air, protecting water resources[6], it make sense to analyze the actual state of water resources, as well as, major issues related, such as, water scarcity problematic.

"During the 20th century the global human population increased fourfold to more than 6 billion, while, withdraw from natural freshwater ecosystems increased eightfold during the same period" (Gleick, 1998) cited by Brian D. Richter (Richter et al., 2003). As global population increase the possibility of *"severe water supply shortages"* in many areas of the globe increase too, therefore, social planners and governments are exploring strategies for managing water resources in a sustainable way (IUCN 2000) cited by Brian D. Richter (Richter et al., 2003).

By 2025 slightly more than 1 billion people will suffer absolute water scarcity and other 348 million people will live in a scenario of severe water scarcity (Seckler, 1999). In the sever water scarcity scenario the efforts made by people to meet basic needs will demand high levels of financial and other resources, which may not be affordable as these people belong mainly to developing countries (Seckler, 1999). Water scarcity will have a special negative impact on poor people as it leads to a decrease of water quality and consecutively to an increase of diseases, plus, it has a huge negative impact on food's production that depend strongly upon water sources (Seckler, 1999).

Another major problem regarding water sources management is the groundwater depletion (Seckler, 1999). Some of the most populated and developing countries of the world (India, China, Middle East countries, etc) have been using groundwater resources in an incontrollable way during the pasts two decades, which has been leading to the depletion of these sources (Seckler, 1999). The negative consequences from this abuse are catastrophic for these countries, as well as, for the whole world as these countries represent a large "slice of the pie" (Seckler, 1999). These negative consequences are basically the rapid decrease of fresh water aquifers and the increase of saline and solid water, as well as, other toxic components that increase the pollution of these aquifers. The problem of groundwater depletion threats food security in the 21st century (Seckler, 1999).

The growing population and the increase use of substances such as medicines and pesticides, as well as, the rising of global temperatures – which increase the growth of micro organisms in

[6] Source: www.air2water.net; www.airqua.com; www.watermicron.com; www.airtowater.com.au; www.awginternational.com; www.ecoloblue.com; www.planetswater.com

water resources, decreasing the water quality in general – leads to stricter demands for purification techniques (Hofman et al., 2011). These techniques are getting more complicated and some of them, for instance, membrane technology (Fritzmann & Löwenberg, 2007) cited by Jan Hofman (Hofman et al., 2011) often have high energy consumption levels and if applied can almost double the energy demanded (Hofman et al., 2011).

The major goal for ecologically sustainable water management is to develop a program that assures water for human purposes and simultaneously not affecting the ecosystem's needs (Richter et al., 2003). This goal will just be achieved when *"humans accept that there are limits to water use"*, these limits *"are defined by the ecosystems' requirements for water"*; it is necessary to find an equilibrium between human water demands and ecosystem requirements to achieve human and ecosystem sustainability (Richter et al., 2003).

The water scarcity problematic that Earth faces in the present century and the urgency in find a balance between human demands and ecosystems requirements to achieve sustainability enhance the potential and strategic value that AWG technology – an environmental friendly technology, that makes water from the air, protecting water resources – may have in the present century. Therefore, by taking in account this scenario, it can be answered more properly and realistically to the research question.

2.2. Atmospheric water generation technology - AWG technology

Atmospheric water generation is a technology that extracts clean and pure drinking water from the air on a simple and reliable way[7]. There are over 12900 cubic kilometers of water in our atmosphere; this amount remains approximately constant due to the hydrologic cycle that ensures continuous evaporation, condensation and precipitation of water (Graham, Parkinson & Chahine, 2000 – NASA official site). Therefore there is a never ending continuous supply of fresh water that is available and accessible almost everywhere in the world, helping to fulfill the growing demand for water on a sustainable way[8].

[7] Source: www.air2water.net; www.airqua.com; www.watermicron.com; www.airtowater.com.au; www.awginternational.com; www.ecoloblue.com; www.planetswater.com

[8] Source: www.air2water.net; www.airqua.com; www.watermicron.com; www.airtowater.com.au; www.awginternational.com; www.ecoloblue.com; www.planetswater.com

Next, it is presented the major characteristics, applications and benefits of Atmospheric water generation technology; all this information is based on official sites of companies that produce or sell AWG units[9], due to the lack of scientific articles about this technology.

Atmospheric Water Generators are a great technological breakthrough; in order to converts moisture in the air into pure water without contaminates, bacteria or other micro organisms, Atmospheric water generators use some of the most advanced drinking water purification and water filtration systems in the world[10]. UV light, Ozone water purification techniques, multi-step carbon water filtration systems, among other advanced technologies allow AWG units to produce 99% to 100% pure drinking water[11]. Moreover, the air is also purified during this process as AWG systems pre-filter and pre-cleans the air in order to eliminate dust, pollen, bacteria, and other airborne particulates and only after, the water is thoroughly filtered and purified without using any chemicals; thus AWG units can also include air conditioning capabilities as this technology has capabilities to cool, filter, purify, and dehumidify air[12]. This process results in water free of chemicals, ground water contaminations, industrial, human and animal wastes[13].

During the whole process of making clean drinking water from the air, any type of chemicals are used, contrary to some processes used in the treatment of water that comes from a tap, lake, river, ocean, etc[14]. Also contrary to some other water filtration systems, AWG technology does not require an existing incoming source of available water, it just depends on water in the air – which is abundant and constant as referred before - this is an enormous advantage in case of an emergency where all water sources have to be interrupted[15].

Atmospheric water generation is an environmentally friendly alternative and is suitable for innumerous situations[16]. The AWG units exist in different kinds of models, with different structures, sizes and capacities, designed specifically to a certain purpose, for instance, to home and office or light Industrial and commercial[17]. Besides this, hotels and clubs, health clinics and hospitals, schools, government and military services, remote and arid locations, as well as,

[9] Source: www.air2water.net; www.airqua.com; www.watermicron.com; www.airtowater.com.au; www.awginternational.com; www.ecoloblue.com; www.planetswater.com
[10] Source: www.air2water.net; www.airqua.com; www.watermicron.com; www.airtowater.com.au; www.awginternational.com; www.ecoloblue.com; www.planetswater.com
[11] Source: www.air2water.net; www.ecoloblue.com; www.awginternational.com
[12] Source: www.awginternational.com; www.air2water.net; www.ecoloblue.com; www.planetswater.com
[13] Source: www.airqua.com; www.awginternational.com
[14] Source: www.airqua.com
[15] Source: www.awginternational.com; www.airtowater.com.au; www.watermicron.com; http://www.airqua.com
[16] Source: www.airqua.com; www.air2water.net; www.watermicron.com; www.awginternational.com; www.planetswater.com
[17] Source: www.airqua.com; www.air2water.net; www.watermicron.com; www.awginternational.com

humanitarian aid and emergency cases, are some applications examples that can benefit a lot with AWG units[18].

By avoiding traditional treatment processes and transport of water, AWG units allow a reduction on pollution, it also protects water sources – oceans, lakes, rivers, etc – as it use water from the air[19]. Besides this, this technology avoids storage costs[20]. Although there are additional costs as machine depreciation and filter replacements, AWG units allow reducing costs as these machines are energy and cost efficient; according to some sites, referred before as sources, in industrial models AWG units can achieve a consumption reduction of 20% to 30%[21]. Notice that AWG units are very easy to install as they do not depend upon pipes, and water systems lines, and it has low maintenance because they have few moving parts and do not require any kind of lubricants – thus there are low maintenance and installing costs.[22]

Most of these machines work through electricity, however, according to some official sites of companies producing and selling AWG units, *"the cost of water production is usually a factor of 1.3 times the cost of a kWh of electricity"*[23]. Also according to these sites, the cost of producing clean drinking water, in a home and office model machine, is around USD 0.04 to USD 0.13 per liter (cheaper than water delivery systems or bottled water), in the industrial models the cost per liter is even more low; the model itself, as well as, local electricity rates make this value varies within a range[24].

Note that this dependency of electricity can be altered as these machines can work with more environmental sources as natural gas, plus, future developments can allow AWG units to work through solar (which already exists) or wind energy, as well as other renewable and clean energies, becoming a totally green technology[25].

When compared with bottled water or water delivery systems, atmospheric water generation is less costly, more convenient and pure, and leads to a smaller carbon footprint[26]. Atmospheric water generation units can provide companies and other organisms with many advantages, some of them referred previously: it saves production costs as it its energy and cost efficient reducing the cost of water; it saves fossil fuels and protects environment, as it avoid plastic bottles; it maintains water quality due to efficient filtration and purification systems; it also save water as it avoids water wastes compared with other filtration systems; it also save electricity as it has

[18] Source: www.airqua.com; www.air2water.net; www.watermicron.com; www.awginternational.com
[19] Source: www.ecoloblue.com; www.awginternational.com; www.planetswater.com
[20] Source: www.airqua.com
[21] Source: www.ecoloblue.com
[22] www.airtowater.com.au; www.awginternational.com
[23] Source: www.air2water.net
[24] Source: www.air2water.net; www.ecoloblue.com
[25] Source: www.planetswater.com; www.airtowater.com.au
[26] Source: www.ecoloblue.com

efficient levels of consumption comparing with other filtration systems; reduce financial risk as it eliminates uncertainty regarding water supply; it also reduce health risk as the water presents almost 100% of purity levels; it also has low installation and maintaining cost; AWG units have a huge variety of models compatible with different kinds of water requirements, house and office models are small with a compact size, and industrial ones are scalable, meaning that they can be installed sequentially to fulfill huge levels of water requirements[27].

As referred previously, this environmentally friend technology can provide companies, governments, individuals and other organism with many different advantages, reducing the carbon footprint and contributing to a more ecological and sustainable development, moreover, AWG technology helps to overcome one of the major problems that Earth will face in the present century, water scarcity.

Because AWG technology is an environmental friendly technology and seems to have the characteristics of an environmental technology, it is important to analyze environmental technologies and their strategic impact on companies, helping to answer later to the research question.

2.3. Environmental technologies' strategic impact, based on a VITO elements analysis

Theoretically, environmental technologies are *"Production equipment, methods and procedures, product designs, and product delivery mechanisms that conserve energy and natural resources, minimize environmental load of human activity and protect the natural environment"* (Shrivastava, 1995). Environmental technologies are not only a set of techniques that allow to decrease pollution, to manage waste, to conserve water, energy and materials and to improve production's technological efficiency; but also a management orientation in which companies follow environmental responsible approaches towards products, production processes, industrial systems, technological choices and management in general (Shrivastava, 1995).

The choice of technologies represents an important strategic variable to companies (Kotha and Orne, 1989) cited by Paul Shrivastava (Shrivastava, 1995); environmental technologies, specifically, are potential strategic resources to companies as their utilization affect the value chain in multiple points, allowing companies to remain competitive (Shrivastava, 1995). The assessment of environmental technologies' impact on value chain and on the overall strategic management of companies was done through an interception of: the themes that, according to

[27] Source: www.air2water.net; www.airqua.com; www.watermicron.com; www.airtowater.com.au; www.awginternational.com; www.ecoloblue.com; www.planetswater.com

Paul Shrivastava, are incorporated and characterize environmental technologies (design for disassembly, manufacturing for the environment, TQEM - total quality environmental management, industrial ecosystems and technology assessment); with the VITO organizational elements (Vision, inputs, throughputs and outputs) (Churchman, 1963; Katz & Kahn, 1968) cited by Paul Shrivastava (Shrivastava, 1995) and (Shrivastava, 1995); and with the outside environment (regulatory, technological, commercial, economic, social, political and cultural).

The VITO elements is an adaptation of the systems view approach in which companies are represented by inputs, throughputs and outputs systems in interaction with the surrounding environment (Churchman, 1963; Katz & Kahn, 1968) cited by Paul Shrivastava (Shrivastava, 1995). The addition of Vision, to the systems view approach, tries to incorporate the values and goals of companies that strongly influence strategic management (Shrivastava, 1995). This VITO elements can be roughly compared with inbound logistics, operations and outbound logistics that composed Porter's Value chain (Porter, 1985) cited by Paul Shrivastava (Shrivastava, 1995).

Actually, VITO elements reveal an interesting approach when addressing corporations and ecological sustainable environments. Notice that, according to Paul Shrivastava, *"corporations are groups of individuals trying to achieve their visions, through systems of inputs, throughputs and outputs"*, moreover, all these elements are interconnected and strongly linked to the environment (Shrivastava, 1995). The vision represent company relation with the environment as a whole; input system use natural resources and energy, that may turn them even more scarce; throughput system expel to the environment wastes and emissions; output system include products and wastes that may cause different kinds of pollution and negative health effects (Bates, 1994; Bucholz, 1993; Smith, 1991) cited by Paul Shrivastava (Shrivastava, 1995).

The study of environmental technologies ends with the advantages of integrate these ones in strategic management, which are the following: cost reduction – by improving ecological efficiencies, operational costs can be strongly reduced; revenue enhancement – possibility of entering in new "green" markets, develop new products and attracting new customers; strong supplier ties – the development of new products and processes with different specifications implies influence suppliers, enhancing flexibility and fit; quality improvement – related with the total quality environment management, imposing high quality standards at all levels; competitive edge – related with cost reduction and revenue enhancement, as well as, with the potential of creating unique and inimitable environmentally based strategies; reduction of liabilities – keep companies aware of environmental risk such as fluctuation on energy costs, resource depletion, etc. avoiding to incur on unexpected costs; social and health benefits to ecosystems and communities; public image – enhancing public relations and corporate image, gaining social legitimacy; being ahead of regulatory curve –avoid some environmental and product liabilities that can arise from new regulations imposed (Shrivastava, 1995).

Corporations can benefit a lot from integrating environmental solutions in their routines as seen previously; however, it is also their duty to help achieving environmental sustainability, as organizational activities have been one of the major sources of nowadays environmental problems (Shrivastava, 1995).

In order to assess how companies can benefit strategically from environmentally sustainable solutions, it is reviewed, next, Natural resource based view (Hart, 1995) which defends that companies can achieve sustained competitive advantages through strategies based on a certain environmental driving force. This theory is the base to assess the strategic impact of AWG technology in companies.

2.4. Natural Resource Based View

The increasing growth of population puts in cause the *"ecological sustainability of current industrial and organizational practices"* (Ehrlich & Ehrlich, 1991) cited by Paul Shrivastava (Shrivastava, 1995). As economic activity needs to increase strongly to follow this population growth, providing enough amenities (MacNeill, 1989; Ruckelshaus, 1989) cited by Stuart L. Hart (Hart, 1995) the existing technologies and production methods will became unsustainable as they will worse environmental problems (Commoner, 1992; Meadows, Meadows & Randers, 1992; Schmidheiny, 1992) cited by Stuart L. Hart (Hart, 1995), (Daly and Cobb, 1989; Commoner, 1990) cited by Paul Shrivastava (Shrivastava, 1995). According to Stuart L. Hart (Hart, 1995), in the future, businesses will be constrained and will depend on ecosystems, to succeed companies will need to base their strategies and competitive advantages on capabilities that fit environmentally sustainable economic activity – Natural Resource Based View (Hart, 1995).

Natural Resource Based View is an adaptation of Resource Based View (Wernerfelt, 1984; Barney, 1986), as it includes constrains imposed by natural environment (Hart, 1995). The narrow concept of environment in management theory, that mainly focus political, economic, social and technological aspects (Shrivastava, 1994; Shrivastava & Hart, 1992; Stead & Stead, 1992) cited by Stuart L. Hart (Hart, 1995) is augmented with the addition of natural environment (Hart, 1995).

Natural resource based view presents three different interconnected strategies: pollution prevention, product stewardship and sustainable development; according to Stuart L. Hart, these three strategies are associated to specific key resources and sources of competitive advantages. This theory also defends that the key resources and capabilities associated to these three corporate strategies allow them to create a sustained competitive advantage (Hart, 1995).

