A Work Project, presented as part of the requirements for the Award of a Master's degree in Management from the Nova School of Business and Economics.

AQUAPURGO – A BUSINESS PLAN FOR A GREENTECH START-UP TACKLING PFAS DESTRUCTION:

Research & Development and Entrepreneurial Finance

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Abstract

This work project is based on a Field Lab (FL), which challenges students to develop a start-up in a real context.

The following thesis is based on a recent scientific finding and its marketability. Throughout the FL, the student group investigated a pressing issue and its repercussions on society. The students pursued the development of a plan through an investigation of all stakeholders involved and backed the material with current industry data in order to provide a novel and distinct solution to the issue. The following thesis depicts a marketable solution that includes managerial, financial, operational, marketing, and branding strategies.

Keywords: Science-based, Greentech, Entrepreneurship, R&D, Sustainability, Social, Start-up, PFAS, Strategy, Business Plan, Innovation, Entrepreneurial Finance

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1. Group Part

1.1. Methodology

Since all founders are business students and their knowledge of chemical processes and industry understanding was relatively low initially, gaining as much insight as possible from other sources was necessary. Therefore, apart from the Literature Review, we decided to conduct several expert interviews with not only chemical experts but also potential customers, industry decision-makers, and state officials. Furthermore, we surveyed the general public to evaluate if an awareness campaign is necessary to push further regulations in Germany. The following chapter will go further into detail on the goals and general results of the methodologies chosen.

1.1.1. Survey

In order to effectively assess our target audience and see how well aware they are of PFAS, we decided to survey the German population. This survey was quantitative with a mix of open-ended and close-ended questions. The mix of question styles allowed participants to engage in the questions and involve their opinions. The goal was to gain insights into awareness and knowledge of PFAS and general thoughts about social start-ups.

1.1.1.1. Description of the questionnaire

The survey started out by asking about general demographics before moving on to questions about practices related to drinking water, particularly filtering. The next question in the survey specifically inquired if the respondent knew about PFAS or forever chemicals. If the respondent was aware of PFAS or not, the survey's logic continued to ask different questions. For those without prior knowledge of PFAS, a page was presented with generic information on the term and asked them repeatedly if they were aware of it and felt concerned for their health. Questions about problem-solving strategies and accountability for resolving the difficulties were posed after bringing both participation groups (the ones who knew something and those who didn't) back together. The survey finally asked participants' opinions about social impact and social

entrepreneurship in relation to the PFAS subject. All of the survey results have been generated into graphs and can be found in Appendix 1.

1.1.1.2. Examination Procedure & Timeline

A pre-test was conducted after the survey's conceptualization to ensure its readability and interpretive consistency. Seven participants have been invited to participate in the pre-test for this process. The test showed that some questions needed to be altered, and it was necessary to provide more context when addressing particular PFAS-related topics. Furthermore, additional pictures were added to the description of PFAS to make it more easily understandable for participants. After adjustments, the final questionnaire was given to non-experts in Germany, the market we were trying to reach. These participants were chosen deliberately to provide a broad overview of PFAS awareness in Germany. The survey was openly accessible from October 13 until October 16, 2022, with an average completion time of 3 minutes.

1.1.2. Expert Interviews (EI)

Semi-structured interviews were used as the method for conducting a qualitative analysis. A discussion guide has been created in advance for every expert (see exemplary questions in Appendix 2). While such an approach creates a controlled procedure, it also leaves room for dialogue to evolve naturally, absorb information, and access both subject and emotional levels (Tracy, 2020). The interview was broken up into two segments, with the first section covering more broad subjects and then going deeper into the specific expertise each expert provided for the business model.

- **Academic:** Having an academic approach to our project was essential for our work, believing that we gained a clear structure and focus on the most important topics.
- **Chemistry:** Founding a tech start-up, we had a huge demand for insights into chemical processes and technology implementation approaches.

- **Government:** Getting in touch with government officials to have insights into the status quo on regulations and a future outlook on the progression of such regulations.
- **Industry:** Looking at the industry, we interviewed experts in multiple areas. It was important to get in touch with first customers and talk to competitors and closely connected market participants. Furthermore, for potential approaches to funding, a VC has been interviewed to gain insight into the industry principles.
- **Informal talks/interviews:** Apart from the official expert interviews with a pre-planned catalog of questions, we also carried out several "informal" talks with specialists and contacts that pre-established contacts from our founders. Furthermore, a profile of our mentor Timo Broeker from our collaboration university TH OWL, will be highlighted in Appendix 1.

In the following thesis, expert interviews will be referred to as:

("Last name interviewee", EI, 2022)

1.2. Introduction

Per- and polyfluoroalkyl substances (PFAS) comprise a large, complex group of chemicals that are ubiquitous in our environment and contaminate ground, waste, and drinking water worldwide (Haist-Gulde, EI, 2022).

This group of chemicals includes at least 4,700 different compounds (Arnold et al., 2021). These compounds have one thing in common: their slow and restricted environmental degradability. Therefore, some PFAS compounds, such as the best-known representatives perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), can be classified as persistent, bioaccumulative, and toxic substances (PBT) (Kempisty et al., 2016; Matthies et al., 2016). PFAS have only been produced synthetically from the 1950s until today and serve as surfactants and surface protection for certain industrial and consumer applications (Edel et al., 2018). They are common in our everyday environment, from non-stick cookware to stain- and water-resistant coatings on clothing, furniture, packaging, food wares, and even in personal care products (Kempisty et al., 2019; Kotthoff et al., 2015). In addition, PFAS have also been incorporated into the agents used to fight hydrocarbon-based fires, particularly in aviation and firefighting communities (Dauchy et al., 2017a). Besides, PFAS are used in the production of various electrical components (Tansel, 2022a). These chemicals have penetrated the environment and contaminated almost every drop of water on the earth through production methods and consumer usage of PFAS-containing items over the past 70 years. Because of their remarkable persistence, they can pass through most water treatment systems unscathed (Kempisty et al., 2019).

