Water management and new clean technologies in Africa: A review of Compotherm

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Abstract

Challenges in water management are becoming more severe in many countries and this is exacerbated by climate change. With the increase of environmental threats, a new market for clean tech companies is emerging on the global scheme. The majority of these companies are small and medium seized companies (SME) under rapid growth. This paper is investigating the clean-tech product Compotherm. Two market overviews of the global solar thermal market as well as the portable water purification market will be shown. Which market-based factors are vital for the products potential success? What current competitors are there? This paper will also study the current needs of water clean technologies in Africa by conducting and reviewing a series of interview.
Findings show that the interest for thermal water heaters is growing in both a local and international view. Compotherm could be seen as plazed in the middle of two traditional product categorise within the market. in the market of portable purification systems the potential success of new products is dicussed upon. In order to survive in the rapid emerging business companies are have shown to market there product for a specific clientele.

Abbreviations

CAGR – Compound Annual Growth rate

CO_2 – Carbon Dioxide

MWth – Thermal Megawatt Hours

NGO – Nongovernmental Organisation

RO Purification – Reverse Osmosis Purification

RoW – Rest of the World

SHC – Solar Hydronic Corporate

SME – Small and medium seized companies

SWH – Solar Water Heating

PBI – Performance Based Instruments

UNEP – United Nations Environment Programme

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1. Introduction

Water is a key resource on Earth. The accessibility of the natural resource strongly affects the world's economic and social activities. Poor water resource management along with the effects of climate change has a major impact on already vulnerable countries as well as the world's ecosystems (UNEP, 2015).

On the 28th of July, the general assembly of the United Nations established resolution nr 64/292 stating that every human has the right to water and sanitation (UNGA, 2010). The resolution is considered as a milestone in human rights legislations of today. In the UN water and sustainable development goals it is also stated that by 2030, universal access to safe and affordable drinking water should be met (UN, 2015). The roads to achieving these resolutions are not easily attained. Approximately 600 million people are still without the lowest entry level of drinking water. Further collaborations amongst the UN members and industry are essential to meet the current goals (UNICEF, 2016).

New technologies within the global water and wastewater sector are emerging daily and are crucial for solving today's water crisis. The sector consists of both traditional tools such as piping, drilling for wells and treatment plants but also a new clean tech market with renewable alternatives. The definition of "Clean Tech" has over the years been altered, widened and today is primarily defined as: "A product, service or process that delivers value using limited or zero renewable resources and/or creates significally less waste than conventional offerings" (Pernick & Wilder, 2007, p. 2). The share of companies active in renewables consisted mainly of large conventional industries such as Ge, Siemens, Vestas and Suez however with the growth of clean technology the number of small and medium sized enterprises (SME) are increasing (Pernick & Wilder, 2007). The water and wastewater sector was estimated to be worth around 0.6 trillion dollars in 2014 and is projected to be steadily growing (Clancy, 2014).

In this study, the clean teach product Compotherm will be reviewed as well as the current needs of new water technologies in Africa.

With a previous planned application in the solar thermal market the developer is trying to reach another niched market within the portable water purification market. Its unique composite formula consisting of 100% recycled materials has shown great potentials to be marked as a portable purification system (Compotherm, 2016). However, more water tests have to be done before launching the product into the portable purification market.

1.1 Purpose and research questions

The purpose of this paper examines the current challenges and potentials for the product Compotherm to enter both the clean tech water market as well as solar thermal market. A review of the current needs for new water technologies as well as the challenges in water management in Africa has been performed through a literature review and a series of interviews. In order to achieve the purpose of this paper, two research questions have guided the research.

1.1.1 Research question 1

What are the current needs in new water technologies in Africa?

1.1.2 Research question 2

What is required for Compotherm to be attractive on the market?

1.2 Delimitation

Through a series of discussions with the producers of Compotherm, the focus area of Africa was decided. Africa is one of the world's largest continents and contains wide differences in the environmental landscape. However due to limitations in data and research in the two selected markets within Africa, an additional geographical delimitation has not been chosen in this study.

2. Method

The paper's methodology is largely divided into two sections. Firstly it will include a literary research, which will function as a base for answering research question nr 1. Secondly a number of interviews base made with people from different backgrounds and careers in order the get multiple view regarding the subject of this paper. The interviews will be the main source in order to conclude what actual needs there are for new water technologies in Africa. Together the two sections will serve as a qualitative study.

2.1 Research search strategy

A series of electronic searches was made in April 2017. The searches were done in Web of Science's core collection, LUBsearch, Google scholar and also ScienceDirect databases. A range of peer-reviewed articles, books and reports from governments and organizations has been used in this study. The chosen books have all been searched upon in Lund University's electronic library catalogue, LOVISA. Keywords applied in the electronic search are: *technology transfer, clean tech, water management, solar thermal system, water purification, water purification projects, market based instruments, start up, venture capital*. An additional sorting during search was done by listing the articles found in the search databases, by the number of times they have been cited. No selected timeframe has been chosen in the searches. Finally some of the used literature was found in reference list in already found literature.