Natural Resource Based View: Conceptual framework

Strategic capabilities	Environmental driving force	Key sources	Competitive advantage
Polution prevention	Minimze emissions, effluents & waste	Continuos improvement	Lower costs
Product stewardship	Minimize life cycle cost of products	Stakeholder integration	Preempt competitors
Sustainable development	Minimize environmental burden of firm growth and development	Shared vision	Future Position

Source: Hart, S.L., 1995. A Natural-Resource-Based View of the Firm, *The Academy of Management Review,* 20(4), pp. 986-1014

2.4.1. Pollution prevention strategy and related competitive advantage: *Low Costs*

Reduction on pollution can be achieved through pollution control and pollution prevention. Pollution control implies the treatment of effluents and emissions as well as the use of pollution control equipment; Pollution prevention implies the reduction of these effluents and emissions, as well as, other means of prevention such as *"better housekeeping, material substitution, recycling or process innovation"* (Cairncross, 1991; Frosh & Gallopoulos, 1989; Willi, 1994) cited by Stuart L. Hart (Hart 1995). While pollution control demands expensive pollution control equipments, pollution prevention occurs during the manufacturing process demanding high level of employees involvement an continuous improvements in reducing emissions; therefore *"end of pipe pollution control technologies"* appears as an expensive solution (Imai, 1986; Ishikawa & Lu, 1985; Roome, 1992) cited by Stuart L. Hart (Hart 1995).

Through pollution prevention, companies can save costs (Hart & Ahuja, 1994; Romm, 1994) and can also achieve higher levels of productivity and efficiency (Smart, 1992; Schmidheiny, 1992) all cited by Stuart L. Hart (Hart 1995). With pollution prevention is possible to make a better waste management which leads to a better utilization of inputs, reducing costs (Young, 1991); it also allows to reduce cycle times by turning production operations more efficient (Hammer & Champy, 1993; Stalk & Hout, 1990); it can also reduce liabilities costs as companies can keep the levels of emissions below the level imposed by regulation (Rooney, 1993), all cited by Stuart L. Hart (Hart 1995).

As pollution prevention strategy implies strong corporate environmental objectives and continuous improvement methodologies (Rooney, 1993), it requires a strong employee involvement, which allows to develop important tacit skills, therefore, it is considered a people

intensive strategy (Cole, 1991; Lawler, 1986), all cited by Stuart L. Hart (Hart 1995). This theory also defends that companies with good quality management processes can easily implement a pollution prevention strategy as they can easily accumulate these tacit resources (Hart 1995).

Pollution prevention implies tacit capabilities, hard to observe and imitate, that is crucial for a sustained competitive advantage (Hart 1995). However, to assess the sustainability of competitive advantages it is important to follow not only an internal approach (allowing to explore the nature of capabilities: tacit, social complex and rare) (Gray & Wood, 1992; Westley & Vedrenburg, 1991), but it is also required to analyze from an external perspective, meaning, competitive advantages *"must be created within a broader scope of social legitimacy"* (Bozeman, 1987; DiMaggio & Powell, 1983; Meyer & Rowan, 1977; Selznick, 1957) all cited by Stuart L. Hart (Hart 1995).

Communities and external stakeholder are increasingly demanding transparency on corporate practices (Bozeman, 1987; Freeman, 1984; Roberts & King, 1989) cited by Stuart L. Hart (Hart 1995); in order to maintain and build reputation, as well as, social legitimacy, companies should adopt this transparency policies, publishing their annual environmental reports, accomplishments in pollution prevention, as well as, other relevant information in which communities and stakeholder are interested in (Hart, 1995). Thus, results achieved by pollution prevention can become a benefic external activity, as it allows companies to be seen as more environmental responsible, enhancing their images (Hart, 1995).

Pollution prevention has an important internal characteristic of being tacit and it is seen as a source of social legitimacy, by enhancing transparency and companies image, therefore, according to Stuart L. Hart (Hart, 1995), Pollution prevention leads to a sustained competitive advantage – lower costs.

2.4.2. Product stewardship strategy and related competitive advantage: *Competitors Preemption*

The second strategic capability defended by Natural Resource Based View is Product stewardship. While pollution prevention is more related with reduction of emissions on production and operation processes, product stewardship tries to integrate external stakeholders' environmental perspectives into development processes and product design – since raw materials selection to the final product (Allenby, 1991; Fiksel, 1993) cited by Stuart L. Hart (Hart 1995).

Actually, over time programs of certifying products as environmental responsible are becoming more and more frequent; life cycle analysis (LCA) is a critical tool to this kind of programs, as it allows determining the environmental burden caused by a product (Abt associates, 1993; Davis, 1993; Keoleian & Menerey, 1993) cited by Stuart L. Hart (Hart 1995). In order to have products with low environmental costs it is necessary to decrease the use of nonrenewable energies, avoid the use of toxic materials and respect the rate of replenishment of renewable resources when used (Robert, 1995), moreover, these products should have specific designs and packages that easy reutilization and recycling (Kleiner, 1991; Shrivastava & Hart, In press) all cited by Stuart L. Hart (Hart 1995).

With product stewardship companies can avoid businesses with negative environmental impacts, can *"redesign existing product systems to reduce liabilities"*, and develop products with low environmental costs (low life cycle cost – LCA analysis) becoming more "green" (Hart, 1995). The earlier the more lucrative are sales of "green products" (Roper, 1992) cited by Stuart L. Hart (Hart, 1995), therefore, through competitive preemption, product stewardship can give companies exclusive access to crucial and limited resources – raw material, customer, facilities; and it allows to establish specific standards and rules that are along with companies' own capabilities –increasing barriers to other potential entrants; thus, through this competitive advantage of preempt competitors, product stewardship builds reputation and differentiates companies as early movers in new "green products" markets (Hart, 1995).

According to Stuart L. Hart (Hart 1995), product stewardship has a great impact on startup companies that do not have any existing products, processes and facilities (Hart, 1995), it can give these companies huge advantages on "green markets" through competitive preemption (Ghemawat, 1986; Lieberman & Montgomery, 1988; Hart, 1995) cited by Stuart L. Hart (Hart 1995).

Product stewardship implies the integration of LCA on companies' product and development processes (Keoleian, & Menerey, 1993); it also suggests that companies develop proactive and close ties with suppliers of raw materials and other components and together minimize environmental impacts on the whole supply system (Smart, 1992), plus, customers and environmental and marketing people are also crucial to develop adequate designs and packages turning these products less prejudicial to environment (Hunter & Auster, 1990; Post & Altman, 1991) all cited by Stuart L. Hart (Hart, 1995). Thus, companies require cross functional management skills (complex capabilities) to coordinate functional groups as design and manufacturing and also needs to integrate crucial stakeholders *"environmentalists, community leaders, the media, regulators"* into products' design and development decisions (Welford, 1993) cited by Stuart L. Hart (Hart 1995).

Product stewardship strategy implies the accumulation of social complex capabilities; plus, this strategy can became an external activity as it requires a huge level of stakeholders' integration that are essential to turn product stewardship accepted and credible – social legitimacy; therefore, according to Stuart L. Hart, product stewardship leads to a sustained competitive advantage – preempt competitors (Hart, 1995).

2.4.3. Sustainable development strategy and related competitive advantage: *Future Position*

The third strategic capability of Natural Resource Based View is Sustainable development. While pollution prevention and product stewardship *"weak the negative link between business and environment in developed countries markets"*, sustainable development allows to *"weak the link between economic activity and environment in developing countries markets"* (Hart, 1995).

It is known that 90% of population growth by the middle of 21st century will come from developing countries (Keyfitz, 1989) cited by Stuart L. Hart (Hart, 1995) implying huge economic activity growth which are not ecologically sustainable with the current technologies and production methodologies (Hart, 1995). Therefore, sustainable development has crucial implication mainly in large multinational corporations, as it allows minimizing the environmental burden of companies' growth and development (Hart, 1995).

Sustainable development implies that companies understand the *"link between material consumption in the North and environmental degradation in the South"* as most of products commercialized in the developed countries of the North required raw material and other sources from the developing countries of the South (Hart, 1995); also implies strategies that aim to reduce material and energy consumption (Shrivastava & Hart, In press; Welford, 1995) cited by Stuart L. Hart (Hart, 1995). Moreover, a sustainable development strategy should lead companies to develop and build markets on South and simultaneously reducing the environmental burden created by these developments (Gladwin, 1992; Hart, 1994; Jansen & Vergragt, 1992) cited by Stuart L. Hart (Hart, 1995).

Companies that aim *"to establish long term positions"* in the developing countries should not be focused on *"short term profits at the expense of the environment"* (Hart, 1995); to be successful on this growing markets, companies have to develop this ability of having a global vision, envisioning products and technologies that do not already exist, in order to distinguish themselves from the competitors (Hamel & Prahalad, 1991, 1994) cited by Stuart L. Hart (Hart, 1995). This vision provides companies with a crucial long term commitment to markets' developments, but it is also needed substantial investments, in low impact technologies and

products, to complement and thus achieve a successful sustainable developments strategy (Hart, 1995; Schmidheiny, 1992) cited by Stuart L. Hart (Hart, 1995).

This long term vision, *"shared vision"*, is crucial to create motivation for change and innovation within companies; it also leads to a *"strong moral leadership"* influencing companies' management (Hart, 1995; Bennis & Nanus, 1985; Selznick, 1957) cited by Stuart L. Hart (Hart, 1995). Actually, it is not easy to create such a *"shared vision"* within companies, as it involves achieving a strong consensus among people; it is also difficult to be totally focused on new technologies and future markets developments, thus, a sustainable development strategy leads to the accumulation of rare capabilities in companies (Hart, 1995; Fiegenbaum, Hart & Schendel, In press; Hammel & Prahalad, 1989) cited by Stuart L. Hart (Hart, 1995).

Moreover, sustainable developments strategies implies high levels of collaboration with private and public organizations, working with them they can together develop infrastructures and create proper conditions to great technological changes – technology cooperation (Hart, 1995; Schmidheiny, 1992) cited by Stuart L. Hart (Hart, 1995).

Over time, sustainable development become an external activity as it requires high level of collaboration (Hart, 1995), plus, it leads to the accumulation of rare capabilities as referred before, thus, according to Stuart L. Hart, sustainable development leads to a sustained competitive advantage – future position in the developing world, the *"markets of the future"* (Hart, 1995).

2.4.4. Path dependency and Embeddedness of Natural resource based view' strategies

Natural Resource Based View also demonstrates that these three strategies: Pollution prevention, product stewardship and sustainable development, are interconnected, meaning, these strategies follow a path dependency and on the other hand are embedded among themselves (Hart, 1995).

Path dependency suggests that is a sequential logic in the three strategies (Hart, 1995). Actually, without implementing a pollution prevention strategy, reducing emissions, it is difficult to develop a product stewardship strategy, as it is almost impossible to defend "green products" while the level of emissions of companies are high - stakeholders will note this incoherence and can destroy the reputation and credibility of companies (Hart, 1995). The same happens with sustainable development strategy; in order to develop a successful sustainable development strategy in the developing markets of South it is required to have already invested in pollution

prevention and product stewardship strategies in North, demonstrating competence and good reputation (Hart, 1995).

"Embeddedness" suggests that companies can take advantage on synergies if implement the three strategies at the same time (Hart, 1995). Actually, it make sense to think that one of the best ways to reduce pollution is through product stewardship, which implies a proper selection of raw materials, a proper design and packaging, reducing the environmental burden of the product; plus, cross functional coordination and stakeholder integration implied on product stewardship can help finding new ways of reduce emissions, and thus enhancing pollution prevention (Hart, 1995). Finally, sustainable developments and the shared vision and technological shifts associated can help achieving and focusing on pollution prevention and product stewardship, leveraging both strategies (Hart, 1995).

Therefore, *"embeddedness"* implies that product stewardship' capabilities facilitate pollution prevention and vice-versa; and that sustainable development' capabilities facilitate pollution prevention and product stewardship and vice-versa (Hart, 1995).

Natural resource based view (Hart, 1995) gives important insights and conclusions about some environmental related strategies and competitive advantages associated. Based on the previous theory, *Contingent resource based view* of natural environment (Aragón Correa & Sharma, 2003), also provides important strategic conclusion; one of them is showing that a proactive environmental strategy works as a dynamic capability. This conclusion is crucial to complement the answer of the research question.

2.5. A Contingent RBV of Proactive Corporate Environmental Strategy - Contingent Resource Based View of the natural environment

Based on Natural Resource Based View (Hart, 1995) and on Contingency Theory (Burns & Stalker, 1961; Lawrence & Lorsch, 1967) cited by J. Alberto Aragón-Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003), it was developed a *Contingent Resource Based View* of the natural environment (Aragón Correa & Sharma, 2003).

Contingency Theory suggests that competitive advantage depends on the right alignment between endogenous organizational variables and exogenous context variables (Burns & Stalker, 1961; Lawrence & Lorsch, 1967) cited by J. Alberto Aragón-Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003). Thus, *Contingent Resource Based View* of the natural environment tries to asses at which extend characteristics of the general business environment affect the development of the dynamic capability of a proactive environmental strategy, also assessing the impact on competitive advantage (Aragón Correa & Sharma, 2003).

There are two kinds of strategies that companies can follow to manage business-natural environment relationship: a reactive or a proactive strategy (Aragón Correa & Sharma, 2003). A

reactive strategy implies to take actions due to pressures of stakeholder or imposition of regulations, most of times leads to expensive investments on *"end of pipe pollution control systems"*; a proactive strategy implies anticipate regulations and stakeholders' pressures, avoiding negative environmental impact by adequate operations, processes and products (Aragón Correa & Sharma, 2003).

Contingent Resource Based View of the natural environment demonstrates that a proactive environmental strategy has the characteristics of a dynamic capability[28], allowing companies to adapt themselves to changes on the general business environment (Aragón Correa & Sharma, 2003). This conclusion was based on the following definition of dynamic capabilities: *"Dynamic capabilities consist of a set of specific and identifiable processes that although idiosyncratic to firms in their detail and path dependent in their emergence, have significant commonality in the form of best practices across firms, allowing them to generate new, value-creating strategies"* (Eisenhardt & Martin, 2000) cited by J. Alberto Aragón-Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003).

Actually a proactive environmental strategy is based on specific and identifiable processes, such as, stakeholder integration and continuous improvement that are also tacit, complex and rare in some details, for instance, employee involvement, cross functional management and global consensus about environmental responsible actions (Hart, 1995; Sharma & Vredenburg, 1998; Eisenhardt & Martin, 2000) cited by J. Alberto Aragón-Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003); plus, it is based on best practices as pollution prevention and sustainable development – proving its commonality (Christmann, 200; Majumdar & Marcus, 2001) cited by J. Alberto Aragón-Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003). Moreover, these strategies are value adding for customer as it allows developing "green" or environmental friend products and services to "green markets" customers (Hart, 1995) cited by J. Alberto Aragón-Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003). Plus, proactive strategies toward environment require path dependence and embeddedness of continuous improvement, shared vision and stakeholder integration capabilities (which provide credibility and acceptance among society) (Marcus & Geffen, 1998; Sharma & Vredenburg, 1998; Hart, 1995) cited by J. Alberto Aragón-Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003).

In fact, proactive environmental strategies are built through path dependency by integrating and accumulating crucial tacit, complex and rare capabilities - employee involvement and coordination, recombination of resources (Russo & Fouts, 1997), as well as, integration on companies' administrative, entrepreneurial and engineering dimensions (Aragón-Correa, 1998) all cited by J. Alberto Aragón-Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003) -

[28] Dynamic capabilities are explored in more detail in the next section "Dynamic capabilities, dynamic markets and knowledge"

that turn these strategies nonreplicable or hardly imitated (Teece et al., 1997; Hart, 1995). Therefore a proactive environmental strategy works as a dynamic capability allowing companies to adapt to changing environments (Aragón Correa & Sharma, 2003).

Another main conclusion of *Contingent Resource Based View* of the natural environment is that the impact of the dynamic capability of a proactive environmental strategy on companies' competitiveness will depend on external variables: environmental uncertainty (state uncertainty, organizational effect uncertainty and decision response uncertainty), complexity and munificence (Aragón Correa & Sharma, 2003).