The unique properties of PFAS originate from the substitution of hydrogen with fluorine along the carbon backbone that makes up the hydrophobic part of a surfactant (Buck et al., 2011; Kempisty et al., 2016). Unlike other known surfactants, the fluorine atoms' strongly electronegative properties mean that such PFAS can repel grease, water, dirt, and oil (Arnold

et al., 2021). The problem with these useful chemicals is that some are known to be chronically toxic at exceptionally low concentrations, and extensive research has shown that exposure to PFAS can harm human health and the environment (Arnold et al., 2021; Stoiber et al., 2020a). In this context, inappropriate or illegal disposal of PFAS-containing waste can be identified as the main contributor to the environmental contamination caused by the hazardous chemicals (Dauchy et al., 2017b; Edel et al., 2018; Kempisty et al., 2016). According to scientists, over 50,000 tons of PFAS are released into the atmosphere each year (Evich et al., 2022). At the same time, the chemical industry is inventing new PFAS molecules at a rapid speed (Kämpfe, EI, 2022).

These very stable chemical compounds cannot be eliminated biologically, chemically, or thermally by in-situ remediation methods, a method where contaminated soil and groundwater are treated directly in the ground (Hussain et al., 2022). Therefore, PFAS-damaged groundwater and drinking water needs to be retrieved from the contaminated aquifer and treated above ground. Only a few of the thousands of PFAS compounds are legally restricted at the European level (Arnold et al., 2021). The diversity of PFAS, however, always allows for evasion to other PFAS that have not yet been regulated and have undergone less extensive research. The degree of PFAS environmental contamination is predominantly based on approximations. The required analytics for monitoring at very low concentrations are still being developed and cannot capture the variety of PFAS deployed.

The following Group Part of our Master Thesis deals with explaining the problem of PFAS and why it is relevant. Then, after explaining the methodologies used, we will provide a summary of our business activities, how we developed our business model, and present a market overview. The group part of this thesis will end with a PESTLE-Analysis, which serves as a reference point to introduce the individual parts.

1.3. The Problem

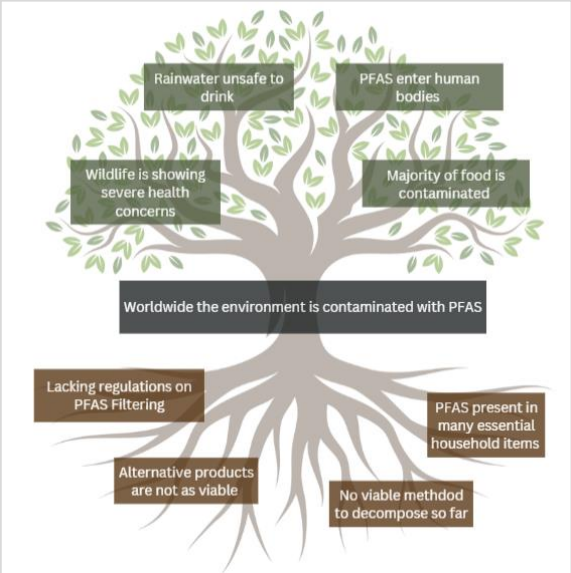


Figure 1: Problem Tree

The topic of PFAS is extensive and can be investigated from many different perspectives. Generally, the high usage of products containing those chemicals, as well as no viable destruction method thus far, feeds into the general problem that worldwide the environment is contaminated with PFAS (see Figure 1).

The following chapter will detail the Problem of PFAS, how it originated and why it is important to tackle.

1.3.1. The cycling problem

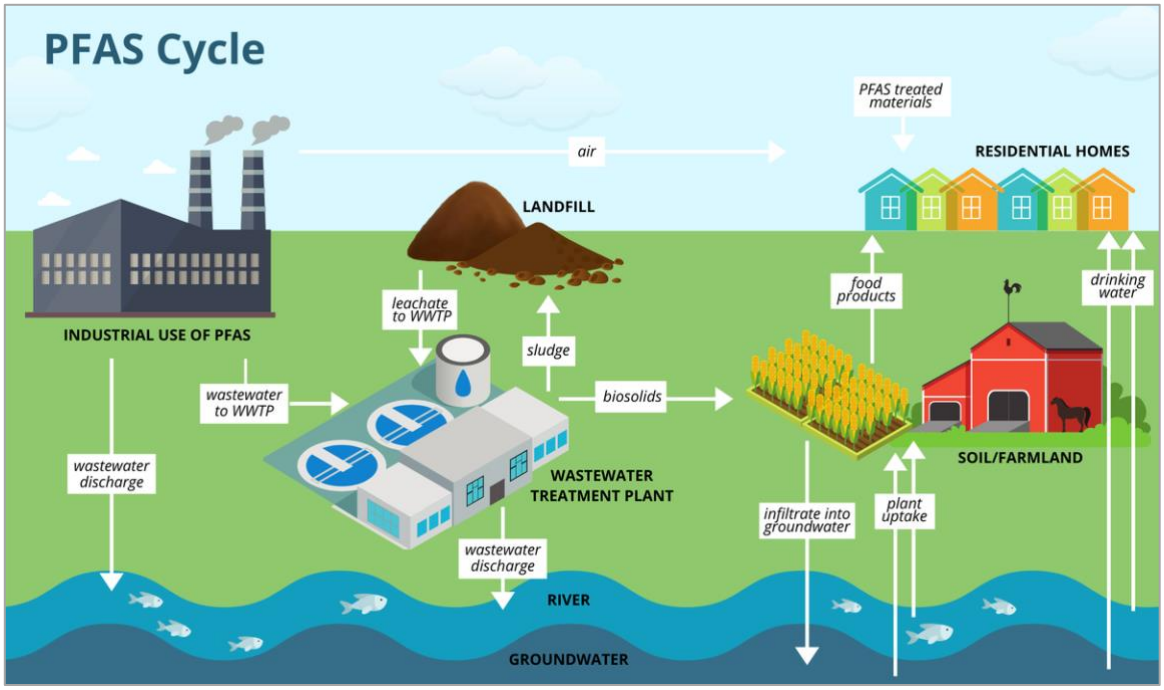


Figure 2: The PFAS life cycle *(Vinny & Casey, 2021)*

The environmental cycling of PFAS starts with direct emissions during manufacturing and industrial processes, as well as the use and disposal of consumer products containing PFAS (as additives or impurities)(see Figure 2). At this point, compounds get released into our water cycle and start spreading. This is particularly problematic for DWTPS since most European drinking water comes from groundwater. Through the latest discoveries of the extensive environmental contamination with PFAS, notably in drinking water, an urgency to the issue of its removal and disposal arose (Stoiber et al., 2020a).