An analysis of the market and the current competitors of Compotherm were completed. In the search of current competitors, used search words are vital for finding possible competitors. As mentioned in the Introduction, Compotherm belongs to two different markets that are of solar thermal systems and of water purification systems. Because of this both markets have been surveyed. The list of possible competitors within unglazed collector market from the three major solar; The United States, Brazil and Australia have viewed in table nr 1.

The four displayed unglazed water collectors have been selected among certified unglazed water collectors. The product are certified by the international

Solar Rating and Certification Corporation (ICC-SRCC) and found in their certification registry. The initial sorting was made in review of the products performance. (ICC-SRCC, n.d). The ICC-SRCC is an international third party certification organisation protected by the International Code Council (ICC-SRCC, 2017). Potential competitors from national and local market levels will also be displayed and discussed.

The possible competitors have been viewed in a series of functions:

- Performance of product
- Lifespan and warranty of product
- Geographic distribution of product

The main competitors and the factors regarding the products will be displayed in a table in the results. An overview summary of respective markets will also be shown in the results, which will later be discussed upon in the discussion section of this paper. The overview of possible competitors within the portable purification have been summarised through a series of snowballing effect while searching reviews and reports.

2.2 Interviews

The interviews made in this study have the purpose of investigating the current needs of water purification technologies in Africa. The interviews are thereby then a key segment in order to answer research question 2. Through the guidance of Johannessen and Tufte (2003) 3 qualitative research interviews were conducted. An additional 3 interviews where analysed in the study.

List of contributing respondents:

- Gunilla Björklund, Steering committee member of Global Water Partnership.
- Annika Fernlund, Board member of Polyplank.
- Ken Surritte, Founder of the humanitarian aid organisation Water is life.
- Magnus Persson, Professor in Water management engineering at Lund University.
- Klara Westling, Research engineer at IVL Swedish Environmental Research Institute.

List of referenced interviews

- Bai-Mass Taal, First Executive Secretary of the African Minister' Council on Water.
- Tom Albanese, CEO of Rio Tinto.
- Patrick K Decker, President of Xylem.

The questions asked in the interviews consisted of both descriptive and interpretive questions. Each interview was slightly customised for the respondent. All interviews were semi-structured in order to allow the respondents to elaborate on their responses in view of the person's current profession and prior experiences. The questions asked where short and relevant of the subject. In Patton's book *Qualitative evaluation and research methods* (1990), why-questions are advised not to be used since it would strongly influence the person's answer. As a result why-questions as a follow-up question was consciously avoided during interviews.

The product Compotherm wasn't introduced during the interview as that could have potentially influenced the interviewee views as well as would serve little use since the interviewee would have then had to be very familiar on the product beforehand. The selected respondents have been found through a series of snowballing effects while searching current studies, projects and organisations. During the selection of interviewees, a wide range of respondents with different types of experiences where chosen. This was done in order to triangulate a wide range of information on the chosen subject while reducing the potential knowledge gap.

The interviewed where initially contacted by mail where they were asked if they would consider being interviewed. After approval, a date was arranged for each interview to be held and the received the structured questions a week before the date. After the interview, the answers where transcribed and summarised and emailed back to the interviewee for a final approval. If no response was made after the summarisation by the interviewee, they were then deemed to be approved. Finally after all interviews where completed and summarised, they where then analysed and compared to each other.

3. Compotherm

Compotherm is a self-supporting sun collector made from composite material and designed to heat water. The product is produced and patented by the company Polyplank AB in Öland, Sweden and was developed in 2014. The materials and invention used to construct this product have earlier been applied in constructing e.g. noise barrier and pool heating systems. The company mission for the product is to deliver process heated water with the least environmental impact. With this product they aim to reach out and help increase the well-being of developing countries (Compotherm, 2016).

The product is made from 100% renewable materials and together with its high durability it separates itself from other competitors. Annika Fernlund, board member of Polyplank sees Compotherm as a relevant product with great market potentials once the research stage is finished. The company is open for future collaborations with local governments and humanitarian aids (A. Fernlund, Communication, 2017-05-30).

Pending this new stage of the products development the product is classified, as an unglazed solar collector in the solar thermal market but in the future it will mainly be marketed within the portable water purification market.

The product consists of a storage tank with designed passageways for the water to travel through. On both ends of the storage tank, the design allows the individual unit to be connected to additional units. In addition to the composite material's own conductivity, the colour black is chosen in order to maximise the absorption of solar heat. The construction is light and durable with the expected life span of 20 to 30 years. After the product can no longer fill its purpose it can then be melted and remade again from the same materials (Bergenstråhle, et al., n.d).

Image 1. Compotherm, mobile solar water-cleaners.