The higher the perceived state uncertainty in general business environment the stronger the link between proactive environmental strategies and competitive advantage – as uncertainty will difficult competitors to duplicate such tacit capabilities (Aragón Correa & Sharma, 2003).

Management' interpretations and perceptions strongly affect the way companies manage "*business-natural environment interface"* (Anderson & Bateman, 2000; Egri & Herman, 2000; Sharma, 2000) cited by J. Alberto Aragón-Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003; thus, the higher the perceived organizational effect uncertainty the weaker the link between proactive environmental strategies and competitive advantage, also, the higher the perceived decision response uncertainty the weaker the link between proactive environmental strategies and competitive advantage – proactive environmental strategies implies managers to take risk and experiment which is not easy when there is uncertainty in organizational effect and decision responses (Aragón Correa & Sharma, 2003).

The higher the perceived complexity in general business environment the stronger the link between proactive environmental strategies and competitive advantage – as in complex environments competitors cannot easily identify, imitate and implement such tacit, complex and rare capabilities (Aragón Correa & Sharma, 2003).

The higher the perceived munificence, low hostility, in general business environment the weaker the link between proactive environmental strategies and competitive advantage – again, because it is hard to imitate dynamic capabilities in hostile industries (Aragón Correa & Sharma, 2003).

2.6. Dynamic capabilities, dynamic markets and knowledge

A dynamic capability translates companies' ability to achieve new ways of competitive advantage in increasingly changing environments (Teece et al., 1997). Companies that have most succeed in these demanding environments are those with *"timely responsiveness and rapid and flexible product innovation"* along with effective capabilities in manage and coordinate internal and external competences (Teece et al., 1997). Dynamic capabilities are based on companies' processes, shaped by assets' position and paths; processes refer to companies'

routines and current practices; assets position refers to specific technological and financial assets, intellectual property, customers base, suppliers ties, etc; path refers to *"strategic alternatives available to the firm"*, moreover, path dependencies defends that companies' current position influence and constrain future paths that companies may choose to follow (Teece et al., 1997). In order to be a dynamic capability it is crucial that capabilities are hardly replicate or imitate by competitors, therefore, they should be tacit (casual ambiguous), social complex and rare (firm specific) (Teece et al., 1997; Hart 1955).

Thus, the purpose of dynamic capabilities is to figure out how companies can rapidly adapt to a constant changing environment achieving sustained competitive advantages (Teece et al., 1997).

"The pattern of effective dynamic capabilities depends upon market dynamism" (Eisenhardt & Martin, 2000). According to some literature in this field, dynamic markets can be defined as moderately dynamic or very dynamic (Eisenhardt & Martin, 2000). Moderately dynamic markets have frequent changes but in most cases they are roughly predictable and follow a linear path, these markets have stable industries' structures, the market is clear and the players are well known; in moderately dynamic markets, effective dynamic capabilities are complicated, predictable and analytic, strongly depending upon existing tacit knowledge, however these dynamic capabilities are codified in formal routines or in technology allowing their sustainability (Eisenhardt & Martin, 2000).

In very dynamic markets changes are very frequent and less predictable, following a nonlinear path; in this kind of markets industries' structures are not clear, as well as, business models, moreover player are not well known and are constantly shifting (Eisenhardt & Martin, 2000). In very dynamic markets, effective dynamic capabilities are related to the capacity of rapidly create new knowledge specific to a certain situation – *"situation-specific knowledge"* (Eisenhardt & Martin, 2000).

Dynamic capabilities in very dynamic markets are less complicated than in moderate ones, as they lack highly detailed and formal routines implied in tacit knowledge and complex social routines of dynamic capabilities on moderately dynamic markets (Eisenhardt & Martin, 2000). Dynamic capabilities in very dynamic markets are simply based on quick learning skills (developed through experiential activities) that allows developing rapidly such a *"situation-specific knowledge"*; as new information is acquired or as conditions change new knowledge is created – these dynamic capabilities are less predictable (Eisenhardt & Martin, 2000). Notice that these kind of dynamic capabilities strongly depend upon *"real-time information, cross-functional relationships and intensive communication"* (Eisenhardt & Martin, 2000). However the simplicity and little structure related with these dynamic capabilities make them easily forgettable (Argote, 1999) cited by Kathleen M. Eisenhardt and Jeffrey A. Martin (Eisenhardt & Martin, 2000), mainly in rapid growing companies associated to very dynamic markets, demanding high levels of efforts to follow changes and to *"stay on the track"* (Eisenhardt & Martin, 2000). The challenge is to find an optimal level of structure neither so simple nor so

predictable; this balance is required as both existing tacit knowledge and *"situation-specific knowledge"* have important contributes to sustainable competitive advantages (Eisenhardt & Martin, 2000).

Knowledge management is a field of huge importance in the majority of management areas at all levels (Swart & Powell, 2006). Actually, knowledge plays a crucial role on dynamic markets, being one of the most important sources of a sustained competitive advantage (Grant, 1996; Kogut, 1996) cited by Kathleen M. Eisenhardt and Jeffrey A. Martin (Eisenhardt & Martin, 2000) and (Drucker, 1995; Spender & Grant, 1996) cited by Susan McEvily and Bala Chakravarthy (McEvily & Chakravarthy, 2002).

The creation or recombination of knowledge leads to valuable organizational capabilities (Kogut & Zander, 1992) cited by Russel W. Coff (Coff, 2003), for instance, improvements in productivity result, most of times, from new technologies implemented that enhance knowledge creation and management (Coff, 2003). The development and acquisition of knowledge based capabilities are crucial (Coff, 2003) as knowledge has three major characteristics that explain its role on building imitation barriers, avoiding replications from competitors – tacitness, complexity and specificity (McEvily & Chakravarthy, 2002). Complexity makes difficult to understand which increase the costs of transfer knowledge and also increase the likelihood of errors when imitated (Dierickx & Cool, 1989) cited by Susan K. McEvily and Bala Chakravarthy (McEvily & Chakravarthy, 2002) ; specificity is related to a certain organizational context in which resources, in this case knowledge, achieve its maximum efficiency, thus when tried to apply outside this context it loses value (McEvily & Chakravarthy, 2002) and (Klein, Crawford & Alchian, 1979; williamso, 1985) cited by Susan K. McEvily and Bala Chakravarthy (McEvily & Chakravarthy, 2002); tacitness makes knowledge difficult to articulate and communicate as most of times it is acquired or learn implicitly, being hard to communicate it explicitly in a casual way (Polanyi, 1962; Nelson & Winter 1982; Reber, 1993) cited by Susan K. McEvily and Bala Chakravarthy (McEvily & Chakravarthy, 2002). Susan K. McEvily and Bala Chakravarthy (McEvily & Chakravarthy, 2002), studied specifically technological knowledge, and how its tacit, complex and specific characteristics are crucial to raise imitation barriers allowing to maintain companies' performance advantages.

The knowledge based view of firms suggest that companies are *"repositories of knowledge and competencies"* (Kogut and Zander, 1996; Spender, 1996) cited by Helena Yli-Renko (Yli-Renko et al., 2001), plus, it defends that the accumulation of knowledge is crucial to the developments and growth of companies as it increases awareness of new opportunities exploiting and then benefit from them (Penrose, 1959; Spender and Grant, 1996) cited by Helena Yli-Renko (Yli-Renko et al., 2001) and (Yli-Renko et al., 2001). Along with knowledge based view of firms, resource based theory also suggests that firm-specific experience of

managers involving tacit knowledge of companies' resources and capabilities leads to better resource allocation decisions and also to a more precisely assess of emergent opportunities; this allows managers to better select the most valuable opportunities to pursue, taking in account their fit with companies' resources and capabilities (Kor & Mahoney, 2005).

Moreover, knowledge has implications in the emergence of dynamic capabilities; dynamic capabilities emerge from path dependence that takes in account historical investments and decisions of companies that influence their future paths and choices (Teece et al., 1997); however path dependence is more correctly described as a learning mechanism within which dynamic capabilities evolve (Argote, 1999) cited by Kathleen M. Eisenhardt and Jeffrey A. Martin (Eisenhardt & Martin, 2000). For instance, practice is positively associated with accumulation of tacit and explicit knowledge as it allows a deep understanding of processes leading to more effective routines allowing companies to achieve a superior performance (Eisenhardt & Martin, 2000) – codification of those routines through technology or formal procedures makes them sustainable and easy to apply (Argote, 1999) cited by Kathleen M. Eisenhardt and Jeffrey A. Martin (Eisenhardt & Martin, 2000).

In the context of corporate strategy, companies need to know how to invest in different types of activities (He & Wong, 2004); there are two important learning activities between which companies need to divide attention and resources – Exploration and Exploitation (He & Wong, 2004). *"Exploration implies firm' behaviors characterized by search, discovery, experimentation, risk taking and innovation, while exploitation implies firm behaviors characterized by refinement, implementation, efficiency, production and selection"*(Cheng & Van de Ven 1996, 1991) cited by Zi-Lin He and Poh-Kam Wong (He & Wong, 2004). While exploitation allows companies to create reliability on experience, improving productivity and refinement, exploration seeks to create variety in experience, improving experimentation and *"free association"* (Holmqvist, 2004). Both exploration and exploitation require different types of structures, capabilities, strategies, cultures, etc. to be implemented successfully, moreover, firms' performance are differently affected by each of the learning activities (He & Wong, 2004). Exploration is more associated with organic structures, improvisation and in general with emerging markets and technologies, while, exploitation is more related with mechanistic structures, routines and in general stable technologies and markets (Ancona et al., 2001; Brown & Eisenhardt, 1998; Lewin et al., 1999) cited by Zi-Lin He and Poh-Kam Wong (He & Wong, 2004). Because exploration returns are more distant and vary more in time, explorative firms face large variations in performance, on the other hand, exploitation returns are closer and more certain in time, thus, exploitative firms, generally, face more stable performances (He & Wong, 2004).

A company that follows specifically exploration, without exploitation will probably have huge costs of exploration without benefit totally from it as these companies have many underdeveloped innovative ideas but lacks some competence (March, 1991). On the other hand, companies that follow, specifically, exploitation without exploration, may achieve a stable equilibrium but in a suboptimal level (March, 1991). Therefore, companies need to find a balance between these two processes as both are essential to their success – *"ambidexterity premise"* (Tushman & O'Reilly, 1996) cited by James G. March (March, 1991).

However, to find this balance is not easy as *"exploration of new alternatives reduces the speed with which skills at existing ones are improved,* plus*, improvements in competence at existing procedures make experimentation with others less attractive"* (Levitt and March 1988) cited by James G. March (March, 1991). To find a balance between exploration and exploitation implies to find a balance between *"processes of selection and variation"* (Ashby, 1960; Hannan & Freeman, 1987) cited by James G. March (March, 1991). Actually it is crucial to companies to select routines and practices efficiently, but it is also crucial to find and develop alternative and new practices, mainly in a continuous changing environment (March, 1991).

The balance between exploration and exploitation is implied in the concept of dynamic capabilities defended by Kathleen M. Eisenhardt and Jeffrey A. Martin (Eisenhardt & Martin, 2000) referred previously; according to this conceptualization, dynamic capabilities should have a balanced structure, based on both tacit knowledge and *"specific situation knowledge",* in order to achieve sustainability - this balanced structure implies exploitation (more related with tacit knowledge) and exploration (more related with *specific situation knowledge"*) activities (Eisenhardt & Martin, 2000; He & Wong, 2004). Actually, throughout literature dynamic capabilities have been being related with exploitation and exploration activities (He & Wong, 2004); some authors have argued that dynamic capabilities are rooted in exploitation and exploration (Ancona et al., 2001); others argued that exploitation of existing capabilities is required to the exploration of new ones, which in turn enhances existing knowledge in firms, defending that exploration and exploitation create a *"dynamic path of absorptive capacity"* (Katila & Ahuja, 2002), all cited by Zi-Lin He and Poh-Kam Wong (He & Wong, 2004).

Some studies have been made in the context of exploitation and exploration learning activities literature; one of them is focused on technological innovation and aims to know how companies turn *"new technological knowledge and ideas into new products or processes"* (He & Wong, 2004). This study develops a new technological innovation strategy which is based in two main dimensions: an explorative innovation dimension highlighting technological innovation activities that allow companies to enter in new product markets; and an exploitative innovation dimension highlighting technological innovation activities that allow companies to improve

their position in markets that already exist (He & Wong, 2004). This study provides empirical evidence of a positive effect of exploration and exploitation balance in companies' sales growth rate on a technological innovation context (He & Wong, 2004).

Exploitation and exploration are two learning activities that compete for scarce resources in companies, thus, managers should manage the tradeoff between both, as they are both crucial to companies (March, 1991). Moreover, literature suggests that there are synergetic effects between these two learning activities (He & Wong, 2004), and that one can generate other (Holmqvist, 2004). According to Mikael Holmqvist (Holmqvist, 2004) there are intermediary learning processes that lead exploration to exploitation and vice versa. An *"opening up"* intermediary learning process describe how exploitation generates exploration, actually, excessive refinement and routinization that sometimes put companies in a suboptimal level may lead these ones to try to achieve a new level opening up learning to other sources of experience; a *"focusing"* intermediary learning process describe how exploration generate exploitation, actually, excessive free association and experimenting may lead to insatisfactions when companies realize that few returns are being generated, thus, they start to focus their attention, refining and increasing routines in processes (Holmqvist, 2004).

In order to succeed in a constant changing environment companies should be able to improve continuously (Winter, 1994), however, to continuously improve companies must have a strong commitment to learn (Senge, 1994) all cited by P. S. Deng and E. G. Tsacle (Deng and Tsacle, 2006). Therefore exploitation and exploration – learning activities – are crucial for companies to learn an acquire knowledge (Katila & Ahuja, 2002) cited by Zi-Lin He and Poh-Kam Wong (He & Wong, 2004). As referred before knowledge has an important strategic role in companies as it allows, among other things, to raise barriers to imitation due to its tacit, specific and complex characteristics (McEvily & Chakravarthy, 2002).

As referred previously, dynamic capabilities have a huge strategic impact on companies facing constant changing environments (Teece et al., 1997). Next, it is presented some facts showing that the actual environment is changing, which highlights the importance of integrate the analysis of dynamic capabilities, in the discussion and future answer of the research question.

2.7. A constant changing environment - challenges that companies may face

As referred before, it makes sense to talk about dynamic capabilities when companies need to adapt themselves to constant changing environments in order to maintain their competitive advantages (Teece et al., 1997). Next, it is presented some facts that show actual and future changes on the environment.

The increasingly concern of societies about environment and the negative impact of companies' activity on sustainability, increase environmental regulations all over the world at many institutional levels (Rugman & Verbeke, 1998). During the next 50 years environmental regulations will evolve strongly, however, at least three major changes have already started to appear (Portney, 2000). First, incentive base approach toward environmental issues, this trend is expected to grow and became increasingly common in the next years (Portney, 2000). Second, requirements of public disclosure of information about their emissions to air, water and land; these requirements start to appear at different federal levels, and also at a state and local level, as well as, in developing countries with weak regulatory bodies (Portney, 2000). The third change, is the increasingly need of coordinate international actions in order to harmonized environmental regulations as most of the environmental problems are not limited to nation's borders (Portney, 2000). An example of increasing regulation towards environment is, for instance, in the USA, where US Environmental Protection Agency – EPA – regulate the quality of water distributed in more that ninety substances, these number will increase (EPA, 2003) – water systems supply will have to follow each new rule (Lockwood et al., 2004). Regulation is one of the most determinant factors of companies' environmental conducts (Dasgupta, Hettige, & Wheeler, 2000; Henriques & Sadorsky, 1996) cited by Petra Christmann (Christmann, 2004).