In general, there are three interconnected disposal pathways for PFAS components - landfilling, waste water treatment, and incineration. For instance, landfill leachate is frequently fed to waste water treatment plants (WWTP), whereas sewage sludge may be incinerated or transferred back to landfills (Masoner et al., 2020; Stoiber et al., 2020b).

Here, both old and active landfills are particularly threatening mankind's safety as the substances prolong for decades, and polymers may break down over time into smaller, more mobile types (Stoiber et al., 2020b; Washington & Jenkins, 2015). Concerns regarding landfill stability also exist in possible future climate change scenarios, including higher annual precipitation and severe storms (EPA, 2014).

WWTPs can receive vast amounts of PFAS-contaminated waste from several sources, including municipal waste water, leachate from landfills, and industrial wastes (Stoiber et al., 2020a). However, most WWTPs cannot remediate persistent organic pollutants (POPs) (Teymourian et al., 2021). As a result, they can be identified as a significant source of PFAS release, with PFAS concentrations in waste water being about 1000 times greater than in its surrounding receiving water bodies (Teymourian et al., 2021).

PFAS are frequently detected in WWTPs effluent, particularly at WWTPs that accept industrial waste, at concentrations up to hundreds of ng/L and are considered the major point source of these hazardous compounds in the aquatic environment (Ahrens, 2011; Becker et al., 2008;

Hamid & Li, 2016). Additionally, like landfills, WWTPs are a source of PFAS air emissions, particularly during aeration treatment (Hamid & Li, 2016). Given the existing situation, waste water effluent treatment to reduce PFAS concentrations and/or eliminate PFAS entirely appears to be required before the effluent can be recycled for reuse (e.g., irrigation) or groundwater replenishment (Page et al., 2019).

So far, research on the conditions under which PFAS are fully mineralized during combustion is limited and contradictory. Most PFAS may be completely decomposed upon combustion if at least 1,100 °C is reached for 2 seconds (Arnold, Brunn, et al., 2021). Thermal destruction of some C-F bonds may necessitate temperatures above 1400°C (Tsang et al., 1998). In order to prevent the production of any harmful organofluorine byproducts, ideal destruction techniques would mineralize all of the fluorine present in the PFAS and break all C-F bonds.

Predominantly, PFAS-containing consumer goods, especially the increasing amount of e-waste, are disposed of as municipal waste and either incinerated or discarded in landfill (Kämpfe, EI, 2022)(Tansel, 2022b). Even though state-of-the-art landfill prevents groundwater contamination, leachate is typically treated before it is released into the sewage system. At present, WWTPs do not biodegrade PFAS; instead, a portion of it is absorbed into sewage sludge and, if not incinerated, dispersed on farmland (Reach-clp-biozid-helpdesk, 2021).

Even though WWTPs play a pivotal role in closing the most valuable natural resource, the water cycle, they also cycle pollutants. Communities affected by contamination from industrial PFAS-loaded waste discharges and firefighting foam are struggling with the economic and health repercussions of tainted drinking water (Crone et al., 2019).

The described cycling problem results in a general exposure of mankind through the diet, including drinking water, as well as PFAS-contaminated indoor environments. This intake of contaminated foods and drinks, and the migration of PFAS from food packaging or cookware, are key sources of human exposure to PFAS (Domingo & Nadal, 2019).

1.3.2. True Cost of PFAS

According to the PFAS industry, the use of these chemicals in industrial and consumer products has numerous advantages and yields $2 billion annually in the United States (Cordner et al., 2021a). However, it fails to acknowledge the long-term, wide-ranging, habitually externalized, and disproportionately experienced costs of exposure. Moreover, focusing on PFAS advantages in a narrow, short-term view ignores how costs are shifted to communities and governments, despite the availability of safer alternatives across nearly all product sectors. The pervasive contamination of surface water and groundwater caused by industrial PFAS releases or the use of PFAS-containing firefighting foams has become a major global issue (Cordner et al., 2021b). For instance, Orange County, California, forecasts that the infrastructure required to reduce PFAS levels in drinking water to state-recommended levels will cost at least $1 billion (Cordner et al., 2021a). Still, chemical manufacturers rarely internalize these costs of cleaning up PFAS pollution in water. Instead, they are commonly shifted to public utilities, their customers, and state and municipal governments. Besides the cleaning costs, and proven by the German PFAS-contaminated region around Rastatt, communities with PFAS-laden drinking water also incur expenses through testing, monitoring, and research (Sandbühler & Marquart, EI, 2022). Low-income communities could struggle to bear such expenditures and, in many cases, have few alternatives for cost recovery, particularly if the source of the PFAS contamination has not been identified. As WWTPs are meant to remove solids and pathogens rather than persistent chemicals, any PFAS entering the plant are substantially discharged into receiving waters or remain as hazardous pollutants in sewage sludge (Cordner et al., 2021a).

The required treatment to remove PFAS will increase costs, but inaction may decrease existing revenue streams. For instance, if WWTPs cannot yield revenue through the sale of the processed sludge as fertilizer due to contaminations, they will instead be forced to incur expenses due to landfilling charges (Cordner et al., 2021a).