The technology is patented 46 countries and hasn't been on the market during a long period of time. In 2010, the product was sent to Burkina Faso for more field tests and a national market research and Swot-analysis was made. The solar heating tests where done by the solar energy company ISOMET, where the measured a maximum temperature of 60 ^{o}C (CDT International, 2010).

After test where done in Burkina Faso and additional tests has been held during the cold winters of Scandinavia as well as in the tropical forests of Malaysia. In all of these tests, an overall performance of 1000 kWh /m^2 and was detected in all locations. The stated efficiency of 55 % is higher than the majority of unglazed solar collectors in the market according to the inventor of Compotherm (Compotherm, 2016).

With the water reaching a temperature of 60^{o}C there is several waterborne organisms that could potentially be reduced bay heating water with Compotherm. Among hazardous waterborne organisms, organisms such as enteric pathogens, E. coli, Vibrio Cholerae and Giardia species could be killed at 60^{o}C (Backer, 2002)

A third party evaluation of the product and initial competition analysis has been made for the solar thermal energy market. This was done in connection to the company applying for it's patent. In this evaluation 3 unique selling points are stated for the product:

- Durable self-supporting construction
- Low production price / affordable retail price
- Efficiency in relation to cost

These selling points where created by the third party company that made the initial evaluation of Compotherm.

4. Results

4.1 New water technologies and perspectives on water resource management in Africa

4.1.1 Views among governmental organisations & researchers

The water crisis in Africa and other parts in the world is a complex problem. Mr Bai-Mass Taal executive secretary of the African ministers' council on water (AMCOW) concludes in a interview made in 2009, that 22 of 54 African will not meet the millennium development goals. He addresses that the international community has failed to allocated it's grant to where it is needed the most. According to Mr Bai-Mass Taal, middle income countries such as Malaysia are prioritised more than rural Africa. In his work at AMCOW he is working on getting rural areas in Africa a higher prioritisation (UN-Water, 2009).

Magnus Persson, professor in water resource engineering at Lund University, discusses on where we are seeing the biggest difficulties in water management. Magnus Persson argues that it is hard to point out a single factor in which are responsible for today's water issues. Countries that have traditionally been water scarce are having the greater difficulties with factors such as increasing population rate, increased living standard together with climate change (Persson, communication May 2017).

Gunilla Björklund steering committee at Global water partnership (GWP) was interviewed in this study. When asked about the possible reason for we there is such a large proportion of countries insufficient in water resource management, she mentions; water scarcity has led insufficient water management. Most lacking water resource management is a result of not agreeing upon an integrated water management on both a national and international scale (Björklund, communication May 2017). Both Gunilla Björklund and Bai-Mass Taal points out that countries must work on shared water resource management in order to manage the water scarcity (Björklund, 2017 & UN-Water, 2009).

When Mr Persson (communication May 2017) discusses about the future, he stresses the importance of seeing more closed loops and circular systems within water resource management. Also by effectively allocating the water consumption

between a number of water sources the environment gets more time to regenerate (Persson, 2017).

Mr Taal discusses the importance of seeing today's declarations and commitments into actions. *" African countries themselves often do not place enough priority on water and sanitation"*. 9% of the world's freshwater resources are located in Africa however only 3.9% is utilised. (UN, 2017). There is also great inefficiencies in the current water mater market leading to large amounts of clean water are wasted. Magnus Persson (communication May 2017) mentions the examples of Tunisia and Egypt where regional distribution of water to motivates landowners to use unnecessary amounts of water. He also gives the example of California USA, where current legislations' are allowing certain landowner to use unlimited amounts of waters when in drought. Future pricing of water is needed to ensure a sustainable water management. *"Today in many ways, the market value of water is not it's true price. Some may pay a fraction of what others get to pay for accessible water, which further influences more people to be wasteful of water"* Additional technologies that Mr person wants to see in the future are mainly cheaper techniques for desalinating water. Due to today's techniques for desalinating water usually requires a lot of energy (Persson, communication May 2017). Gunilla is working with GWP to enable countries to develop shared water resource management on both a national and regional level. In the future she would like to see there would be a bigger requirement for countries to collaborate and in order to strengthen the current agreements and conventions that are in place (Björklund, communication May 2017).

When asked what actors would have the greatest potential for improving current water issues both Björklund and Persson argues that there are great possibilities for the industry influence governments and the economy. (Björklund, May 2017 & Persson, May 2017).

Research engineer Klara Westling discusses future water technologies. During discussion on quality of materials in comparison to efficiency and pricing, she stresses the importance on the quality of the material, especially regarding larger and conventional purification systems. The materials have to be able to manage the demanding processes it is designed for. Also in the aspect of pricing compared to efficiency with technologies with smaller flows, she says that low pricing is key for individual households When asked how important it is for technologies to be portable she says: "*When it comes to smaller flows and individual households, it can certainly be an option but when it comes to larger equipment, there is no need". "And even if you install it at a single drain, the option portable is not a significant function".* However in the aspect of Compotherm that you have mentioned I certainly think it's very important to be portable. During (K.Westling. communication June 2017).