Another determinant factor of companies' environmental conducts is customer pressure (Arora & Cason, 1995; Christmann & Taylor, 2001; Henriques & Sadorsky, 1996) cited by Petra Christmann (Christmann, 2004). As environmental issues and concerns increase, customers become more aware, including on their purchasing decision environmental factors (Christmann, 2004). Actually, green markets are expanding significantly in most sector of economy as customers, due to their concerns about environment, are willing to pay a premium for environmental friendly services and products (Kotchen, 2006). Previous literature argued that these growing opportunities in green markets are *"the next big thing for small businesses"* (Murphy, 2003) cited by Matthew J. Kotchen (Kotchen, 2006). Customers, industries and governments are focusing their attention on green products due to their environmental benefits; therefore, companies are actively engaged in marketing developments towards to these green products (Chen, 2001).

Actually increasing concerns about a sustainable environment and decisions towards its improvement will lead to changes in competitive landscape, consumer behavior, regulations, market opportunities, etc. (Shrivastava, 1995; Rugman &Verbeke, 1998; Christmann, 2004).

Beyond changes in environmental regulation and customers' patterns of choice, there are technological changes, as *"current state of technology is constantly evolving"* (Cuddington & Moss, 2001). Technology has been evolving constantly in the last years affecting many different

areas as information, communication and biotechnology; this trend tends to maintain as technologies are also evolving in new areas as nanotechnology and robotics (Straf, 2003). Technology evolvement leads to other different kinds of changes as technology has a strong interaction with social, political and economic factors, thus, change is a fact and not *"an option"* (Straf, 2003).

Besides these technological changes there are also constant climatic changes, stressing even more ecologic and economic systems due to the risks and consequences that they represent (Kesavan & Swaminathan, 2006), as well as, demographic changes which points to a continuous increasingly population (Hofman et al., 2011) altogether leading to sustainability issues (Hofman et al., 2011), (Ehrlich & Ehrlich, 1991) cited by Paul Shrivastava (Shrivastava, 1995). The growing consumption of natural resources is one of those issues, which are concerning society; actually this increase in use of natural resources is a consequence of world population growth and also a consequence of increases in per capita consumption (Arrow et al., 2004). Evidence suggests that the continuously growing rates of consumption of some resources are not sustainable (Vitousek, Ehrlich, Ehrlich & Matson, 1986, 1997; Postel, Daily & Ehrlich, 1996) cited by Kenneth Arrow (Arrow et al., 2004). Regarding water, as referred before, it is already known that by 2025, slightly more than 1 billion of people will live in absolute water scarcity (Seckler, 1999).

2.8. Summary of the Chapter

This literature review stresses the importance of focusing on environmental technologies (Shrivastava, 1995) which allows companies to grow in a sustainable way, protecting the environment and natural resources that start to be scarce. In the case of water resources, it is clear the urgency of finding solutions to accomplish future water demands, as water scarcity is a huge problem of the present century, leading to devastating consequences (Seckler, 1999). Atmospheric water generation seems to have an important impact on the solution of this problem as it can produce clean drinking water from the air, allowing the production of huge amounts of water even in the more remote locations[29]. Moreover this technology presents a variety of advantages from which companies can benefit. This section also highlights the pertinence of certain strategic frameworks and the importance of their conclusions, in assessing the research question.

The state of art provides bases for the discussion which takes place in the next chapter. The study follows based on some assumptions that are made in the beginning of the next chapter.

[29] Source: www.air2water.net; www.airqua.com; www.watermicron.com; www.airtowater.com.au; www.awginternational.com; www.ecoloblue.com; www.planetswater.com

The next chapter also provides intermediary conclusions that allow answering later to the research question.

3. Discussion:

This chapter refers to the discussion, in which some intermediary conclusions are taken in order to help answering to the research question. It is firstly presented the assumptions in which the work is based, and then a brief review of methodology.

As referred previously, the discussion and consecutively the answer to the research question are based in some major assumptions. First, it is considered that the competitive environment is dynamic, meaning, it is changing. Literature review (section: *"A constant changing environment - challenges that companies may face"*) gives information that shows actual and future changes in the environment: increasing environmental regulations; growth and weight of "green" markets and the increasing awareness of customers about environment which affects consumer' behavior; technological changes; climatic changes; natural resource depletion; increasing water scarcity, etc. Thus, this assumption is pertinent and enhances the importance of studying the impact of an environmental friend technology on companies. Moreover, this assumption turns relevant the utilization of dynamic capabilities in the discussion, as the study of dynamic capabilities just make sense in a constant changing environment (Teece et al., 1997). Second, the study is restrained to tacit environments, meaning, difficult to imitate. Literature about dynamic capabilities and the role of knowledge in raising imitation barriers and in creating sustained competitive advantages support this assumption (section: *"Dynamic capabilities, dynamic markets and knowledge"*). Actually, the discussion follows with a technology's analysis; as referred previously in literature review (section: *"Dynamic capabilities, dynamic markets and knowledge"*), technology enhances the creation and management of knowledge (Coff, 2003); knowledge is tacit, complex and specific which difficult imitation (McEvily & Chakravarthy, 2002), therefore, this second assumption is pertinent.

The methodology follows as established in Chapter 1. First, it starts with a theoretical analysis, where it is demonstrated that AWG technology can be considered an Environmental technology (Shrivastava, 1995); then it is demonstrated that the use of AWG technology is along with the three environmental strategies of Natural Resource Based View (Hart, 1995) contributing to their development, therefore, having potential to lead to sustained competitive advantages; then it is proved that the use of AWG technology can contribute to a proactive environmental strategy, which, according to *Contingency Resource Based View* of natural environment (Aragón Correa & Sharma, 2003), can be a dynamic capability (Teece et al., 1997). Second, a practical demonstration is done through illustrative examples that shows how AWG technology can be a factor of adaptation on companies' value chain, thus, showing how this technology can be strategic to companies.

3.1. AWG Technology as an Environmental Technology and its strategic potential to companies

By definition, an environmental technology is *"Production equipment, methods and procedures, product designs, and product delivery mechanisms that conserve energy and natural resources, minimize environmental load of human activity and protect the natural environment"* (Shrivastava, 1995). Based on this definition, and taking in account the description about AWG technology and its application on the literature review chapter (section: *"Atmospheric water generation technology - AWG technology"*), it can be concluded that AWG technology is an environmental technology as it is showed next. AWG units can be part of the production equipments, for example, in industries that need a continuous pure water supply source or in industries in which fresh water is one important component in production (example: Beverages and food[30]). Actually AWG units are equipment that can be installed sequentially in order to fulfill the most variety of water needs, as referred in the state of art (section: *"Atmospheric water generation technology - AWG technology"*). Moreover, AWG units can be crucial equipments in hospitals and health clinics, proving almost 100% pure water, constantly, at a low cost, when comparing with common water delivery systems (section: *"Atmospheric water generation technology - AWG technology"*). AWG technology provides a constant source of water without requiring any available water source, it is cost and energy efficient and it avoids storage and transportation costs, therefore, it can lead to much more efficient methodologies and procedures, as it reduces wastes, risks (for instance: water depletion and contamination and water prices fluctuations) and may reduce cycle times (for instance, time spent in traditional water treatment systems) (section: *"Atmospheric water generation technology - AWG technology"*). Because, AWG is cost and energy efficient, it decreases the carbon footprint, having a lower impact on environment, and protecting natural water resources,

[30] Beverage and food industries are two of many industries affected by future limitations regarding water scarcity. In fact, some of these companies have already started to deal with this major issue trying to explore more efficient ways of using water. Because food depends on agriculture that in turns depend hugely on water sources, and because beverages are per se a liquid product, water resources are essential to these industries that have been using huge amounts of this precious good – water. Because water is expected to be scarce in a near future, some companies of beverage industries can see water supply interrupted or may have to deal with huge water prices, those are severe risks that can put in cause companies continuity. Moreover, these companies can have many troubles in terms of reputation and image as they are contributing to water resources scarcity.

Beverage Industry Environmental roundtable (BIER), recognize the problem of water scarcity and the importance of their companies in preserving access to fresh water resources. Therefore they are developing some principles related with water stewardship (based on *"water footprint"*), that beverages companies should follow in order to achieve a more efficient water management and sustainable solutions for future.

Sources:
http://www.nytimes.com/2011/03/22/business/energy-environment/22iht-rbog-beverage-22.html;
http://bieroundtable.com/files/BIER%20World%20Class%20Water%20Stewardship%20in%20the%20Beverage%20Industry%202010.pdf

it also cleans and purifies the air, without using any kind of chemicals (section: *"Atmospheric water generation technology - AWG technology"*).

If AWG technology is an environmental technology, according to Paul Shrivastava (Shrivastava, 1995), it should be seen as potentially strategic by companies (literature review, section: *"Environmental technologies' strategic impact, based on a VITO elements analysis"*); as referred in the state of art (section: *"Environmental technologies' strategic impact, based on a VITO elements analysis"*), environmental technologies can be strategic to companies as they impact multiple points in value chain and provide a huge variety of advantages. Based on literature review (section: *"Environmental technologies' strategic impact, based on a VITO elements analysis"* and *"Atmospheric water generation technology - AWG technology"*) it can be seen that AWG technology is along with these advantages: it can reduce cost of production, as it lower the cost of water, cost of storage and transportation, cost of environmental liabilities, as companies can maintain low levels of pollution and it also has low maintaining and installing costs; it can also enhances revenues because it may allow companies to enter in "green" markets, attracting "green" customers; AWG helps in reducing risks and associated costs, as water supply is assured, even in the more arid and remote location, as well as, in emergency cases, also avoiding water price fluctuations' impacts; AWG also improves quality standards in companies, as it uses efficient systems to purify and clean water, providing the most pure and free of chemicals water; AWG also contribute to a better image and reputation of companies, because it reduce carbon footprint, being environmental friendly, because it can be crucial in humanitarian aid initiatives and because it address and minimize one of the most serious problems of the actual century – water scarcity; to multinational companies, and companies growing to developing countries, AWG also gives a competitive edge to firms as it allows to provide water in a reliable and continuous way in the more arid and remote locations.

Therefore, by definition and by the above analysis, it can be concluded that **AWG technology is an environmental technology** and thus, according to literature (section: *"Environmental technologies' strategic impact, based on a VITO elements analysis"*), **it has strategic potential to companies** as it may provide competitive advantages, as described previously.

In order to assess the strategic potential of the use of AWG technology in companies, it is applied, next, the conceptual framework of Natural Resource Based View (Hart, 1995) to the use of AWG technology. Thus, it should be demonstrated that the use of AWG technology is along and contribute to the developments of the three basic strategies defended by this framework: Pollution prevention, Product stewardship, Sustainable development.

3.2. The contribution of AWG Technology utilization to a Pollution Prevention Strategy and resulting competitive advantage – based on the Natural Resource Based View

The following demonstration is done based on literature review (section: *"Natural resource based view"*, subsection: *"Pollution prevention"* and *"Atmospheric water generation technology - AWG technology"*).

The use of AWG technology is in accordance and contribute to a pollution prevention strategy because it reduces emissions, effluents and wastes; the use of AWG technology reduces emissions and effluents because it uses efficient purification and filtration water techniques, without using any chemicals in the whole process, avoiding to expel chemicals and other residuals while it produces clean drinking water, moreover, it also cleans the air eliminating airborne particles; the use of AWG technology allows to reduce and manage wastes because it is cost and energy efficient, moreover, it also avoids water wastes that may happening in traditional water treatment processes – AWG technology integration leads to a more efficient input utilization. Thus, AWG technology can integrate manufacturing, leading to more efficient processes, which may allow to reduce cycle times (for instance, time spent in traditional water treatment systems) and increase productivity, lowering companies' costs.

Therefore, the use of AWG technology contributes to continuous improvements in companies' manufacturing processes – by increasing efficiency, by reducing cycle times, by increasing productivity and by reducing liabilities that may arise from environmental regulations imposed – which, based on Natural resource based view framework (Hart, 1995), leads to a lower costs competitive advantage.

AWG technology integration can be part of a pollution prevention strategy as demonstrated before, thus its integration and utilization is also people intensive, implying knowledge about how to work and manage this new technology, as well as, employees' involvement in the continuous improvements that the utilization of AWG technology can provide. Besides these tacit skills that can be accumulated by using AWG units, the use of this technology also enhances social legitimacy of companies; as it maintains low levels of pollution, companies can benefit by showing their results and accomplishments in reducing pollution, enhancing transparency and companies' image.

Thus, the use of AWG technology allows companies to have continuous improvements in manufacturing processes (which as referred above leads to lower costs) accumulating tacit skills and also having social legitimacy; therefore, based on Natural Resource Based View (Hart, 1995), the use of AWG technology leads to a sustained lower cost competitive advantage - the

lower costs competitive advantage is sustainable because it implies tacit skills and gives companies social legitimacy, which according to Natural Resource Based View (Hart, 1995) assure the sustainability of the competitive advantage.

Next, it is explored an example in which the use of AWG technology can contribute strongly to a pollution prevention strategy, which leads, as demonstrated before to lower companies' costs. In companies requiring a continuous drinking water supply (beverages industry, for instance) AWG technology integration can strongly help them in preventing pollution. With AWG technology, these companies do not need anymore to depend upon traditional water systems treatment that most of times need to use chemicals and techniques that demand high energetic consumptions. The chemicals and toxic residuals released by these traditional water systems treatment are very prejudicial to environment; by using AWG technology companies can avoid them reducing pollution. Although AWG technology works most of time through electricity, it is energy efficient, thus it reduces indirectly the pollution that may arise from electricity production. Recent developments make AWG technology works through other clean and renewable energies, for instance, solar energy; in this case AWG technology can became a completely clean technology, having almost any impact on pollution.

3.3. The contribution of AWG Technology utilization to a Product Stewardship Strategy and resulting competitive advantage – based on the Natural Resource Based View

The following demonstration is done based on literature review (section: *"Natural resource based view"*, subsection: *"Product stewardship"* and *"Atmospheric water generation technology - AWG technology"*).

The use of AWG technology contributes to product stewardship, as it reduces the environmental burden of companies' products and processes. AWG technology allows minimizing water depletion, respecting water replenishment rates, as it makes drinking water from the air, moreover, as demonstrated previously this is an environmental technology, which does not use any chemical or toxic substance while produce clean drinking water, having a low impact on the environment. Thus, based on life cycle analysis (LCA), the use of AWG technology reduces the environmental burden (Life cycle cost) of products and processes that require water as a source, allowing companies to be seen as more "green".

Based on Natural resource based view reasoning (Hart, 1995), using AWG technology, companies can enhance product stewardship having the advantage to preempt competitors in

"green" markets, which allows them to be seen as early movers in these markets building reputation – as they can be the firsts protecting water sources through an environmental technology while producing, protecting environment, reducing businesses' negative environmental impacts, such as, health problems, diseases and avoiding water resources depletion; to have preferred access to important sources, for instance, locations (locations with more humidity are preferred as they allow AWG units to produce more drinking water from the air) or customers – those willing to pay a premium for a green and differentiated product; and to establish some environmental standards and rules, according to specificities of company, which may represent barriers or difficulties to other potential entrants (for example establishing levels of water purity, limits in using water resources, levels of energy consumption in production, as well as, limits in using chemicals and toxics). Moreover, and based on the Natural Resource Based View (Hart, 1995), through competitors' preemption, the implementation of AWG technology may have a huge impact on startup companies, planning to enter in "green markets", as they can easily implement, since the beginning, AWG units in their facilities or plants, because they do not have any existing ones.

To change product and development processes to a more environmentally friend solution, by implementing AWG technology, it is necessary to coordinate different departments and functions in companies. To integrate AWG technology as a new source of water in companies' processes may imply to reorganize some systems and operations - it may imply, among other things, proactive relationships with suppliers in order to adequate the integration of this new technology on the existing processes and systems, assuring compatibility (for example in beverage industries it is needed to integrate AWG in the existing plants' production system, which may imply the supply of different components or raw materials); it is also necessary to coordinate simultaneously marketing department to assure customer needs' fulfillment, required products' developments and proper awareness about the new technology used; it is also crucial to integrate stakeholders' perspectives and opinions about AWG technology to create acceptance and credibility about it. Thus, integration of AWG requires complex capabilities of coordination in companies.