Several other PFAS-related expenditures are often passed on to the general public rather than being borne by polluters. To prevent additional contamination of water resources, for example, the stock of AFFF firefighting foam still present at military bases, airports, industrial locations, and municipal fire stations must be decontaminated and replaced with PFAS-free foams (Cordner et al., 2021a).

The discovery of water contamination or the perception of potential pollution can drag down property values and stigmatize communities. This could result in lower home values and hinder residents from selling their properties, especially when contamination levels reach public notoriety. Households and local businesses that want to avoid drinking water contamination may have to buy bottled water or build and operate their own water filters. The example of Rastatt shows that farms in PFAS-contaminated locations may be obliged to destroy crops or goods or even cease its operation (Klatt, 2020). Again, the costs of governance and research are significant, especially if the contamination source is unclear. First, local and state governments must invest in technical expertise and manpower related to exposure assessment. Second, expensive but required human biomonitoring and cleaning operations will also burden public entities. Rastatt, for example, has set aside ≈€5 million for its PFAS examinations to investigate uncertain concerns about PFAS exposure (Klatt, 2018).

In 2019 the Nordic Council of Ministers published a book that assesses the cost of inaction. The authors discovered an overall range of estimated non-health costs of EUR 46 million – 11 billion due to PFAS contamination that will incur over the next 20 years, just for the Nordic countries (Goldenman et al., 2019). Appendix 4.1 displays the range of costs for the five Nordic countries' various actions related to environmental remediation. Moreover, they estimated the health and environmental costs to society associated with PFAS exposures at EUR 52-84 billion per year in the European economic area alone (Goldenman et al., 2019). Parallel computations for all 31 EEA Member Countries and Switzerland reveal total non-health costs for

environmental remediation ranging from EUR 821 million to EUR 170 billion (Goldenman et al., 2019).

1.3.3. Environmental & Health Concerns

As already explained in chapter 2.1, PFAS enter the environment mainly through production in industrial plants and subsequent usage and non-recycling of consumer products containing these forever chemicals. New research suggests that even rainwater worldwide could be polluted by PFAS, leaving it unfit for human consumption. In fact, according to a recent study on environmental contamination, the worldwide boundary for PFAS has already been exceeded in many human-inhabited areas (Cousins et al. 2022, based on testings of levels of PFAS in rainwater, surface water, and soil).

Connected to the contamination of rainwater is the effect this poses on sea and wildlife consequently. In 2019, for example, consumer protection in Germany significantly lowered the consumption recommendations for fish in the Ruhr catchment area due to concerning high values of PFAS found in these fish (LANUV, 2019). The impact of PFAS on the environment even reaches the most secluded places on earth. In 2008, a study revealed high levels of PFOS found in the livers of mother and cub polar bears (Bytingsvik et al., 2012). According to a study from Lancaster University, PFAS have been found in Arctic ice to a high degree. With global warming increasing yearly, melting Arctic ice can lead to “a rapid release of the stored chemicals resulting in high concentrations in surrounding waters” (Sexton, 2021), directly impacting adjacent wildlife. Regarding plants, researchers studied the uptake of PFAS in plants in North Baden/Rastatt. They discovered that short-chain PFAS accumulated in winter wheat and winter triticale(Umweltbundesamt, 2022a).

Having a large amount of PFAS in our environment can cause severe health concerns. As explained in the previous chapter, PFAS can enter the human body in many ways. Primarily, these chemicals enter the body through food and water. According to the European Food Safety

Authority, PFAS are mostly found in “drinking water, fish, fruit, eggs, and egg products” (EFSA, 2020). In 2017, the GerES Study monitored children from 2014-2017 and found that 100 percent of the 1109 participants showed constant exposure to PFOS in particular (Duffek et al., 2020, p.3). Furthermore, the amount of PFOS found in the bodies was above the recommended tolerable weekly intake (TWI) of 4,4 ng/kg per week (Duffek et al., 2020, p.2). Exposure to these chemicals to the degree that is happening right now can lead to several health concerns, ranging from minor illnesses to life-endangering health risks. Health effects that can occur with high certainty (according to Fenton et al., 2021) include:

- **Delayed onset of puberty and changes in reproductive organs:** In 2019, a study in the Veneto region, one of the four regions most polluted with PFAS worldwide, found evidence that PFAS can interact with hormonal processes, which may result in male infertility and hormonal imbalance (di Nisio et al., 2019).
- **Effects on the immune system:** Exposure to PFAS substantially decreases the number of antibodies that form after children have their vaccinations (Grandjean et al., 2012). PFAS exposures are linked to reduced childhood vaccination humoral immune responses and an increased risk of antibody concentrations below those required for long-term protection (Grandjean et al., 2012, p.395).
- **Impacts on child development during pregnancy**: Several studies have discovered a significant connection between prenatal PFOS exposure and low birth weight. The risks associated with low birth weight include an increased risk of disabilities such as blindness and cerebral palsy (Stanford Childrens Health, 2017). Even after childbirth, the dangers of PFOS can still be transmitted through the mother's breast milk since the fluorinated chemicals can easily cross the placenta.
- **Higher probability for cancer**: The most prominent study on the topic of health risks of PFAS investigated the correlation between high PFOA exposure and several forms

of cancer in residents living near a Teflon-manufacturing plant. Findings imply that there is a small but precise correlation between high exposure to PFAS and the occurrence of kidney cancer (Vieira et al., 2013).

- **Liver damages:** The chemical structures of PFAS are similar to those of fatty acids, and in laboratory studies, they attach to receptors that are normally activated by fatty acids. As a result, animal research has shown that PFAS exposure may affect the liver similarly to a high-fat diet(Bourzac, 2022). In this case, however, it is important to note that while animal research consistently links PFAS exposure to abnormal fat accumulation in the liver, drawing the same conclusion in humans is difficult due to a lack of biopsy-confirmed data (Hamashige, 2022).