4.1.2 Views from industry and human aid organisations

As earlier stated, the industry is one of the key drivers for increasing water consumption. Water reliant companies such as the mining company Rio Tinto has early on developed a strategic water resource management in their corporate structure. In an interview with the CEO of Rio Tinto Tom Albanese, talks about the strategic water management and the economics of water. With operations commonly in arid locations and with water demanding processes, Rio Tinto has made long term sustainable efforts. By investing in water resource management Rio Tinto are potentially eliminating external high risk factors such as water scarcity, flooding and large variation in water accessibility. *"Probably the most important part of our strategy would be ensuring that future facilities that we build or mines that we develop are actually designed from the very beginning with the principles of water conservation"* (McKinsley, 2010).

Mr Albanese discusses on the eventual needs for pricing of water in order to make the appropriate capital trade-offs for water inefficiencies. He also exemplifies where market trade-offs for water are already occurring; the company has joint venture in Chile where sustainably water has come from desalination. The company's pricing for their water consumption is reflecting of the energy bill that is generated by desalinating the water. He continues to explain that the pricing of the desalinated water use in Chile will give future incentives for similar mines to work for a sustainable water consumption. Mr Albanese argues that investing in water conservation is a form of enabling future business advantages rather than a required investment. Some of the greatest challenges for Rio Tinto are to create a strategic water management that satisfies the need from both local and global stakeholders (McKinsley, 2010).

In an interview with the president of Xylem Patrick K Decker he talks about the advantages of water management (Xylem, 2016). Xylem is one of the leading water technology companies working with smart solutions in water purification (Xylem, 2017). Xylem published a

Show that approximately 50% of the green house gases emissions derived from the wastewater sector can be reduced at a neutral or negative cost to the costumer in a practical timeframe. This was calculated by using data from various sources and based on using already new and available technologies. Peter Decker discusses on the possibilities for countries where water infrastructure is being built to invest in smart infrastructure with energy efficient water pumping networks. Although the are greater difficulties for improvement where a water infrastructure is already built, Mr Decker argues that there are sill long term possibilities for those areas. Estimating the time scale for the global utility sector to go over to smart water infrastructures varies great on both a national and global level. Leading countries such as the UK, Sweden, Middle East, China and India are moving quickly towards smart water infrastructure. Some of the greatest

investments on smart water technologies are found in developing countries. Xylem is going to continue their business model and to invest even more in smart solutions. Mr Decker further discusses the huge potentials within the advanced treatment space for industrial. Lastly Mr Decker summarises that there are great possibilities for the company moving forward in the fragmented market (Xylem, 2016).

The Founder of humanitarian aid organisation WaterIsLife Mr Ken Surritte, has been interviewed in this study. His organisation is in over 40 countries worldwide dealing with water quality and water scarcity. In Africa the organisation has developed strategic foundations Kenya, Ghana, Tanzania, Ethiopia, Namibia, South Africa, Democratic Republic of Congo as well as tentative agreements with some of the north-western countries. WaterIsLife uses several technologies in order to tackle the needs of drinking water and sanitation. Technologies used in the organisations operations are both short and long term purification system. Among the short term technologies used are the WaterIsLife's straw, WaterIsLife's ceramic bucket filter and the drinkable book. Among the long term solutions offered, the organisations works with traditional techniques such as drilling for wells and installing pumps and using their own patented centralised water treatment plants. Mr Surritte explains; "*This is how we do our treatment simply because everybody got water, its just not potable"*. Long and short term technologies are used for different purposes. The short-term filter systems are essential for the organisation when natural disasters or epidemics such as cholera occur. Mr Surritte states that by using short-term technologies such as the straw, it gives them a time period of 6 to 12 months to find a sustainable solution (Surritte, communication May 2017).

In order to assess the needs in each area that WaterIsLife is working in they are teaming up strategic partners, originating or living in the certain area. In Africa the organisation also has in-country directors that are supervising the work as well as monitoring the follow up of WaterIsLife's operations. *We believe that the change is only going to happen when the people themselves adopt change. So we work developing a water action in the communities and made up of key influencers"*. The organisation structure is to develop a strategy together with the community and Mr Surritte is confident the structure both the start of a new foundation as well as a incentive for other villages to also change. Ken Surritte states that it is usually the women in the communities that are pushing the key influencers and tribal leaders towards a sustainable change (Surritte, communication May 2017).

Water is life is also working with communities who want to move from open defecation to defecation free certification by giving out micro loans for end-users to invest in sanitation utilities (Surritte, communication May2017).

When discussing communications with both country and local governments Ken Surritte says that communications with every government is different. The

majority of governments are positive for the organisations work and especially if they don't need to invest themselves. However there is a portion of the governments in the developing countries whom are partially funding WaterIsLife's work (Surritte, communication May 2017).