Thus, the use of AWG technology contributes to product stewardship, allowing companies to preempt competitors in new "green" markets, mainly those that depend strongly on fresh water resources; because it implies complex skills of coordination within companies, it can be said based on Natural resource based view, that AWG technology, by enhancing product stewardship, helps companies in preempt competitors which is a competitive advantage. Furthermore, the use of AWG technology leads to social legitimacy, as the integration and acceptance of this technology depends upon stakeholders' integration and influence; therefore,

based on Natural Resource Based View (Hart, 1995), the advantage of preempt competitors, by using AWG technology, is a sustained competitive advantage.

Next, it is explored some examples showing how the use of AWG technology can enhance product stewardship. For instance, companies selling those common water dispensers machines may find in AWG technology a great opportunity to start a product stewardship strategy; the existing product concept should be altered and also its design, however, this is a much more sustainable solution as it uses an environmental technology, moreover, tones of plastic bottles are saved as they are not needed anymore (traditional water dispensers machines depends on big water plastic bottles to storage water). The same may happen in beverages industries, as referred before, actually companies can start producing beverages based on a much more reliable and sustainable source of fresh water, ending up offering products with a low environmental burden, which make them more "green" and sustainable companies.

3.4. The contribution of AWG Technology utilization to a Sustainable Development Strategy and resulting competitive advantage – based on the Natural Resource Based View

The following demonstration is done based on literature review (section: *"Natural resource based view"*, subsection: *"Sustainable development"* and *"Atmospheric water generation technology - AWG technology"*).

Finally, it is demonstrated that the use of AWG technology contributes to the third environmental strategy defended by Natural Resource Based View (Hart, 1995) – sustainable development. According to literature review a sustainable development strategy should weak the link between economic activity and environment in developing countries; it also should lead companies to develop and build markets in South (markets in developing countries) in a sustainable way avoiding environmental deteriorations. As referred in the literature review (section: "*Natural Resource Based View"*, subsection: *"Sustainable development"* and *"Water resources - the problematic of water scarcity"*), in 21st century, 90% of population growth will come from developing countries *("the markets of the future"*) that also will face the most extreme scenarios of water scarcity, bringing consequences in terms of health, diseases and food quality (which is a huge limitation to companies' growth and thus to markets' developments). Because, AWG technology makes drinking water from the air, it does not depends upon water sources, which allows companies to better adapt to these extreme scenarios overcoming a major problem – absolute or severe water scarcity (literature review, section: *"Water resources - the problematic of water scarcity").*

In companies that strongly depend upon continuous fresh water sources and envision to invest in *"the markets of the future"*, the use of AWG technology provides huge advantage as they do not face anymore risks about water supply and contamination, as well as, prices' fluctuations that will surely happens, in an increasing trend, as water become more and more scarce; simultaneously these companies are contributing to build and develop sustainable South markets, as they are investing there, through an environmental technology, which gives them advantages to a sustainable growth. Moreover, companies that decide to implement their plants in developing countries, selling the resultant products on developed countries, can use AWG technology to decrease the *"link between material consumption in the North and environmental degradation in the South"*, as they avoid using water resources of developing countries that as referred previously will face extreme scenarios of water scarcity (again, this effect is even more visible in companies that depend strongly upon fresh water resources). Moreover, AWG technology is an environmental technology, as demonstrated before, thus it has a low impact on environment, (it is cost and energy efficient and has low levels of emissions, expels and wastes) which once again contributes to decrease environmental degradation on south, helping to build environmental sustainable markets in these developing countries.

This technology also allows companies to implement plants or facilities in arid locations because they just depend upon water in the air; notice that most of arid regions have lots of sun, thus huge solar energy potential[31]; because AWG can also works through this renewable energy, in arid regions of South (for instance, in Africa deserts and dry regions)[32], AWG technology implementation leverage its effect in developing south markets in a sustainable way.

As referred above, companies depending strongly upon fresh water resources can see in AWG technology, a reliable way to a sustainable growth; multinational companies, specifically, can find AWG technology a sustainable solution to develop their expansion strategies to developing countries, reducing negative environmental impacts, while improving their reputation and image.

---

[31] *"Many people who live in underdeveloped countries spend more of their disposable income on fuel for cooking food than they have to spend on food itself. Most of these are tropical countries where, ironically, there is ample sunlight to power many of the people's basic needs"*, *"Arid areas with few cloudy days are ideal locations for solar power"* by David Harring.

Source: http://earthobservatory.nasa.gov/Features/RenewableEnergy/renewable_energy.php

[32] According to NASA official site, Sub-Saharan Africa presents many types of climates according to each region (as it is possible to see in the figure in the site below). These climates vary according to more wet or dry, as well as, a mixed of both. Desert regions (arid regions) represents a big percentage of Sub-Saharan Africa; semi-arid regions (short grass prairie), although less, still represent an important percentage of Sub-Saharan Africa. In general, in many parts of the continent, there are frequent droughts.

Source:
http://earthobservatory.nasa.gov/Experiments/PlanetEarthScience/GlobalWarming/GW_InfoCenter_Africa.php

Taking in account all what was just said, and based on the Natural Resource Based View framework (Hart, 1995), it is demonstrated that **the implementation of AWG technology leads and contributes to a sustainable development strategy**, giving companies advantages of future position in South markets.

The use of AWG technology by companies, in order to contribute to a sustainable development in the *"markets of the future"*, implies a long term commitment to sustainability and environment, which translates a shared vision within companies, a consensus in following and acting through environmental sustainable principles – rare capabilities. Actually, envision new strategies and possibilities, that can arise from the use of AWG technology, having always in mind, environmental impacts; invest in this technology searching for long term benefits on developing markets instead of short term profits; and find a consensus and general acceptance, within companies about the value and contribution of AWG technology to sustainable growth, are rare capabilities. Therefore, based on the Natural Resource Based View (Hart, 1995), the advantage of future position in south markets to which AWG technology implementation can contribute, through a sustainable development strategy, can be a competitive advantage, because it implies rare capabilities.

In order to implement AWG technology in companies (mainly in south markets), as the main or only source of fresh water, may imply the cooperation of some public or private organizations, to develop proper conditions (for instance, political and regulatory ones: incentives to use environmental technologies as subsidies, tax benefits, etc) and infrastructures as it may represent a huge technological change (for instance in companies depending hardly on fresh water resources, in which the integration of AWG technology has a huge impact and may represent an enormous investment; AWG industrial models can be installed sequentially in large scale to support high levels of fresh water demands, thus some infrastructure should be built). Therefore, over time, the implementation of AWG technology, as a way of contributing to sustainable developments, can lead to social legitimacy as it involves cooperation of external organizations.

Because the implementation of AWG technology contributes to a sustainable development strategy, implying the accumulation of rare capabilities and leading to social legitimacy, it can be said, based on the Natural Resource Based View (Hart, 1995), that it helps achieving a sustained competitive advantage: a future position in the *"markets of the future"*.

Next, it is developed an example in which AWG technology integration can contribute strongly to a sustainable development strategy. Beverage industry' companies, for instance, depend intensively on fresh water resources, as referred previously; most of them have plants in

developing countries and sell their product in developed ones[33]. Actually, they contribute to the depletion on natural water resources in developing countries and also to the devastating consequences that it represents, health problems, diseases, food contamination, etc., thus they impede sustainable developments and growth of south markets.

By integrating AWG technology in their plants' production systems, these companies are decreasing the link between their business activity and impact on environment in south markets; with AWG they do not need to use water sources of developing countries anymore, as this technology makes fresh water from the air, moreover because AWG is an environmental technology, as refereed previously, it has a low impact on environment in terms of emissions, expels, wastes, energy consumption, etc. By invest and integrate AWG technology in large scale, beverage industry' companies are developing a long term commitment with the environment, investing in build sustainable markets on South, in which they can grow in future; moreover these companies overcome problems of water scarcity (one of the big issues this Industry is facing) and risks associated, which allows them to grow in a sustainable way. Therefore, through AWG technology utilization, beverage industry' companies can develop a sustainable development strategy.

[33] One illustrative example is Brewery Industry in Africa.

The African continent has a huge amount of water resources, although its distribution and availability are not equality allocated, thus, many regions face water scarcity scenarios. *"Brewing is intrinsically a water intensive industry. Commonly available best practice technologies still require in excess of four liters of raw water for every liter of beer produced. Older technologies that are inefficiently operated can easily double or triple this consumption, to the detriment of neighboring communities and additional cost to the company itself. High water consumption also means higher energy use, as much of the excess water has to be heated in the brewing and cleaning processes"*. Therefore, Brewery Industry companies are strongly present in Africa, as they found here important fresh water resources. Most of these breweries belong to multinational companies.

Because this continent do not already have strong environmental legislation, also due to weak access and lack of information, as well as, poor water policies, it is difficult to implement better water management in brewery industry' companies. Moreover these companies have low monitoring and control, and are more focus in increase output instead of contributing to more sustainable solution, they are not also aware of the costs they can reduce by implementing more efficient solution.

Source:
http://www.uneptie.org/scp/water/publications/other/cdrom/breweries/resource%20kit%20material/current%20practices%20and%20prospects.pdf

3.5. The leverage effect of AWG technology utilization in companies' environmental strategies – Path dependency and Embeddedness, based on the Natural Resource Based View

According to the Natural Resource Based View (Hart, 1995), the three strategies - Pollution prevention, Product stewardship and Sustainable development – are path dependent (one helps leading to another) and are embedded among each other (there are synergies if implement the three technologies at the same time). As demonstrated in the previous three sections, AWG technology contributes to pollution prevention, product stewardship and sustainable development, giving companies sustained competitive advantages; thus when companies integrate AWG technology each strategy will have a leveraged effect, as one leads to other and there are synergetic effects between the three, which enhance each one of them.

Next, it is addressed again the example of a beverage industry's company, in this case, the company has plants in developing countries, and sell beverages all over the world. By introducing AWG technology this company will prevent and reduce pollution (pollution prevention), decreasing emissions, expels, wastes and energetic consumptions, thus they have a proper base to produce beverages with a low environmental burden, as they are using an environmental technology to produce them, protecting fresh water sources (product stewardship); by developing a pollution prevention strategy that leads to product stewardship strategy, this company is decreasing the link between its activity and environmental degradation in south markets (sustainable development). Actually, with AWG technology, company's plants on developing countries have low impact on environment, allowing companies to grow in a sustainable way, and thus contributing to a sustainable growth and development of these countries – sustainable development strategy.

Regarding embeddedness, by developing a product stewardship strategy, through AWG technology integration, the beverages company can offer products with low environmental burden, as they are protecting water sources depletion using an environmental technology; these low environmental burden beverages are an important way of reducing pollution, thus helping to develop a prevention pollution strategy; on the other hand, if the company has already invested in AWG technology to follow a sustainable development strategy, having a global vision and a long term commitment with environment, it is simultaneously contributing to pollution prevention and products stewardship – this reasoning reflects the synergetic effect among the three strategies and how one strategy can enhance other.

Therefore, due to the path dependency and embededness of the three strategies defended by Natural Resource Based View (Hart, 1995) to which the implementation of AWG technology

contributes, it can be said that, AWG can lead to a leveraged effect on companies' environmental strategies and consecutive competitive advantages (mainly those depending strongly on fresh water sources and interested in the *"markets of the future"*).

Based on the Natural Resource Based View (Hart, 1995) it is demonstrated that the integration of AWG technology contribute to Pollution prevention, Product stewardship and Sustainable development strategies leading companies to sustained competitive advantages: lower costs, preempt competitors in green markets and future position in developing countries, respectively.

As referred in literature review (section: *"Contingent Resource Based View of the natural environment"*), based on Natural Resource Based View (Hart, 1995) and Contingency Theory (Burns & Stalker, 1961; Lawrence & Lorsch, 1967) cited by J. Alberto Aragón-Correa and Sanjay Sharma (Aragón Correa & Sharma, 2003), it was developed the *Contingent Resource Based View* of the natural environment (Aragón Correa & Sharma, 2003). One important contribute of this theory is to conclude that a proactive environmental strategy works as a dynamic capability.

3.6. The contribution of AWG technology utilization to a Proactive environmental strategy – based on the Contingent Resource Based View of the Natural environment

In this part of the discussion, and based on the *Contingent Resource Based View* of the natural environment (Aragón Correa & Sharma, 2003), (literature review, section: *"Contingent Resource Based View of the natural environment"*), it is demonstrated that the utilization of AWG technology contributes and helps achieving a proactive environmental strategy – which according to this theory can be a dynamic capability.

According to the *Contingent Resource Based View* of the natural environment (Aragón Correa & Sharma, 2003), a proactive environmental strategy implies anticipate regulations and stakeholders' pressures, avoiding negative environmental impact by adequate operations, processes and products; it also require path dependence and embeddedness of continuous improvement, stakeholder integration, and shared vision capabilities (Aragón Correa & Sharma, 2003).

As demonstrated previously the utilization of AWG technology contributes to pollution prevention, product stewardship and sustainable development strategies (characterized for being path dependent and for their embededness): pollution prevention allows anticipating liabilities and related environmental regulations, by reducing emission, expels and wastes – it leads to continuous improvement capabilities as demonstrated before; product stewardship allows to anticipate stakeholder pressures as companies integrate their opinion and perspectives in

product' design and developments – stakeholder integration capability; sustainable development avoid negative environmental impacts on developing markets – shared vision and long term commitment capabilities. Altogether, these three strategies form a proactive environmental strategy, as they adequate companies' product, processes and operations, contributing to a more sustainable environment.

Therefore, by contributing to pollution prevention, products stewardship and sustainable development, the utilization of AWG technology contributes to a proactive environmental strategy which, according to *Contingent Resource Based View* of the natural environment (Aragón Correa & Sharma, 2003), is a dynamic capability – the utilization of AWG technology can indirectly lead to dynamic capabilities. Actually, indirectly and through path dependence, the utilization of AWG technology leads to the accumulation of tacit, complex and rare capabilities (continuous improvement, stakeholder integration and shared vision respectively); moreover this capabilities are leveraged as they are embedded among themselves (as they are related with strategies also embedded among themselves); so these capabilities makes a proactive environmental strategy difficult to replicate or imitate, allowing companies to better adapt in a constant changing environment.

Therefore it can be concluded, based on *Contingent Resource Based View* of the natural environment (Aragón Correa & Sharma, 2003), that **the use of AWG technology, can contribute indirectly to the development of companies' dynamic capabilities**.

In order to further clarify, how the use of AWG technology can contribute to the development of companies' dynamic capabilities, it is presented some illustrative examples that demonstrate how the use of AWG technology can be a factor of adaptation on the value chain allowing companies to survive in constant changing environments.

3.7. The use of AWG technology as a Dynamic capability – Illustrative Examples

This part of the Discussion has as base literature review' contents (mainly, sections: *"Atmospheric water generation technology - AWG technology"," Environmental technologies' strategic impact, based on a VITO elements analysis", "Dynamic capabilities, dynamic markets and knowledge"* and *"A constant changing environment - challenges that companies may face"*).

3.7.1. Brewery Industry example

As referred previously, in this part of the discussion it is assessed, through illustrative examples, at which extent the utilization of AWG technology by companies can be a factor of adaptation

in the value chain. However, instead of use traditional Porter's Value Chain it is used VITO elements analysis (Vision, inputs, throughputs and outputs) (Churchman, 1963; Katz & Kahn, 1968) cited by Paul Shrivastava (Shrivastava, 1995) and (Shrivastava, 1995), which as seen previously is a good adaptation of the previous one, mainly regarding environmental themes (Shrivastava, 1995), (literature review, section:" *Environmental technologies' strategic impact, based on a VITO elements analysis"*).