Because these compounds are only eliminated at a very small pace by our bodies, prolonged exposure can lead to accumulation. As a result, continued exposure to even low levels in drinking water may increase your chance of experiencing above mentioned health concerns (Connecticut Department of Public Health, 2021).

All in all, it can be concluded that the usage of PFAS in industries across the globe and, consequently the contamination of the environment poses a real threat to the health of not only the planet but also the people inhabiting it.

1.3.4. State of the Art

The following chapter will give an overview of PFAS treatment and remediation techniques that have been established to this date. Furthermore, it will serve as a mean to understand what efforts were made to tackle the PFAS Problem established in the previous chapter.

1.3.4.1. Remediation Strategies for PFAS

As of today, there are various PFAS remediation strategies for water treatment available. These remediation approaches involve two major processes: separation and destruction. For the first step, the separation, there are several different approaches such as conventional flocculation and coagulation techniques, sedimentation and filtration; sorption techniques involving the application of activated carbon and biomaterials, minerals, ion exchange resins or polymers, nanomaterials; foam fractionation and ozofractionation membrane technologies such as nanofiltration and reverse osmosis (Merino et al., 2016). The purification processes activated carbon adsorption, ion exchange and reverse osmosis used to treat the groundwater, drinking water but also waste water are currently considered state of the art (Dr. Oles, EI, 2022). However, there is a definite tendency towards activated carbon adsorption, which has proven to be the most viable approach for eliminating PFAS from waste and groundwater thus far (Kämpfe, EI, 2022) (Edel et al., 2018).

Generally speaking, the most applied destruction method is incineration (Dr. Oles, EI, 2022). Other, more complex destruction approaches are advanced oxidation and reduction; biological remediation, in-situ foam fractionation and ultrasonication (Anumol et al., 2016; Ateia et al., 2019; Ross et al., 2018). Besides, there are fairly new hybrid techniques and plasma technology with limited information (Magureanu et al., 2018; Stylianou et al., 2015). PFAS elimination is mostly based on existing, validated remediation solutions designed to remove other pollutants. Nevertheless, the severe chemical characteristics of PFAS and their behavior in water necessitate careful consideration for creating novel water treatment remediation strategies. In

comparison to numerous other pollutants, the treatment options for PFAS are limited. These circumstances trigger the demand for creativity and innovation. Therefore, most existing approaches for PFAS removal are ineffective owing to various issues, including inapplicability and most importantly costs (Ateia et al., 2019; Merino et al., 2016; Ross et al., 2018). Moreover, Wanninayake (2021a) demonstrates that these limitations include high energy demands, extremely poor removal rates under field settings, difficulties in applying optimal conditions at full scale, high capital cost, and the requirement of decomposition technology while separating or transferring pollutants from liquid to solid phase (Espana et al., 2015). Above all, she revealed no credible evidence of a sustainable and viable biological degradation (Wanninayake, 2021b).

The 4th Treatment Stage and its Wastestreams

Municipalities with a 4th treatment stage aim to filter trace substances out of their water treatment process (stmuv, 2022). To achieve the filtration and elimination of these trace substances, filters like reverse osmosis, activated carbon adsorbtion, and ion exchange are implemented into the treatment process (Brugger, 2019). These filter systems are specialized for separating the smallest waste materials like pharmaceuticals, cosmetics, cleaning agents and other household and industrial chemicals (stmuv, 2022). The waste accumulated by these filter systems is either channeld back to the beginning of the water treatment process or transferred to a landfill or incineration plant (Zhao, 2016).

Reverse Osmosis (RO) Treatment

Membrane separation is the most effective, yet most expensive method for removing all types of PFAS, both long- and short-chain (Crone et al., 2019). Reverse osmosis generally removes more contaminants than nanofiltration (Crone et al., 2019). Membrane separation technologies can also be combined with granulated active carbon to improve removal rates and lifetime of filter material (Arndt, EI, 2022). In comparison to other PFAS filtration methods, RO requires

significantly more energy (Dickenson & Higgins, 2016). It should also be noted that RO treated water is more corrosive to pipes and plumbing equipment (Crone et al., 2019). Besides that, reverse osmosis-treated water also needs to be “re-mineralized” because consuming ion-free water might cause nutritional deficits (Crone et al., 2019).

Ion Exchange

Ion exchange treatment, a fairly new method for PFAS removal, can be extremely effective (Haist-Gulde, EI, 2022). Similar to GAC, ion exchange resin is packed in a tank and operated in a passing-through mode. Also, both treatment techniques are more effective at eliminating longer chain PFAS than shorter chain PFAS (Appleman et al., 2014). In comparison to GAC, ion exchange treatment can cost more to install initially, still ion exchange materials need to be replaced less frequently (Dickenson & Higgins, 2016). One of the main drawbacks of ion exchange resins for PFAS removal is the regeneration and disposal of used resins. According to studies, single-use resins are more effective at adsorbing PFAS and require shorter contact times than regenerated resins (Das & Ronen, 2022). The spent resin is predominantly incinerated or transferred to a landfill (Crone et al., 2019).

Activated Carbon Adsorption

Adsorption is the accumulation of molecules at the interface between solid and fluid phase (Artioli, 2008). According to our expert Arndt, activated carbon adsorption is a very effective method of drinking water and groundwater treatment that can remove water dissolved organic compounds below the detection limit (Arndt, EI, 2022). The quality of the activated carbon is decisive for the amount of substance that can be adsorbed (Arndt, EI, 2022). Here, the inner surface is an essential criterion (Edel et al., 2018).