When asked, what are the greatest difficulties to work as an organisation Ken Surritte says: *"Most of all of us say funding is a huge issue. We have the technology and we even have the manpower; we just need the resources in order to implement"*. The organisation is currently collaborating with several different companies and Mr Surritte says there are great possibilities for NGO's and companies to work together. When asked if there was any technologies or processes, which are missing on the market, he said that he together with other partners where working on is an affordable, low power, non-RO desalination process. Ken Surritte argues that RO purification is an answer but not the answer for solving the worlds water management problems. This is because RO purification systems require a lot of power that are usually not coming from renewable energy sources (Surritte, communication May 2017).

4.2 Market analysis of solar water heating

Commonly, water collectors such as Compotherm in the solar thermal market are sorted into glazed or unglazed water collectors. Glazed water collectors have traditionally been dominating the global solar thermal market. In addition to the glazed and unglazed water collectors, air collectors are also included into to the solar thermal market (Mauthner et al., 2016).

The term of glazed and unglazed refers to the use of glass in the range of collectors. The glass can be seen in various forms around an active agent, which are driving the thermal heating in order to preserve the heat. Further changes between unglazed and glazed water collectors are seen in the efficiency. The unglazed has a lower efficiency in heating water and it also generally has fewer possibilities in restoring the temperature of the heated water. Because of this, unglazed collectors are usually more reliant on the ambient temperature (Iceri et al., 2013).

Due to lower in efficiency in unglazed compared to glazed products, unglazed water collectors are primarily for operations in low medium heat such as heating domestic hot water and swimming pools, therefore the majority of the clientele of unglazed water heaters arrives from single residential homes (UNEP, 2015). The product Heliocol which will be displayed later in the studies generated a maximum temperature of when comparing glazed collectors to unglazed collectors, glazed collectors are commonly used for domestic water hearing with an average temperature of 60 to 80^{o}C (Struckmann, 2008).

During the year 2014, approximately 93.2% of total installed capacity consisted of glazed and 6.3% of unglazed water collectors. However the development and need for both glazed and unglazed water collectors have been steadily increasing since the year 2000 (Mauthner et al., 2016). Some of the potential reasons for the steady increase in solar water heating (SWH) are: Sustainable design, cost-effective life cycle and several environmental benefits (UNEP, 2015). The three largest economies for unglazed collectors are found in Australia, Brazil and lastly the United States. Figure nr 2 displays the global distribution of unglazed water collectors by totalled installed capacity during the period of 2000 to 2014. The capacity is measured in thermal megawatt hours (MHth) and 4 different comparisons for each year is shown: United States, Brazil, Australia and rest of the world (RoW). The diagram encompasses data from 61 countries and does not take into account of the expected amount of self-made thermal heating systems. (Mauthner et a., 2016).

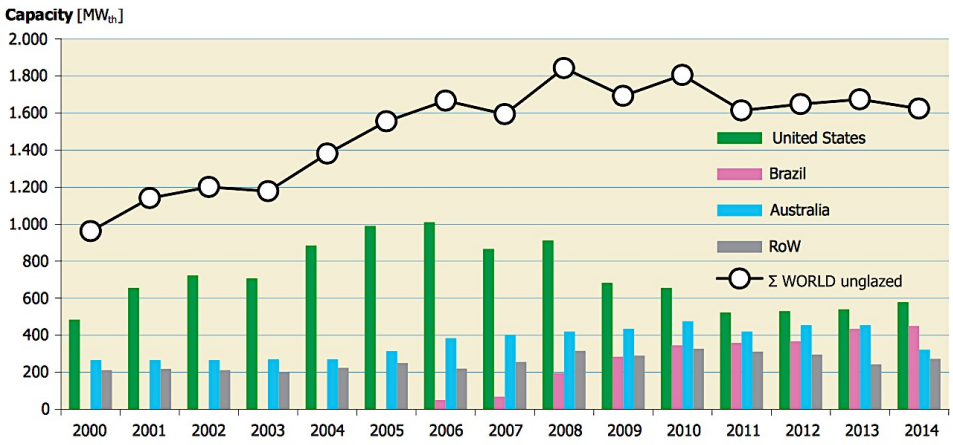

Figure 1. Global development of unglazed water collectors (Mauthner et al., 2016)

One of the leading advantages in solar thermal heating systems is that it gives way for several environmental benefits such as a reduction carbon dioxide (CO_2). In a study where glazed and unglazed water collectors were compared to oil heating alternatives, an annual global reduction of $120*10^6$ t_{co2eq} was estimated during the year of 2014 (Mauthner et al., 2016). SWH is also expected to be among the top technologies with the highest carbon reduction potential in the next 25 years (ESTTP, n.d).