As it has been being referred throughout the Discussion, companies in Beverages Industry are water intensive, meaning; they depend strongly upon fresh water resources. Breweries for instance are one of these examples, having many negative effects on the environment[34]. Therefore, the following example addresses an established brewery, a beers company that wants to grow and expand its business in a more environmental sustainable way. As demonstrated previously, by using AWG technology companies, in this case the brewery, can enhance pollution prevention, product stewardship and sustainable development environmental strategies, which according to the Natural resource based view (Hart, 1995) lead companies to sustained competitive advantages (lower costs, preempt competitors in green markets, and future position in the *"markets of the future"*, respectively). Moreover, as already demonstrated too, the use of AWG technology by enhancing the previous three environmental strategies contributes to a proactive environmental strategy, which according to *Contingent Resource Based View* of the natural environment (Aragón Correa & Sharma, 2003) works as a dynamic capability. However, next, it is demonstrated specifically how AWG technology integration can be strategic to companies (as a factor of adaptation to a changing environment) and under which conditions and assumptions it is possible; in order to demonstrate this, it is explored the impact

[34] Brewery Industry is an intense water industry, as referred previously; beyond water consumption many other environmental issues are associated to breweries: water waste, energy consumption, solid wastes and emissions to the air.

Water consumption is a major environmental issue related with breweries; an efficient brewery use between 4 to 7 liters of water to produce 1 liter of beer, actually, 90% of a beer is water; water is also used to other purposes inherent to beer production. Breweries' energy consumption is high, the refrigerator system is one of the most responsible for these high levels or energy consumption, however, waste water treatment plant accounts for other substantial part of energy consumption. This industry is associated with high levels of water wastes that should be reused, for instance residual beer, *"Techniques for treating industrial process wastewater in this sector include flow and load equalization, pH correction; sedimentation for suspended solids reduction using clarifiers; and biological treatment. Biological nutrient removal for reduction in nitrogen and phosphorus and disinfection by chlorination are sometimes required"*. Moreover, brewery industry is responsible for other solid wastes and emission to air.

Therefore, breweries have strong negative effects on the environment, being responsible for an intense use of water which enhance its scarcity and depletion, being also responsible for water and solid wastes and high levels of energy consumption during the production and in the treatment of some of these wastes; the treatment of water wastes as referred previously, requires most of times chemicals with negative impacts on the environment.

Source: International Finance Corporation, World Bank Group – Environmental, Health and safety guidelines for Breweries
http://www.ifc.org/ifcext/enviro.nsf/AttachmentsByTitle/gui_EHSGuidelines2007_Breweries/$FILE/Final+-+Breweries.pdf

of the use of AWG technology in VITO elements, and how it helps companies adapting to major changes in the surrounding environment.

3.7.1.1. The impact of AWG technology integration on Brewery' VITO elements – Vision, Inputs, Throughputs and Outputs

In this section it is first assessed how the use of AWG technology by the Brewery affects and improves its vision, inputs, throughputs and outputs systems. Then, in section *3.7.1.2* it is explored how these improvements allow the Brewery to adapt to a changing environment. By doing this, are drawn conclusions used later on (section *3.7.1.4 "Conclusion of the example"*), to conclude about the strategic impact of the use of AWG technology in the Brewery (and under which conditions and assumptions it is possible). Notice that conclusions drawn from the present section are then used in section *3.7.1.2*.

Vision

By investing and integrating an environmental technology – Atmospheric Water Generation – in production systems, the brewery is demonstrating a long term vision and commitment to the environment and with sustainability, this improves brewery' reputation and image (actually as referred previously, breweries are associated with many negative effects on the environment, for instance, intense water consumption, high levels of energy consumption, water and solid wastes, emissions, etc). Notice that, according to Natural resource based view (Hart, 1995), to have this long term vision and commitment with environment and sustainability, which allows the Brewery to strongly invest in a new technology changing its processes and methodologies, is a rare capability; moreover, based on Natural resource based view (Hart, 1995), technology change, meaning the integration of AWG in production systems, implies cooperation of external entities and organism which gives brewery social legitimacy – therefore, the resulting improvements in image and reputation are sustainable and hardly imitable as they depend on this rare capability of a long term vision, also giving brewery social legitimacy.

Actually, because breweries depend strongly upon fresh water resources being responsible for its intense use – which contributes to water resources depletion and scarcity – they can improve substantially their image and reputation by adopting a sustainable solution (AWG technology) that protects water sources, that prevents pollution (emissions, expels and wastes) and that allows to offer products (in this case bears) with a low environmental burden (product stewardship). In this way, this brewery is contributing to a more sustainable development, moreover, this brewery can be proud of selling beers produced with water respecting high levels of quality and purity – thus, the brewery can enhance reputation and image by contributing to a

more sustainable development, protecting the environment and scarce natural resources, and also by producing beers with high levels of quality.

Inputs system

In terms of inputs the use of AWG technology by the brewery (industrial AWG models integrated in the production system, that can be implemented sequentially to provide huge water demands, as referred in literature review, section: *"Atmospheric water generation technology - AWG technology"*) allows to produce water at a lower cost comparing with the traditional water delivery system. Moreover this technology is cost and energy efficient, because it uses the minimum required levels of energy to produce water, which helps to maintain lower costs of water and electricity required (section: *"Atmospheric water generation technology - AWG technology"*). Furthermore, this brewery can opt for AWG technology units working trough solar energy that already exists; in this case the brewery also decreases its electricity costs. Thus the integration of AWG technology in the production system of the brewery will decrease the costs of production, by decreasing water costs. Notice that, as referred previously, Breweries depend strongly upon fresh water resources, thus water costs are an important percentage of the total production costs; therefore by integrating AWG technology this Brewery can reduce its production costs. Moreover, the integration of AWG technology in the production systems allows having a continuous flow, without requiring to storage or transport water, thus as demonstrated before this technology can lead to a more efficient input utilization and less wastes. Plus, because AWG technology does not depend on existing water sources neither on traditional water systems, just depends on air, this brewery reduces risks of water resources depletion and contamination, as well as, risk of water prices fluctuations – this means more certainty in inputs availability. This independency of fresh water resources, gives brewery, freedom to implement new plants in new locations (locations that previously were not suitable due to the lack of available fresh water resources).

Throughputs system

The implementation of AWG technology on production has important impacts on throughputs system, as it decreases wastes of water and energy that may happen with traditional water treatments systems, increasing efficiency (literature review, section: *"Atmospheric water generation technology - AWG technology"*). As it also avoids storage and transport of water, it helps reducing cycle times, which jointly with more efficiency lead to improvements in productivity and operations. Therefore, by integrating AWG technology the Brewery improves

its throughput systems, as AWG technology allows increasing efficiency; by reducing wastes the company is also saving costs. Moreover, as demonstrated and seen before, AWG technology is an environmental technology, which allows to reduce effluents too; this happens because AWG technology use advanced purification and filtration techniques avoiding any kind of chemicals or toxic substances, thus by integrating AWG technology the brewery avoid expels, that most of time, are toxic and prejudicial to the environment and to health (literature reviw, section: *"Atmospheric water generation technology - AWG technology"*). As also referred previously in the literature review (literature review, section: *"Atmospheric water generation technology - AWG technology"*), AWG technology has air purification characteristics, thus by integrating this technology in production systems, brewery can reduce emissions.

Therefore by integrating AWG technology the brewery reduce wastes, effluents and emissions, turning the throughputs system more efficient and environmentally sustainable; this allows brewery to reduce costs (cost of wastes, environmental liabilities, storage and transportation costs, etc.), to be seen as more environmental and social responsible and also provide conditions to produce low environmental burden beers allowing brewery to expand to new markets (already concerned with environmental issues, demanding strict environmental standards) attracting new "green" customers.

Outputs system

In terms of outputs the implementation of AWG technology (an environmental technology with low impact on environment) by the brewery has two major impacts: it reduces wastes, emissions and expels (that are also considered outputs of the activity), and enhance revenues as it allows the brewery to enter in "green" markets, attracting "green" customers who are willing to pay a premium for a "green" product (in this case a "green" beer). By turning beers more "green" products (with the AWG technology integration), the brewery is developing a product stewardship strategy reducing the environmental burden of beers, and therefore, attracting this growing and special "green" market (section: *"A constant changing environment - challenges that companies may face"*). Notice that due to the independency of available fresh water resources, possible by integrating AWG technology in production system, the brewery can implement new plants in new markets, attracting new customers and enhancing revenues.

Notice that by improving its input, throughput and output systems and by enhancing reputation and image (through AWG technology integration) this brewery can improve its gross margin, as

well as, the contribution margin of each beer[35]; actually by integrating AWG technology in the production system the production costs reduce, as seen previously; moreover because it is a "green" product, and because there is a growing market willing to pay a premium for this environmentally friend products, the price per beer can slightly increase; plus due to the independency of water and freedom to implement plants in new markets, entering and selling on them also, companies can increase the number of customers. Therefore, gross margin can increase: revenues increase (either because the number of customers increases or because the price per bear slightly increase) and cost of goods sold decrease (as production costs decrease, as referred previously). Contribution margin also increase: either because product revenue (price) may increase if brewery decide to apply a premium to the new "green" beer, or simply by reducing the variable production cost of each beer.

Now that it is understood how the integration of AWG technology can affect and improve the input, throughput and output systems, as well as, enhance reputation and image, creating value to the brewery, it is next explored how these improvements help companies adapting to the changes in markets.

3.7.1.2. The integration of AWG technology and related improvements on Brewery' VITO elements as a factor of adaptation on a changing environment

As referred previously in the literature review (section: *"A constant changing environment - challenges that companies may face"*) the environment is changing and there are many important changes that companies may take in account, giving them the proper attention in order to know how to adapt to the same. Therefore, next, it is explored how improvements made

35

$$\text{Gross margin (\%)} = \frac{\text{Revenue} - \text{Cost of good solds}}{\text{Revenue}};\ \text{Contribution margin (\%)} = \frac{\text{Product revenue} - \text{Product variable costs}}{\text{Prodcut revenue}}$$

Cost of goods sold: *"This amount includes the cost of the materials used in creating the good along with the direct labor costs used to produce the good. It excludes indirect expenses such as distribution costs and sales force costs"*
Variable costs: "Examples of common variable costs include raw materials, packaging, and labor directly involved in a company's manufacturing process"

Source: http://www.investopedia.com/; http://www.investinganswers.com/term/variable-costs-804

by AWG technology in Brewery' VITO elements can be a factor of adaptation to this changing environment. Then, in section *3.7.1.3.1*, it is assessed the sustainability of AWG technology integration as a factor of adaptation to Brewery, by exploring the relation between AWG technology integration and knowledge involvement and creation. After that, there are conditions to conclude if AWG technology integration is strategic or not to the Brewery and under which conditions that is possible. Therefore, the conclusions drawn in the present section are used in the final conclusion of the example.

As referred above, it is now explored how improvements made by AWG technology in Brewery' VITO elements can be a factor of adaptation to a changing environment. This changing environment is characterized, according to literature review (section: *"A constant changing environment - challenges that companies may face"*) by: changes in environmental regulations that are increasing and then affecting companies' behavior and decisions; by the growing relevance of "green" markets representing changes in customers' preferences and pattern of choices; by the increasing trend of fresh water scarcity as water depletion, contamination and prices fluctuations are risks and possible limitations to companies' activity; by the unsustainable growth trend, characterized by technologies, procedures and methodologies that are not sustainable to follow the increasing population's growth; by the increasing growth of developing countries representing opportunities for companies to expand and growth; and also by the trend of higher prices in brewery industry. These are the changes that characterized the dynamic market in this example.

Increasing environmental regulations

Regarding the growing increase of environmental regulations (literature review, section: *"A constant changing environment - challenges that companies may face")*, the implementation of AWG technology in Brewery's production, and consecutive improvements in inputs, throughputs and outputs systems, can help Brewery overcoming and adapt to this new reality.

By reducing emissions, wastes and expels the Brewery is avoiding environmental liabilities imposed by environmental regulations; by having more energy efficient procedures with less wastes, Brewery can produce below the imposed levels of energy consumption and pollution levels; moreover, by using an environmental technology that protects water, Brewery can also reduce liabilities related with water consumption; by enhancing product stewardship Brewery is also avoiding some negative environmental impacts and consecutive liabilities.

Therefore, due to a long term vision and commitment with the environment, Brewery, develops more efficient processes and input utilization, reduce emissions, wastes and expels, diminishing negative impacts on the environment and anticipating and avoiding some actual and future

environmental regulations and consecutive costs – Brewery can reduce costs. Notice that if Brewery invests in AWG technology, working through solar energy, a referred previously, the reduction of environmental liabilities is even bigger, as their water resources and treatment start to depend just upon natural renewable resources. Therefore, the implementation of AWG technology in Brewery' production system helps it to adapt to increasing environmental regulations.

Growing relevance of "green" markets

"Green" markets are growing (Kotchen, 2006), and customers' patterns of choice are changing too, as environmental issues have now more urgency and are more aware among customers (Shrivastava, 1995; Rugman &Verbeke, 1998; Christmann, 2004); actually "green" customers are willing to pay a premium for a "green" products (literature review, section: *"A constant changing environment - challenges that companies may face"*) .

The implementation of AWG technology in Brewery's production and consecutive improvements in inputs, throughputs and outputs systems, allows to produce beers with low environmental burden (as now the source of fresh water, an important element of beer, is done and treated through an environmental technology, which protects water depletion avoiding its scarcity). Thus, by producing more "green" beers, the Brewery in study can enter and establish in new markets ("green" ones), attracting new customers, creating a position by enhancing its image and reputation as a more "green" and environmental sustainable company. In this way, the brewery is following the growing trend of "green" markets, and may achieve an important position in the market and customers' minds, as they are along with new customers' patterns of choices and environmental sustainable principles.

Notice that the Brewery can be even more "green" if it adopts AWG units working through solar energy. If the Brewery can be the first implementing this AWG technology on its production systems, it can have a first mover advantage. Therefore, AWG technology implementation helps the Brewery to adapt and take advantage of this change in the market and customers' patterns of choice.

Fresh water scarcity trend

The long term vision and commitment with the environment allows the Brewery to invest strongly in AWG technology; by implementing this technology on its production systems the brewery are overcoming a major future limitation on Brewery Industry: fresh water scarcity

(literature review, section: *"Water resources - the problematic of water scarcity"*). As referred previously, water resources are scarcer, in the present century many areas of the globe will face severe or absolute water scarcity scenarios (literature review, section: *"Water resources - the problematic of water scarcity"*).

With the implementation of AWG technology in production systems the brewery does not depend any more on available fresh water resources, thus they avoid uncertainties and risks regarding water sources availability and price fluctuations – which is crucial as breweries are intense water companies. Moreover, this independency of existing water sources, allows the brewery to establish new plants in new locations, where previously was not possible due to the lack of fresh water resources availability; these new locations may be more affordable (in terms of prices, as they are less rich in natural water sources) and may bring advantages to the brewery, for instance, arid locations with huge solar energy potential (arid location are poor in water resources, however it is not a limitation since AWG technology is implemented; moreover, AWG technology can work through solar energy, allowing to produce water just through natural renewable resources at a low cost and in a more sustainable way - literature review, section: *"Atmospheric water generation technology - AWG technology"*).

In fact, as seen previously, fresh water resources scarcity is a huge limitation for Brewery industry, by implementing AWG technology in production systems, the brewery in study can overcome this major limitation, assuring continuing fresh water sources, with high levels of quality and purity, at a low cost (when comparing with traditional water systems delivery), moreover, the brewery has independency to implement plants in different, and previously not possible, locations. Therefore, by implementing this technology the brewery can overcome water scarcity issues and adapt to this new reality.

Unsustainable economic activity growth

As referred in literature review (section: *"Natural resource based view"*) the increasing population growth requires a growth of economic activity in order to provide enough amenities to population, however, this economic activity growth will not be sustainable with current technologies, procedures and methodologies adopted by companies (Ehrlich & Ehrlich, 199; MacNeill, 1989; Ruckelshaus, 1989) cited by Stuart L. Hart (Hart, 1995). Notice that 90% of population growth in the 21st century will come from developing countries, those ones, who will also face the most severe scenarios of water scarcity (section: *Natural resource based view"*, subsection: *"Sustainable development"* and *"Water resources - the problematic of water scarcity"*).