Adsorption is a method for concentrating PFAS. It is either applied in a multiple step treatment or as a standalone system. Operating costs, pre-treatment needs, and used media management are all factors that influence the selection of sorption technology (Arndt, EI, 2022). Each of

these parameters is determined by the sorbent material's properties, with the loading capacity for the target PFAS chemicals serving as the primary treatment parameter (Ross et al., 2018). Sorbents are most commonly used in flow-through fixed-bed filtration tanks, where contaminated water enters the tank and PFAS adsorb to the filter material, resulting in cleaned effluent (Mueller & Yingling, 2018; Ross et al., 2018). The spent sorbent is replaced with fresh or regenerated material as soon as it reaches its maximum loading capacity of the target PFAS compound(s) (Rahman et al., 2014; Ross et al., 2018). Experience has shown that two (or more) sorbent tanks may be installed in series to optimize the operation of these PFAS removal systems (Rahman et al., 2014). The first tank removes the majority of the PFAS, while the second works as a refining filter. While tank volume and flow rate are fixed values that can be adjusted, the concentration of PFAS in the influent and the presence of other pollutants is variable and site-specific. The time required to saturate the sorbent with PFAS is usually the most important element to consider when operating an ACF. As a field-proven technology, adsorption of PFAS via GAC is the most common method that is frequently cited as a cost benchmark (Dr. Oles, EI, 2022). The researcher from the U.S. Environmental Protection Agency, Thomas Speth, states, “GAC can be 100 percent effective for a while, depending on the type of carbon used, the depth of the bed of carbon, flow rate of the water, the specific PFAS you need to remove, temperature, and the degree and type of organic matter as well as other contaminants, or constituents, in the water.”(US EPA, 2018).

Backwashing

After some time of use, the filter mass of a filter systems reaches its maximum loading capacity. This event requires immediate action to prevent a breakthrough of pollutants. ACFs are one of the filter system types that can be treated by backwashing. To eliminate the adsorbed particles and regenerate the GAC, the ACF has to be cleaned periodically to maintain a steady flow and their functionality. Irregular cleaning of ACFs is one of the main reasons why systems fail.

The process of backwashing the ACF is done in several steps (see Appendix 8.1). First, the filter has to be taken offline from the main water treatment process and drained of the water just above the filter bed, which is the desist and most contaminated area of the filter material (PWP, 2022a). In the second step, compressed air is pushed up through the charcoal in order to widen the filter bed and lift the collected particles into suspension. At that stage, the dense filter bed breaks apart. Subsequently, clean backwash water is forced upwards the filter bed to wash the suspended particles out of the charcoal through an extraction pipe (PWP, 2022b). In some applications, the granular media is simultaneously run through with air and water streams, then again rinsed with water. Backwashing continues until the water's turbidity drops below a set limit (PWP, 2022b). In the case of two or more ACFs, the backwash water can be used in a cycle to limit water consumption. This is known as back- and forth washing where the water first runs multiple times in a loop though all filters and then gets discharged after the charcoal is clean. At the end, the filter bed sinks back down though gravity and the normal water treatment process can continue until the next backwash cycle has to be initiated. With this process, the lifetime of the activated charcoal can be extended and change intervals can be reduced. An elaboration on this process will follow in the operational management part as it is a part of our service process. Nevertheless, this process has limits and the charcoal has to be exchanged at some point.

Monitoring

The development of PFAS sensors now represents an emerging area of research which has already been acknowledged as a significant international problem by numerous water treatment facilities. Dr. Oliver Happel from the Department of Water Quality of the DVGW Technology Centre for Water (German Water Centre), provided us with an insight into his latest study on sensors for quality monitoring in water supply (Happel, EI, 2022). This study classifies sensor systems into electrochemical sensors, optical and fluorescence detectors, and biosensors.

Following discussions with manufacturers and researchers of PFAS online monitoring sensors, it became apparent that electrochemical sensors are described as the sensor system with the highest accuracy down to the ng/L range while featuring a great selectivity for single chemicals. Therefore, this solution offers the best available technology regarding upcoming guidelines and regulations. According to Dr. Happel the current systems are classified with a technology readiness level (TRL) of 1 to 5 and thus titled as feasibility studies. The study points out that statements on the long-term stability cannot be assessed yet, underlining the need for further research until these sensor systems are suitable for practical use.

The SenSOS project of Stadtwerke Rastatt, the Technology Centre for Water and the company Unisensor served to design a sensor system for the online detection of organic trace substances in practical situations (Municipality Baden-Baden, n.d.; Technologiezentrum Wasser, n.d.). The application of this technology was aimed at DWTPs and WWTPs. During the project, sensor systems were installed in the Baden-Baden/Sinzheim DWTP and their applicability for monitoring activated carbon filtration was tested (Technologiezentrum Wasser, n.d.). The project was a first successful demonstration of the sensor system in continuous operation under real conditions, provided information for improved monitoring of water quality through automated detection as well as information for the expansion of analysis possibilities (Municipality Baden-Baden, n.d.). The project lasted 22 months until June 2020 and is today considered one of the most advanced projects in the online monitoring of trace substances (Technologiezentrum Wasser, n.d.).

1.3.4.2. Latest Developments

In a paper published on 19th of August 2022 in the journal Science, researchers have found a simple technology to destroy the hazardous chemical. A research team, led by Brittany Trang, identified a new destruction method by targeting a group of less-charged oxygen atoms that sit at the end of the long tail of carbon-fluorine bonds. The researchers use dimethyl sulfoxide

(DMSO), a rather unconventional, but inexpensive and common solvent which is approved as a medication for bladder pain syndrome, to destroy the compounds. In this solvent, they heated the PFAS at medium temperatures (between 80°C and 120°C) with sodium hydroxide, a common chemical that is also used to make household products such as soap or painkillers. The method effectively "decapitated the head group from the tail," causing the PFAS to breakdown and leave only fluoride ions and other harmless byproducts (Trang et al., 2022). Ms. Trang describes the findings as "exciting because of how simple — yet unrecognized — our solution is."(BBC News, 2022).

"The current way that people will try to dispose of firefighting foams that contain PFAS is to incinerate them, but there has been evidence that these incinerators are actually just blowing the PFAS around the community in which the incinerator is located," Trang said. "So there's a need for a method to get rid of PFAS in a way that does not continue to pollute."(BBC News, 2022).