With the global market working for a turn too more renewable alternatives, solar thermal heating is expected grow considerably. International organisations such as United Nations Environment Programme (UNEP) have created a strategic

guide for introducing solar thermal heating in developing countries and to weaken the current market barriers that exist. The UNEP strongly advocates for economic instruments such as subsidization and performance based instruments (PBI) in order to lower the initial costs and to increase the incentives for end users to choose SWH (UNEP, 2015). Generally the largest cost of investing in SWH is in an installation fee, which makes up for 40-60% of total costs. This is largely due to the relative shortage of available SWH installer and distributors worldwide (ESTIF, 2015).

The SWH market is mainly a decentralized market and because of this a large share of the market's revenues are gained in the last stages of the value chain. By investing in SWH large employment opportunities are made (ESTIF, 2015). Establishing minimum requirements of products is also key subject in order to create a trustworthy foundation of which the SWH market can build upon (UNEP, 2015a).

Lastly educational efforts in order to further strengthen the SWH market are vital. In an market analysis on the European SWH market made by the European solar thermal industry federation (ESTIF), several of the examined countries argues that there is a low awareness of SWH and it's potentials, which prevents the market from growing (ESTIF, 2013).

4.2.1 Main competitors

Among possible competitors to Compotherm, the best performing competitors within the unglazed water collector are shown table 2. The 4 competitors are sorted by their respective performances and additional facts such as distribution span and expected lifetime warranty are shown. The performance shown in table 1, displays the maximum achieved performance in a controlled location with solar radiation of 6.3 $kWh/m^2/day$. The price of these four items are not stated, this is largely due to there are numerous of factors influencing the price for each costumer, for example: location of client and dealer, required capacity and installation costs.

Among unglazed water collectors certified at ICC-SRCC there was an average performance of 5.6 kWh/m^2 at the selected solar radiation of 6.3 $kWh/m^2/day$. When looking at distribution of unglazed water collectors, the minority of certified collectors has a worldwide distribution. Warranty as well as accessible guaranties varied greatly (ICC-SRCC, n.d).

Table 1. Competitors
List of possible competitor to Compotherm.

Distributor	Product	Performance (kWh/m^2)/ day	Distribution	Expected lifetime guaranty
Uma Solar	Heliocol	6.5	USA	35 years
Fafco	Sunsaver	5.9	USA, Worldwide*	12 years
Techno-solis	SwimMaster	5.8	Europe*, North America, South America* and Oceania*	Undefined
Solar Hydronic corporation	Hi-Tec	4.9	USA	Limited lifetime warranty

4.2.2 Local market competitors

Market analysis in Burkina Faso was contracted by the producers of the product in order to locate potential competitors as well as market possibilities. In Burkina Faso SWH is mainly used for heating of showers and bath and is seldom used for drinking purposes. In the market analysis two categories of products was identified; imported equipment from mainly China and locally manufactured SWH equipment. In the market of imported products, majority of contacted dealers experiences a strong clientele. In contact with government humanitarian aid organisation, both parties said they would be positive of collaboration. Among possible collaborations that were discussed, a potential local manufacturing of Compotherm was the most in favour of the governmental party (CDT International, 2010).

4.3 Water purification market

The global water purification market value is increasing at a rapid speed. According to a market analysis made by Allied Market Research, the global purification market is expected to be worth $45.3 billion by 2022 and growing at a compound annual growth rate (CAGR) of 10.4% (Marketwatch, 2016). Another

report made by Technavio, the market is projected to grow even faster with a CAGR of 14% by 2020. This is due to the launching more of low costing water purifiers entering the market. Estimating market potentials is generally hard to achieve and market values can fluctuate (Techniavio Research, 2016).

Market drivers for the water purification market is commonly divided into 5 categories: Human population growth, Agriculture, Energy, Industry and Ecosystems. Agriculture makes up for nearly 70% of the global water consumption in order to feed the ever-growing human population. The demand of food is projected to increase by 30% between 2012 and 2030. With the increase in energy demand more water is used as process water when generating energy (UNESCO, 2012).

Industries are experiences troubles in their own water consumption. Production usually requires a reliable influx of clean water and around 20% of the world's annual freshwater consumption is derives from industries. Lastly ecosystems are in demand for a continuous flow of water in order the preserve it's current ecosystems. By preserving ecosystem, it gives way for a series of co-benefits to take in place (UNESCO, 2012).

One of the largest investors in the water market is India where approximately 70% of all surface water resources are polluted. The large share of polluted surface waters has leaded to a number of water-borne deceases hitting the workforce of India and leaving has a large impact on the Indian economy. India's water purification market is expected to grow considerably with a CAGR of 22% and by 2019 it is expected to be worth $1.53billion (ValueNotes, 2014).

The clean tech water and wastewater market is increasing every day and is expected to invest $ 6.4 trillion in developing countries. The regions with the largest market potentials for clean tech SME are in the water and wastewater sectors are South America and Africa with a market potential of $349 billion and $235 billion respectively (Infordev, 2014).