By including AWG technology in production systems, the brewery is following an important technological change, which allows substituting former and less efficient technologies, procedures and methodologies, to more environmentally sustainable ones (AWG technology is an environmental technology). This technological change leads to improvements in inputs, throughputs and outputs systems (resulting from AWG technology integration) assuring brewery' growth and sustainability in future. Because the brewery does not depend upon fresh water sources (inputs system) it is not affecting water availability to this growing population, moreover, the company is using a more "green" and energy efficient solution reducing negative impact on the environment (a more efficient throughputs system avoiding emission, expels and wastes, as well as, outputs system with more "green" products with low environmental burden), this enhance its reputation and image avoiding possible boycotts or criticisms by stakeholders.

Therefore, by integrating AWG technology in production systems the brewery can assure its growth and sustainability in future without compromising a sustainable development, mainly in developing countries - this reflects brewery adaptation to global changes in the world.

Developing countries' growth - "*the markets of the future*"

Actually developing countries are growing a lot and as referred previously will represent 90% of population growth in the present century; according to Stuart L. Hart (Hart, 1995) these are the markets of the future. As also referred previously these developing countries will be the ones facing the more severe or even absolute water scarcity scenarios. The long term vision and commitment with the environment which allows the brewery in study to invest strongly in an environmental technology, also allows brewery to envision entering in these developing markets, contributing to their sustainable developments and growth (notice that at the beginning it was established that this brewery wants to growth and expand).

Actually by integrating AWG technology in production systems, the brewery improves input, throughput and output systems, turning them more efficient, green and sustainable; thus, the brewery has conditions to invest in these developing countries: first, the problem of water scarcity and possible water contamination (due to groundwater sources depletion which as referred in literature review, section: *"Water resources - the problematic of water scarcity"*, is a big issue in developing countries; actually these countries have been using groundwater sources in an incontrollable way, which has been leading to their depletion and pollution, resulting in devastating consequences in terms of health and food quality) will not be a limitation as now the brewery does not depend on fresh water sources availability to the production of beer, moreover, the brewery has now freedom to expand and implement new plants in some remote

or arid locations, frequent on developing countries, in which previously was not possible to implement, this represents more possibilities to growth and expand. In this way, the integration of AWG technology and the resulting improvements in inputs, throughput and output systems, give brewery capabilities to enter and growth in a sustainable way, in the markets of the future.

Once again, in terms of reputation and image, brewery can benefit a lot, they can be seen as more green, and environmentally responsible, as well as, a company aware and concern about actual problems and tendencies, helping to build developing countries contributing to their sustainable growth. Moreover, if the brewery is the first implementing new plants in developing countries with AWG technology in its production systems (producing low environmental burden beers – product stewardship), the brewery can have first mover advantages having preferred access to some resources, such as locations (the most proper ones), customers (who are aware of brewery developments and may develop trust and preference for its beers), and may establish some environmental standard regarding levels of pollution, water consumption, energy consumption, etc. which may represent barriers to other potential entrants.

Therefore, the integration of AWG technology and related improvements in inputs, throughput and output systems the brewery allow brewery to growth and succeed in the markets of the future, adapting to the limitations and different conditions inherent to these countries. By entering in developing countries, the brewery is adapting itself to world' changes, assuring its sustainability in the future.

As showed previously in the discussion (section: *"The impact of AWG technology integration on Brewery' VITO elements – Vision, Inputs, Throughputs and Outputs"*), the use of AWG technology allows the brewery to increase its margins, because production costs are lower (cost of water is lower) and because it is possible to apply a premium to a green product. Just focus, now, on the decrease of the production costs. Experts in the brewery industry foresee that prices of beers will increase due to increases in prices of raw materials, such as, hops and barley[36]. On the other hand it is known that the cost of water will also increase due to its growing scarcity[37]. Therefore, breweries' cost of production will increase which leads to higher prices. Because the brewery in study integrated AWG technology in production systems, it decreases at least the cost of water, having a higher margin, and thus remaining more competitive in the industry. Even if the brewery needs to increase the price of beer (due to increases in prices of raw materials such as hops and barley), because the brewery improved its reputation and image being seen by customers as more "green" and committed with sustainability, this increase may

[36] Source: http://www.allbusiness.com/food-beverage/beverage-industry-beverage-manufacturing/8889823-1.html

[37] Source: http://findarticles.com/p/articles/mi_m1272/is_2743_135/ai_n19039009/; http://www.igd.com/index.asp?id=1&fid=1&sid=5&tid=157&foid=84&cid=908; http://www.eea.europa.eu/data-and-maps/indicators/water-prices

be better accepted by customers, as a significant part of them ("green" customers) are willing to pay a premium for a "green" product (notice that the Brewery may not need to increase prices as competitors, because at least the cost of water in lower).

3.7.1.3. Sustainability of AWG technology integration as a factor of adaptation to the Brewery

In this section, it is demonstrated at which extend the adaptive capability to a changing environment, resulting from the integration of AWG technology by the Brewery, is sustainable. Although it was established at the beginning of the Discussion, as an assumption, that the environment is tacit, in the next subsection, it is explored the relation between Brewery's AWG technology integration and knowledge involvement and creation. After conclude about this, there are conditions to conclude if AWG technology integration is strategic or not to the brewery and the conditions and assumptions under which that is possible. Therefore, conclusions drawn in the present section are used in the final conclusion of the example.

By improving inputs, throughput and output systems brewery is adopting a pollution prevention strategy (avoiding emissions, water depletion and pollution), a product stewardship strategy (now it produces beers with low environment burden, integrating stakeholders' opinion) and allows a sustainable developments strategy (as brewery is investing hugely on an environmental technology, envisioning to enter and growth in developing markets, and has condition to do it). Therefore, and as defended by Natural resource based view (Hart, 1995), the brewery is accumulating tacit skills, due to continuous improvements in its systems, complex skills, by having cross functional capabilities that allows it to coordinate production, marketing and stakeholders' demands, and rare skills, for this long term and shared vision that allows companies to radically change – tacit, complex and rare capabilities are hardly imitable or replicated (Teece et al., 1997).

Moreover, this work takes as assumption that the environment is tacit; thus, this capability of adapting to a changing environment by using AWG technology in breweries' production systems is not easily imitable or replicated from competitors. However, and to reinforce the difficulty of imitate or replicate this adaptive capability, it is next explained how the use of AWG technology implies explorative and exploitative learning activities. By doing this it is demonstrated that the use of AWG technology implies and leads to knowledge creation (knowledge is tacit, complex and specific, thus difficult to imitate), which according to literature is crucial to companies' success in dynamic markets; notice that according to some authors, exploration and exploitation are the base of dynamic capabilities being implied in the same (literature review, section: *"Dynamic capabilities, dynamic markets and knowledge"*).

Therefore, by showing that the use of AWG technology is based on explorative and exploitative learning activities it is finally demonstrated that the use of this technology implies and creates knowledge within the brewery which makes this adaptive capability to changing environments difficult to imitate or replicate – thus a dynamic capability.

3.7.1.3.1. AWG technology use and knowledge creation – exploitative and explorative learning activities

As referred in literature review, exploration and exploitation are learning activities and both are crucial to companies' success (literature review, section: *"Dynamic capabilities, dynamic markets and knowledge"*). Let's see how the use of AWG technology in production systems allows brewery to find a balance between exploration and exploitation; the next demonstrations are based on literature review, sections: *"Atmospheric water generation technology - AWG technology"* and *"Dynamic capabilities, dynamic markets and knowledge"*).

The use of AWG technology implies and develops an explorative dimension because: it allows developing a new way of produce water also leading to the development of new procedures and methodologies, thus enhancing innovation; AWG technology also gives space to go further allowing brewery to explore new alternatives as more efficient ways of use AWG technology, for instance, to put it working through solar energy or other renewable and clean energy, breweries can also find other interesting ways to use AWG technology beyond production systems; this technology is new and allows brewery to explore and enter in new and emerging markets (new possible plant locations, new customers, etc), which is according with the definition of exploration; moreover, by exploring new alternatives and by enhancing innovation AWG technology allows brewery to develop *"specific situation knowledge"* adapting easily to changing conditions in changing environments - as new information is acquired or as conditions change new knowledge is created (Eisenhardt & Martin, 2000).

The use of AWG technology also implies and develops an exploitative dimension because: it allows a refinement in processes and methodologies, as it allows increasing efficiency having less emissions, expels, wastes and risks (for instance, water scarcity and water contamination); it improves productivity, as beyond efficiency it allows reducing cycle times, as referred previously; AWG technology is included in the routine of production systems, enhancing formal routines in the brewery, which is along with exploitation definition and characteristics; by allowing to improve productivity and refine processes, as well as , by enhancing routines, AWG technology integration allows creating tacit knowledge within the brewery, due to tacit skills implied in these continuous improvements – in fact, the manage and use of this technology, in order to achieve all these improvements within the brewery, is a people intensive activity and

implied deep knowledge about the most proper use of the technology according to brewery' needs, knowledge about plants' processes and functionalities, as well as, industry and environmental requirements, actually it requires a broad knowledge that most of times is created in an implicit way, during the activity, and therefore is tacit. Notice that while exploration activities allow brewery to enter in new markets, exploitation allows brewery to reinforce its position in markets where it is already established.

As explained before, the use of AWG technology by the brewery implies and develops exploitation and exploration that, according to literature review (section: *"Dynamic capabilities, dynamic markets and knowledge"*), are learning activities that help to acquire and create knowledge – tacit knowledge and *"specific situation knowledge"*. Actually, as referred previously, AWG technology integration requires a proper management and strategic utilization of the technology, which implies and develops tacit and specific knowledge in order to be successful.

Therefore, as the use of AWG technology implies and creates knowledge, the adaptive capability resulting from this use (AWG technology integration leads to improvements in input, throughput and output systems, as well as, improvements in reputation and image due to a long term vision, that allow brewery to adapt to changing environments as seen previously) is difficult to imitate or replicate thus, the use of AWG technology is a dynamic capability (under some assumptions and conditions resumed in the next section *3.7.1.4*). Notice that as referred in literature review (section: *"Dynamic capabilities, dynamic markets and knowledge"*), the balance between exploitation and exploration, and consecutively, tacit and *"specific situation knowledge"*, is crucial to companies as it allows to develop sustainable and not predictable dynamic capabilities – therefore the use of AWG technology is a sustainable dynamic capability to the brewery.

3.7.1.4. Conclusion of the example

From this illustrative example it is concluded that **by integrating AWG technology in production systems** (which demonstrate a long term vision and commitment with the environment and sustainability) **the brewery can improve its inputs, throughput and output systems** which allows it to reduce productions costs (water cost decrease), to enhance efficiency (reduce emissions, expels and wastes which avoids resulting environmental liabilities), to enhance productivity (reduce cycle times as water does not need to pass by traditional water systems treatments, storage and transportation), to enhance revenues (attract new customers, "green" markets) and to enhance reputation and image (a more sustainable company aware and

concerned with global issues). **By affecting and improving VITO elements** (a rough comparison with Porter' value chain elements) **the use of AWG technology allows brewery to adapt to actual and future changes in the environment, remaining competitive in its industry**.

As explained previously in the Discussion (section *3.7.1.3 "Sustainability of AWG technology integration as a factor of adaptation to the Brewery"*), by improving inputs, throughput and output systems brewery is adopting pollution prevention, product stewardship and sustainable developments strategies (Natural Resource Based View' strategies), which allows it to accumulate tacit, complex and rare capabilities that are hardly imitable or replicated (Hart, 1995; Teece et al., 1997). Moreover **the use of AWG technology implies knowledge as it is based on exploitative and explorative learning activities**; because knowledge is tacit, complex and specific it is hardly imitable or replicated, **thus the use of AWG technology is also hardly imitable or replicated by competitors**.

Therefore, based on Natural Resource Based View (Hart, 1995) and dynamic capabilities analysis, taking in account the assumption that the environment is changing and tacit and under the condition established at the beginning of the example that the brewery is envisioning to enter in "markets of the future", it can be concluded that **the use of AWG technology is a dynamic capability to the brewery** – thus it is strategic to the Brewery.

Notice that **the use of AWG technology is only strategic** (as a dynamic capability) **to the Brewery under the assumptions and conditions referred above**, resuming: the example has as base Natural Resource Based View (Hart, 1995) and dynamic capabilities analysis; the example takes as assumption a changing environment characterized by changes in environmental regulations, growing "green" markets, increasing fresh water scarcity trend (and consecutive water depletion and contamination risks, as well as, higher water prices), unsustainable grow trend (due to technologies, procedures and methodologies not sustainable when facing increasing population growth), increasing importance of developing markets (*"markets of the future"*), and also the trend of higher prices in Brewery industry; the example also takes as assumption that the environment is tacit, thus strategies and capabilities are hardly imitable and replicated; the example is based on a Brewery (a company from a water intensive Industry) envisioning to enter and expand in developing markets.

3.7.2. Pharmaceutical industry example - another smaller illustrative example

Now, it is explored another smaller example in which the utilization of AWG technology can help companies adapting to changing environments. For instance, pharmaceutical industry;

pharmaceutical industry requires high quality water for production being water one important commodity in this industry[38].

Actually, by implementing AWG technology in its production systems, pharmaceutical companies can reduce operational costs as the cost of water is lower (to reduce operational costs is one of the big issues in this industry[39]); moreover, pharmaceutical companies can assure high water quality levels, as AWG technology contains advanced filtration and purification techniques; by integrating AWG technology, pharmaceutical companies can also assure a continuous pure fresh water supply without incurring in risk of depletion or contamination (all the information about AWG technology is based on literature review, section: *"Atmospheric water generation technology - AWG technology"*).

Pharmaceutical companies can also benefit from AWG technology as it allows them to be more efficient and "green"; actually, AWG technology allows to reduce emissions, expels and wastes (which turns pharmaceutical companies more efficient, and helps them reducing possible environmental liabilities, contributing to lower pharmaceutical' costs), moreover, it helps companies in this industry to become more green and committed with the environment, as they protect natural water sources (that are more and more scarce) decreasing their negative environmental impact, as they are using an environmental technology (all the information about AWG technology is based on literature review, section: *"Atmospheric water generation technology - AWG technology"*). Notice that corporate responsibility is crucial to these companies as public perception can damage their image and ratings; pharmaceutical companies more and more want to be seen as more efficient and environmental committed - pressures and scrutinizes are increasing in this industry[40].

By integrating AWG technology in production systems, pharmaceutical companies reduce negative impact on the environment, protects fresh water resources, and produce more "green" products with a low environmental burden, moreover pharmaceutical can assure high levels of water quality and avoid risks of depletion and contamination (more frequent due to water scarcity and groundwater depletion as referred in literature review, section: *"Water resources - the problematic of water scarcity"*), (all the information about AWG technology is based on literature review, section: *"Atmospheric water generation technology - AWG technology"*). These improvements, resulting from AWG technology integration, help pharmaceuticals to

[38] Source:
http://www.ema.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/09/WC500003394.pdf
http://www.water.siemens.com/en/industries/biopharmaceutical/Pages/water-energy-conservation.aspx

[39]Source: http://www.water.siemens.com/en/industries/biopharmaceutical/Pages/water-energy-conservation.aspx

[40] Source: http://www.water.siemens.com/en/industries/biopharmaceutical/Pages/water-energy-conservation.aspx

adapt, among other things, to environmental regulatory changes, to water scarcity scenarios, to stakeholders' pressures and demands, and to customers requirements and increasing concerns with the environment (by improving image and reputation as these companies are more "green"). Moreover, Pharmaceutical companies can decrease their operational costs and improve their image and reputation (two major issues faced by this industry[41]), which helps them adapting to a changing environment, remaining competitive.

Because the right implementation and use of AWG technology implies knowledge, as seen in the previous example, and because the environment is tacit by assumption, the use of AWG technology by pharmaceuticals is hardly imitable or replicated by competitors. Thus, based on Natural Resource Based View (Hart, 1995) and dynamic capabilities analysis, taking in account the assumption that the environment is changing and tacit, and having in mind some major issues faced by pharmaceutical industry (operating costs reduction and conservation of natural resources and public perception – conservation/corporate responsibility), it can be concluded that AWG technology integration can be a dynamic capability to pharmaceutical companies allowing them to remain competitive - thus being strategic.