As of today, the method cannot be carried out in water; the organic DMSO solvent is integral to the reactivity. Still, DMSO should not be mixed with drinking water directly because that would pollute the water further, so the destruction method will have to occur after the PFAS has been removed from the water by filtration. However, the new method was able to degrade PFAS such as the notorious PFOA and GenX chemicals, PFOS can't be destroyed in the same way. So, researchers are exploring other methods for that. In our expert interview with the head scientist B. Trang, she revealed that the study serves as an impetus for further research to eliminate PFAS once and for all. She also states that the introduced process should not be considered final, as it needs more optimization through iterations and resulting modifications. Hence, the final process might look very different (Trang, EI, 2022).

1.4. Aquapurgo

1.4.1. Road to our Business Model

After the ideation process, we started talking to various experts to start conceptualizing a possible solution to the identified problem. After a few conversations, we came up with a first draft of our business model. We then sought further assistance in experts from industry incumbents and scientific professionals to concretize the business model. On our journey, we experienced some setbacks due to impracticalities, which meant we had to reevaluate our entrepreneurial options. We started with the idea of creating clarifiers for WWTPs that would decompose PFAS directly in the waste water with the new, simple and validated method. Due to the fact that we are all business students with little to no scientific background, we contacted TH OWL, an engineering university, to discuss technicalities to determine the feasibility of the concept. We then discovered that the method is not applicable directly to waste water or sewage sludge meaning that a PFAS filter process is an inalienable part of the process. Thus, we concluded that our destruction process had to occur beyond the water treatment plants (WTP). During the ongoing research, we came across the start-up Aquagga, a spin-off business from the University of Alaska and the University of Washington focusing on the on-site destruction of PFAS in their domestic market. The existence of an American competitor in the PFAS destruction industry validated our business case. Timo Broeker from the Institute for Life Science Technologies, responsible for the application management of research projects, likewise confirmed this validation method. However, Chris Woodroff (EI, 2022) added, that Aquaggas's solution focused on a different destruction method which, according to our research, does not seem as efficient as the one we are planning to use. Nevertheless, we were now focusing on a similar approach to destroy the chemicals decentral and thus directly on the customer’s site. The exchange with Chris Woodroff (EI, 2022), COO and co-founder of

Aquagga, helped in validating some of our assumptions concerning the business model, pricing, R&D, strategy and finance and funding.

In further exchanges with the technical university, however, the problem arose that with our method we first had to filter out the PFAS, which left us with the contaminated filter mass. These concerns were confirmed in an with the leading scientist, Brittany Trang (EI, 2022), who invented our destruction approach which again forced us to rethink our solution. Further on, we came across the back-and-forth washing method to treat loaded AGC. This gave us the idea to dispatch a truck with the developed LTM process directly to the customer to clean the activated carbon on-site and eliminate the PFAS. However, due to the time-consuming destruction process (24 hours) and the associated downtime, we discarded this approach. Nevertheless, we will keep the back & forth washing technique, as it provides us with a waste stream similar to RO and IE. This allows us to address all these filtering methods with our future service.

From the previous approaches, we developed a new solution and built a further business model around it based on the knowledge already gained, the ongoing exchange with experts, and a profound literature analysis. In this approach, we divided our project into two steps, short-term, and mid-long term.

First, we concentrate on the filtration of PFAS. To do so, we consulted with scientists, plant engineers, and the Federal Environment Agency to validate the most common filtering method for PFAS. Thereby, it was confirmed that activated carbon filtration could be used in various ways within this area (Oles, EI, 2022). For example, this method could be targeted at WWTPs and DWTPs, making it particularly attractive to us and leading the way to our final product as described in the solution description part. In cooperation with Timo Broeker, we devised the idea of equipping our activated carbon filters with an online monitoring system. However, during our research, we initially discarded this idea as it turned out that these systems are still in their early stages. In a conversation with Dr. B. Haist-Gulde (EI, 2022) an expert in the areas

of activated carbon applications and trace substance removal from the German Water Centre, the urgency of such a system became apparent again. She further assured us that incorporating the new EU Drinking Water Directive into national law will increase the importance of a monitoring system, especially in the field of DWTPs (Haist-Gulde, EI, 2022).

However, our long-term focus remains on the efficient destruction of PFAS chemicals. Since decentralized destruction of these seems technically unfeasible, we finally designed a service around our product. As our destruction method is currently still carried out at the laboratory level, we decided to establish a cooperation with the University of Applied Sciences and Arts Ost Westfalen Lippe (TH OWL) to advance this technology as a research project and transform it to an industrial level.

During the process, we learned about current products and services on the market. From conversations with Richard Arndt (EI, 2022) or Chris Woodruff (EI,2022) we learned that the business model could evolve due to individual customer demands, changing legislation or the start-up's mature development process. Thus, our business initially revolves around the distribution of filter systems prior to launching our fully developed PFAS destruction service on the market. The complete business model, including all facets and details, is presented in the Individual Part: Operations.