The global water market is increasing with large market potentials but there are still large challenges for the market. Introducing water technologies to rural areas in need have initially been a difficult task and early evaluations indicate that investment costs outweighs the possible benefits; this has haltered the growth of end users (Johnson et al., 2008). In an interview with Mahesh Gupta, founder chairman of Kent RO, he points *"One of the major challenges is to educate the consumers about the need for RO purification. Even today, boiling is considered the best method for purifying water, but consumers should understand that boiling does not remove dissolved impurities"* (Ravikumar, 2015). Johnson et al., (2008) argues that biggest difficulty is to deliver new technologies at a price point where it is accessible while complying with requirements related to safety and functionality.

4.3.1 Competitors in the Water purification market

Key investors in the water purifier market are Best Water Group, GE Water and Process Technologies Inc., Tata Chemicals, Brita, Kent RO System Ltd and Veolia (MarketWatch, 2016). The market share of large size companies in 2015 amounted to 54% of the total market share. With the market value increasing more large companies are buying up smaller players on the market and at 2018, the market share of large companies is expected to be around 70% (Ravikumar, 2015). However by enabling small companies and start-ups to enter the market, the possibilities for new innovations increase (OECD, 2010).

The market of portable water purification system has increased over the time and is promoted for a wide range of clientele. Portable purifiers are vital for organisations such as humanitarian aids organisations in order to reach even the people in the most rural areas (Surritte, communication 2017-05-15).

The portable market is commonly categorized into: Reverse osmosis, distillation, filtration and disinfection systems. Close competitors such as Solvatten offer a product with similar processes (Solvatten, n.d). Other products that are becoming increasingly popular are small purification systems such as filtrations straws and gravity filtration systems (Outdoorgerlab, 2017 & Safewise, 2016). Bestselling competitors such as the Life straw claim to purify much of the same features as Compotherm, but is available in a number of sizes and forms (Lifestraw, 2017). Life straws core marketing is towards the market of outdoor equipment but also for humanitarian aid (Lifestraw, 2017a).

4.3.2 Clean tech SME's entering the water purification market

SMEs have large market potentials within the clean tech market, but entering the clean tech market has several uncertainties. There are significant capital requirements and many are dependent on governmental funds (Infodev, 2014). SME's with new innovations are generally strongly dependent on funds although SME's whom had been solely reliant on governmental support during research and development stage tends to be having setback in funding during later stages of commercialisation of the product (Tillväxtverket, 2010). There are several market barriers for SME to enter a new market. The SME's that do become actors on the water purification market have a great role in reducing CO_2 (Johnson et al., 2008).

Some of the major market barriers are: high risks in relation to possible returns, difficulties in attracting venture capitals, expected long time-to-market and "the valley of death". The term valley of death is referred to the possible time period where funding from venture capital as well as governmental funding is not

accessible. Development is haltered and SMEs that are heavily reliant on external funding have difficulties in continuing operations (Vendel et al., 2017).

Sweden is among the countries with the highest research and development investments. Generally Sweden is seen as a forefront for clean tech and approximately 300 to 900 companies are incorporated into the Swedish clean tech market (Business Sweden, 2015). Current structure of environmental legislation, policies as well as taxation laws in the country of the SME impacts probability of the venture capitalists to invest (Vendel et al., 2017).

International organisations and nongovernmental organisations (NGO) have a vital role for further development and humanitarian aid for developing countries. Still the potentials for NGO's and international organisations to invest in new water technologies such as water purification systems are not evident. In a review made by Johnson et al., (2008) it is claimed that the potentials for international organisations and NGO's to collaborate with single private actor in the market have traditionally been limited. This is largely because organisations are trying to have a neutral position in the global market and therefore they traditionally don't want to promote a single actor in the market. However in an interview with Ken Surritte, Founder of WaterIsLife, points out that there a great possibilities for organisations and private companies collaborating. The human aid organisation WaterIsLife is currently collaborating with several different enterprises (Ken Surritte, 2017).

Partnering with larger enterprises has several benefits for SMEs within the clean tech market. Apart from possible funding through corporate venture capital, already established enterprises within the market could bring resources, contacts and knowledge to the SME (Vendel et al., 2017).

5. Discussion

This report has covered a number of areas in order to give a full view of the market potentials for Compotherm, in the two selective markets of unglazed water collectors and of portable water purification systems. In addition to the two market overviews, a study on the current needs for new water technologies in Africa has been made.

5.1 Current challenges and needs for purified water in Africa

In this study, several different views have been shared on today's water issues. The water crisis affecting large parts of Africa involves a variety of actors. Both local and national authorities as well as NGO's are working in order to mitigate the effects of water crisis. The UN is working hard ensuring a future where everybody has the right to clean water for drinking and sanitation purposes. The industry is emerging with new technologies into a fast growing international market.