3.8. Summary of the chapter

The previous Discussion starts by establishing some major assumptions: the environment is changing and the environment is tacit. Then the methodology is reviewed and it starts some theoretical demonstrations: AWG technology as an environmental technology; the contribution of this technology to pollution prevention, product stewardship and sustainable development strategies, and their impact on companies' sustained competitive advantages (lower costs, preempt competitors and future position in developing countries, respectively) – based on Natural Resource Based View (Hart, 1995); the leverage effect caused by AWG technology in companies due to path dependency and embeddedness characteristics of the previous three strategies - based on Natural Resource Based View (Hart, 1995); and the contribution of AWG technology to a proactive environmental strategy. Actually based on Natural Resource Based View (Hart, 1995) it is possible to develop the previous demonstrations and to drawn some intermediary conclusions that are helpful throughout the discussion and in the final conclusion of this work. This theoretical part also allows concluding about some conditions in which the use of AWG technology has more strategic impact and potential, they are: companies in water intensive industries, envisioning entering in developing markets. Water intensive industries make the advantages of AWG technology more indispensable and critical; to envision entering

[41] Source: http://www.water.siemens.com/en/industries/biopharmaceutical/Pages/water-energy-conservation.aspx

in developing countries is required to follow the third strategy of Natural Resource Based View, benefiting from its resulting capabilities and competitive advantages. After the theoretical demonstration, it starts a more practical part in which a practical demonstration is done through illustrative examples in order to explore how the use of AWG technology can be strategic to companies and under which conditions.

The first example is about a Brewery envisioning to enter and invest in developing countries (the two conditions referred above are accomplished as Brewery industry is a water intensive industry and it is established at the beginning of the example that the brewery envisions to expand to developing markets). Moreover, it is taken as assumptions that the environment is changing and that the environment is tacit. To assess if the use of AWG technology is strategic or not to the brewery, it is first assessed at which extend the use of AWG technology can affect and improve Brewery' input, throughput e output systems, as well as, improves its vision. After assessing how the use of AWG technology improves Brewery' VITO elements, it is explored how those improvements helps Brewery to adapt to a changing environment. Then, in order to reinforce the tacitness of the environment and to assure that the use of AWG technology and resulting capabilities are hardly imitable or replicated, it is explored how the use of AWG technology involves and creates knowledge.

With all the intermediary conclusions drawn throughout the example it is possible to conclude if the use of AWG technology is strategic or not to the brewery: because the use of AWG technology allows brewery to adapt to a changing environment, through improvements in VITO elements, and because this is hardly imitable or replicated by competitors, the use of AWG technology is a dynamic capability to the brewery, thus it is strategic. However, this conclusion can just be drawn under some assumptions and conditions that make it possible, they are: the example has as base Natural Resource Based View and dynamic capabilities analysis; it takes as assumption a changing and tacit environment; this changing environment is characterized by changes in environmental regulations, growing "green" markets, increasing fresh water sources scarcity, unsustainable developments trend, growing relevance of developing markets, and increases in beer' prices; moreover, and as referred above, the brewery is envisioning to enter in developing markets and is an intensive water company.

The second and smaller example is about a company in pharmaceutical industry. Water is a crucial commodity in pharmaceutical industry; this industry requires water with high levels of quality (purification). In this example it is assessed how the use of AWG technology allows this company to overcome some major problems in pharmaceutical industry (operating costs reduction and conservation of natural resources and public perception – conservation/corporate responsibility) also adapting to changes in the environment, reducing risks and consequences

associated with these changes (for instance water contamination or depletion, stakeholders' pressure, environmental regulations' demands, customer requirements for a more sustainable activity, etc).

Therefore and under some assumptions and conditions it is possible to demonstrate that the use of AWG technology is a dynamic capability to pharmaceutical companies. These assumptions and conditions are: the example is based on Natural Resource Based View (Hart, 1995) and dynamic capabilities analysis; by assumption the environment is tacit and is changing; this changing environment is characterized by changes in environmental regulations, "green" markets and increasing concern of customers, as well as, stakeholder pressures (very common in this industry), increasing fresh water scarcity scenarios (and resulting contamination, depletion, etc), and unsustainable developments trend; in terms of water requirements, pharmaceutical industry strongly depend upon high quality water, being water one important commodity in the industry; moreover, the example is also based on two major issues faced by the industry – the need of operating costs reduction and conservation of natural resources and public perception – conservation/corporate responsibility.

Based on the theoretical intermediary conclusions drawn throughout the discussion and also based in the practical demonstrations done through illustrative examples, it is now possible to answer properly to the research question. The final answer and overall conclusion is done in the next chapter.

4. Conclusion

As referred at the beginning (Chapter 1 *"Introduction"*) the purpose of this work is to answer to the research question: *"Can Atmospheric Water Generation be strategic to companies according to the Natural resource based view approach?"*. In order to answer to the research question, a methodology is adopted which allows drawing intermediary conclusion used in the final conclusion of the work – the present chapter. The methodology starts with a theoretical analysis, based on the theories approached in the *"State of art"* (Chapter 2), and then two examples are developed to illustrate the theoretical conclusions.

In the present Chapter it is firstly summed up the theoretical conclusions drawn in the beginning of the discussion, as well as, some conditions under which they are possible; then the conclusions drawn from the illustrative examples are also summarized. After that, the research question is finally answered and it is also presented the set of particular assumptions and conditions under which the final answer is possible. At the end of the Chapter a small subsection regarding *"Future Research"* is developed.

Throughout the discussion it is concluded that **AWG technology is an environmental technology**; it is also concluded, **based on Natural Resource Based View (Hart, 1995), that the use of this environmental technology is along and contributes to pollution prevention, product stewardship and sustainable development strategies, which can lead companies to sustained competitive advantages** (lower costs, preempt competitors and future position in developing countries, respectively); moreover, the use of AWG technology can have a leverage effect on these sustained competitive advantages as they are path dependent and embedded. By contributing to these three strategies, the **use of AWG technology is contributing to a proactive environmental strategy, which according to *Contingent Resource Based View* of natural environment** (Aragón-Correa & Sharma, 2003), **can be a dynamic capability** (Teece et al., 1997) – by contributing to a proactive environmental strategy, the use of AWG technology can indirectly be a dynamic capability, however, according to conditions dictated by the market.

Throughout the Discussion it has been referred that the **conclusions above make sense in water intensive industries' companies** (strongly depending upon fresh water resources) **envisioning to enter and invest in developing countries**, because companies in these conditions can profit more from the use of AWG technology. Actually, in these companies AWG technology has a stronger impact when compared with companies that require less fresh water sources and that are not interested in enter or invest in *"markets of the future"*, for instance, sustainable development strategy would not be applied to these companies – altering

the above discussion – and the costs' reduction (resulting from a pollution prevention strategy) would be smaller as these companies do not depend intensively upon fresh water.

After reaching to these theoretical conclusions, it is demonstrated, through an illustrative example, how the use of **AWG technology can be strategic to a brewery**[42] helping it to adapt to a changing environment, remaining competitive – it is illustrated how the use of **AWG technology can be a dynamic capability to the brewery and under which conditions and assumptions that is possible**. Another smaller illustrative example is done to a pharmaceutical company, showing how the use of **AWG technology can be strategic to the pharmaceutical**, also helping it adapting to a changing environment, allowing the pharmaceutical company to remain competitive in its industry (also under some conditions and assumptions that make it possible).

Taking in account the intermediary conclusions drawn in Chapter 3 (*"Discussion"*), it is possible to answer to the research question: **according to Natural Resource Based View (Hart, 1995) and based on dynamic capabilities analysis, AWG technology can be strategic to companies** as its utilization can be a dynamic capability (allowing companies to adapt to changing environments remaining competitive) also providing companies with sustained competitive advantages (lower costs, competitors preemption, future position in developing markets). However, and as referred above, **the integration of AWG technology can be strategic to companies under a set of conditions and assumptions that make it possible**; as stated at the beginning of this work as an assumption, **the environment should be tacit and should be changing** (this changing environment should be characterized by changes in environmental regulations, growing "green" markets, increasing fresh water scarcity scenarios, unsustainable economic activity growth and by the increasing growth of developing markets, *"markets of the future"*), moreover, **companies should be water intensive and should envision to enter and invest in developing countries**, in order to benefit more from AWG technology' advantages.

Therefore, companies can strategically benefit from the use of AWG technology as they can better adapt to a changing environment also remaining competitive. Moreover by integrating AWG technology companies are contributing to a more sustainable environment and simultaneously assuring a sustainable growth and position in future.

[42] As referred previously, brewery Industry depends strongly upon fresh water resources, moreover, many breweries have their plants on developing countries, for instance in Africa, thus, the choice of a brewery industry's company to develop the illustrative example is an appropriate choice.

4.1. Future Research

In future developments it should be studied which other industries can benefit strategically from AWG technologies and what conditions and assumption would make it possible. Still, in water intensive industries it would be interesting to study AWG technology not only as part of production systems but also as part of the products themselves; for instance brewery machines[43] that requires a source of water, it could be interesting to study if in future it would be possible to integrate AWG technology in the machine itself[44], this would enhance product stewardship and innovation. Another example is also coffee machines[45] that require a water storage recipient, which in turn requires be cleaning and refilling frequently; in future companies may find advantageous to integrate AWG technology in the coffee machine itself, and these machines will not need anymore water storage recipients – this would also enhance product stewardship and innovation[46].

Moreover, it would be interesting to study how governments and respective countries could benefit from AWG technology, how this technology can turn them more competitive and environmentally sustainable. It should be also interesting to study AWG technology from humanitarian organisms' point of view and explore how it would help and contribute to a more effective and expansive intervention in developing countries and emergency cases, without restrictions and risks and with higher reliability levels.

[43] Source: http://www.beermachine.com/files/how-beer-machine-works.htm
[44] Notice that this would imply developments of AWG technology as it implies completely different models in a small size proper to a machine with small dimensions.
[45] For example: *Nespresso* and *Tassimo* kind of coffee machines
Source:
http://www.tassimo.pt/descubra/886;
http://www.nespresso.com/#/pt/pt/coffee_machines/consumer_service/maintenance_advice_machine

[46] Notice that this would imply developments of AWG technology as it implies completely different models in a small size proper to a machine with small dimensions.

5. References

Articles

Aragón-Correa, J.A. & Sharma, S., 2003. A Contingent Resource-Based View of Proactive Corporate Environmental Strategy, *The Academy of Management Review,* 28(1), pp. 71-88

Arrow, K., Dasgupta, P., Goulder, L., Daily, G., Ehrlich, P., Heal, G., Levin, S., Mäler, K.G., Schneider, S., Starrett, D. & Walker, B., 2004. Are We Consuming Too Much?, *The Journal of Economic Perspectives*, 18(3), pp. 147-172

Barney, J.B., 1986. Strategic Factor Markets: Expectations, Luck, and Business Strategy, *Management Science*, 32(10), pp. 1231-1241

Chen, C., 2001. Design for the Environment: A Quality-Based Model for Green Product Development, *Management Science*, 47(2), pp. 250-263

Christmann, P., 2004. Multinational Companies and The Natural Environment: Determinants of Global Environmental Policy Standardization, *The Academy of Management Journal,* 47(5), pp. 747-760

Coff, R.W., 2003. The Emergent Knowledge-Based Theory of Competitive Advantage: An Evolutionary Approach to Integrating Economics and Management, *Managerial and Decision Economics,* 24(4), pp. 245-251

Cuddington, J.T. & Moss, D.L., 2001. Technological Change, Depletion, and the U.S. Petroleum Industry, *The American Economic Review*, 91(4), pp. 1135-1148

Deng, P.S. & Tsacle, E.D, 2006. Emergent Learning Behaviour in a Simulated Organization Faced with Tasks Requiring TeamEffort, *The Journal of the Operational Research Society*, 57(5), pp.603-611

Eisenhardt, K.M. & Martin, J.A., 2000. Dynamic Capabilities: What Are They?, *Strategic Management Journal*, 21(10/11), pp. 1105-1121

Graham, S., Parkinson, C. & Chahine, M., 2000. The Water Cycle, *NASA Earth Observatory Articles*

Hart, S.L., 1995. A Natural-Resource-Based View of the Firm, *The Academy of Management Review,* 20(4), pp. 986-1014

He, Z.L. & Wong, P.K., 2004. Exploration vs. Exploitation: An Empirical Test of the Ambidexterity Hypothesis, *Organization Science*, 15(4), pp. 481-494

Hofman, J., Hofman-Caris, R., Nederlof, M., Frijns, J. & Loosdrecht, M., 2011. Water and Energy as Inseparable Twins for Sustainable Solutions, *Water Science and Technology,* 63(1), 88-92

Holmqvist, M., 2004. Experiential Learning Processes of Exploitation and Exploration within and between Organizations, *Organization Science*, 15(1), pp. 70-81

Kesavan, P.C. & Swaminathan, M.S., 2006. Managing Extreme Natural Disasters in Coastal Areas, *Philosophical Transactions: Mathematical, Physical and Engineering Sciences*, 364(1845), pp. 2191-2216

Kor, Y.Y. & Mahoney, J.T., 2005. How Dynamics, Management, and Governance of Resource Deployments Influence Firm-Level Performance, *Strategic Management Journal*, 26(5), pp. 489-496

Kotchen, M.J., 2006. Green Markets and Private Provision of Public Goods, *The Journal of Political Economy*, 114(4), pp. 816-834

Lockwood, J.R., Schervish, M.J., Gurian, P.L. & Small, M.J, 2004. Analysis of Contaminant Co-Occurrence in Community Water Systems, *Journal of the American Statistical Association*, 99(465), pp. 45-56

March, J.G., 1991. Exploration and Exploitation in Organizational Learning, *Organization Science,* 2(1), pp. 71-87

McEvily, S.K., & Chakravarthy, B., 2002. The Persistence of Knowledge Based Advantage: An Empirical Test for Product Performance and Technological Knowledge, *Strategic Management Journal,* 23(4), pp. 285-305

Portney, P.R, 2000. Environmental Problems and Policy: 2000-2050, *The Journal of Economic Perspectives*, 14(1), pp. 199-206

Richter, B.D., Mathews, R., Harrison, D.L. & Wigington, R., 2003. Ecologically Sustainable Water Management: Managing River Flows for Ecological Integrity, *Ecological Applications*, 13(1), pp.206-224

Rugman, A.M. & Verbeke, A., 1998. Corporate Strategies and Environmental Regulations: An Organizing Framework, *Strategic Management Journal,* Vol.19, pp. 363-375

Seckler, D., Barker, R. & Amarasinghe, U., 1999. Water Scarcity in the Twenty-first Century, *Water Resources Development,* 15(1/2), pp. 29-42

Shrivastava, P., 1995. The Role of Corporations in achieving Ecological Sustainability, *The Academy of Management Review*, 20(4), pp. 936-960

Shrivastava, P., 1995. Environmental Technologies and Competitive Advantage, *Strategic Managements Journal*, Vol. 16, pp.183-200

Straf, M.L., 2003. Statistics: The Next Generation, *Journal of the American Statistical Association*, 98(461), pp. 1-6

Stuart, J. & Powell, J.H., 2006. Men and Measures: Capturing Knowledge Requirements in Firms through Qualitative System Modelling, *The Journal of the Operational Research Society*, 57(1), pp. 10-21

Teece, D.J., Pisano, G. & Shuen, A., 1997. Dynamic Capabilities and Strategic Management, *Srategic Management Journal,* 18(7), pp. 509-533

Wernerfelt, B., 1984. A Resource-Based View of the Firm, *Strategic Management Journal*, 5(2), pp. 171-180

Yli-Renko, H., Autio, E. & Sapienza, H.J., 2001. Social Capital, Knowledge Acquisition, and Knowledge Exploitation in Young Technology-Based Firms, *Strategic Management Journal*, 22(6/7), pp. 587-613