In the interview both many of the respondent have talked about challenges in water management. Difficulties in sharing and collaborating among neighbouring countries are haltering the processes initiated from the UN as well as organisations such as the GWP (Björklund, May 2017 & UN, 2009). Injustice is both a structural as well as on a policy level causes a continued wastage of water (Persson, communication May 2017). The global wastage of water puts more pressure on industries to mitigate their environmental impact as well as water usage. Water reliant companies such as Rio Tinto are introducing strategic water management into their company structure in order to order to

prevent unforeseen expenses (McKinsley, 2010). Water companies such as Xylem are experiencing great market potential with the ever-growing clientele of authorities, organisations and the end users (Xylem, 2016). Among the list of clientele are the humanitarian aids organisations are benefited by the increased competition among water purification systems. An increase in competition is likely to lower the cost of purification systems, which is according the Ken Surritte the greatest obstacle.

5.2 Solar water heating

Compotherm belongs to the smallest market share of water collectors, the unglazed water collectors. Because of its generally low efficiency compared to other water collector new market possibilities are limited. Unglazed water collectors are usually sold in the niched market of renewable pool heaters. However the categorisation of glazed and unglazed water collects is made by structural design. There are no requirements for a water collector to reach a certain water degree. In previous field tests, Compotherm measured a maximum temperature of 60 ^{o}C which is significally higher than general unglazed water collectors (CDT International, 2010). Also with the registered efficiency of 55%, it´s performance makes it more suited for it to be competing amongst glazed water collectors (Compotherm, 2017).

The global distribution of unglazed water collectors during a period of 15 years has experienced minimal changes in market sales compared to glazed water collectors. In 2008 the sales of unglazed water collectors in its biggest economy the United States, started to decline. The following year other markets experienced an increase in sales and thereby keeping the distribution at a relatively unchanged rate (Mauthner, 2016).

Information of current competitors is easily traceable through several certification organisations (ICC-SRCC, 2017).

The water collectors displayed in table 1, all requires that sales go through a certified dealer. 3 of the 4 competitors view teamed up with larger pool companies in order to promote their products. All of the 4 competitors are made from new plastic materials and no water collectors with recycled materials where found. Compotherm uses 100% recycled materials which could potentially distinguish Compotherm for other players within the market. Also the majority of competitors reviewed were based in the United States and majority of them did

not offer an international distribution. By strategically promoting the product in areas where the market is less developed could potentially give Compotherm a better chance.

In my opinion the market potentials for Compotherm in the solar thermal market are good but will probably need an active promoting for the product to be successful. This is largely because Compotherm is traditionally placed between two markets which means that one has to even more stand out among competition in order not to lose market potentials

5.3 Portable water purification market

The water purification market is growing rapidly and new products are emerging almost daily. There are still more research and development that needs to be done in order to launch Compotherm into the competitive market. There are great possibilities for Compotherm to succeed in the portable purification market if they get the possibilities to get the product into the market. Compotherm is of a smaller size than traditional water purification systems however unlike other small sized purification systems; it's not designed to be a temporary equipment.

With the life expectancy of 25 years and with it's relatively small environmental impact, it distinguishes itself from other products with similar performances (Solvatten, n.d). Westling pointed out the importance of quality in the materials used in the purification systems. All of the discussed competitors of Compotherm in both selected market are mainly of newly produced plastics which further continues the usage of fossil sources. Compotherm is also based on plastics, however the features of the product allow it to have a long life expectancy. The potentials for relocating are a positive feature of the product but not anything that separates itself from its competitors.

One can argue that by creating the materials used in Compotherm, a negative impact is created by permanently mixing organic and fossil based materials in order to make composite materials. Further the guaranty of a remelting feature is only ensuring if the company Polyplank is till active after Compotherm's expected life span.

Vendel et al., (2017) describes the needs for to quickly attract venture capital in order to succeed, but he also stated the numerous advantages there are for companies to joint venture. Even though Johnsson et al., 2008 states that there are slim potentials to collaborate with NGO's, WaterIsLife in many ways exemplifies the opposite. As we have seen through the interviews from various respondents, water management and the need for new water technologies is complex problem and not every solution is suitable for everywhere.

6. Conclusion

In this study we have reviewed the markets of solar water heating, the portable water purification market as well as the current water crisis situation in Africa. Limitations in shared water management, strategic water management and shortcomings and climate change are among key factor according to the respondents.

There is still a long way for Compotherm to reach each selected markets. With a rapid growing water purification market there is a lot of challenges for SME to enter the market. However with the emerging new SME's into the markets, a new innovation spur takes on and great possibility for both economic and public health is achievable. Compotherm has great possibilities to take a part in this action. Lastly the possibilities for Compotherm to reach it's two selected markets could be heavily reliant the progress of it's research and development stage. Funding from government and venture capitals has shown to be vital for the success of SME within clean tech.

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