1.4.2. Products & Services

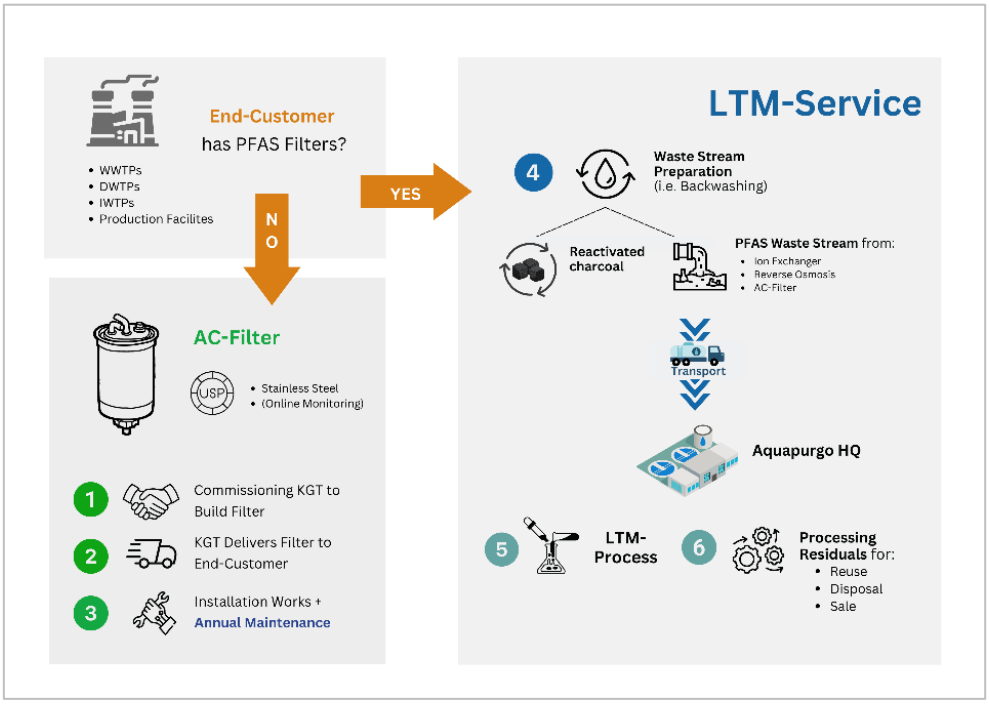


Figure 3: Our Products & Services (Own Illustration)

Our products and services are designed to serve all kinds of water treatment sites (see Figure 3). We support companies and government facilities to remove organic trace substances, particularly PFAS, from water through activated carbon filters in accordance with the latest standards. During these processes, we strongly focus on the filtration and disposal of PFAS chemicals as their jurisdiction is changing particularly rapidly (Schulze, EI, 2022). With the reactivation of the AC, which will happen at the customers site, we plan to establish a circular economy (see *Individual Part Robin-Kate Stegner*).

1.4.2.1. Filter

Our jurisdiction starts with the filtration of trace substances on customer sites. Our activated carbon filter systems are field-proven, of high quality and purpose-built for the purification of water and processing fluids. The filter unit is a tank, which is pre-filled with the selected adsorbent from our strategic supplier unicarb and fitted with features that simplify maintenance. In contrast to several competitors, the entire filter system will be made of V4A stainless steel (material 1.4571), a highly durable material (Böttcher, EI, 2022). Also, it has the advantage of

extending the lifetime of our filters by decades, compared to common industry standards (Werdohl, 2002). For the adsorption we will rely on special activated carbon (UNICARB® L-W20C) developed for organic trace substances, especially PFAS, from the experienced and innovative manufacturer LSR Materials GmbH & Co. KG (see Appendix 4.7). This type of activated carbon has been analyzed, tested, and employed on various water treatment sites and is now theoretically able to filter organic trace substances with an efficiency of > 99% (Arndt, EI, 2022). Thanks to the comprehensive knowledge gained from the research work as well as the experience of our partners, we can calculate the loading capacity of the activated carbons and thus the service life of the filters very precisely. As a result, we can offer individual and precise dates for removing and renewing the loaded activated carbon to keep efficiency at the highest possible level. Along with collecting the backwash water from our customers, we also carry out the annual maintenance in accordance with the DWA guidelines. This maintenance service includes safety and functionality tests (Böttcher, EI, 2022).

All filters can be configurated individually in terms of size, flow rate, pressure etc. enabling us to address specific customer requirements and ensuring seamless integration into existing systems. Thus, different applications such as industrial water treatment plants (IWTP), WWTPs, and DWTPs can be served. They can be used as single filters, parallel or series connections, depending on the requirements of the customer's application (see Appendix 4.6). For small-scale remediation projects, we can offer mobile filters which are taken out of service and removed from the site as soon as the adsorbent is used up or the treatment target has been reached. If further treatment is required, the filter is replaced. Besides that, we can also offer a smart solution for long-term treatment where just the inlay (cartridge) containing the loaded filter material is changed directly on-site. Hereby, changing the filter cartridge is quick and clean, reducing the filter's downtime. In general, we also offer our services if third-party products are installed.

1.4.2.2. Monitoring

Optional, we will offer a recently developed trace substances analysis and online monitoring through built in sensors that can investigate complex matrices and trace substances. Therefore we started contacting Unnisensor and 2wiTech solutions as both companies are currently developing PFAS sensor systems. This technology will detect organic pollutants in water resources down to the trace concentrations and provides its user with accurate information on water quality threats and changes (Deutsche Bundesstiftung Umwelt, 2020). Utilizing this sensor module helps ensure accordance with PFAS limits and assess the service life of our activated carbon filters, leading to higher efficient replacement cycles. Furthermore, our customers will be enabled to monitor removal performance in their water treatment facilities making external quality monitoring superfluous. This offer will be primarily targeted at DWTPs but will be available to all our filter customers. As monitoring at industrial level is not yet possible, we will closely follow the development of this technology to offer this important feature as early as possible to our customers.

1.4.2.3. Service

Our service offer is aimed not only at our filter system customers but at all facilities using trace substance filtration systems (ACF, RO, IE). Our service includes an all-encompassing solution from the installation of our ACF to the maintenance of the filter and from selecting suitable activated carbon to the filling of the filters to the disposal of the filter mass.

First, water samples are taken to determine the concentration of trace substances. For this purpose, different samples are taken within the system and at inlets to determine the appropriate filter mass. As a next step, the durability of the filter mass is determined based on these samples and the period for a filter change can be calculated in advance. Before chemicals break through the filter and the service life expires, our service includes the backwashing of the filter material (as described in section 3.4.1.4 of the group part) and subsequently the transportation of the

backwash water to our headquarter. The backwashing significantly extends the life cycle of the activated carbon since replacements can be less frequent. After the backwashing the activated carbon is reactivated and can be used again, considering a potential material loss of 10% - 15% according to our expert R. Arndt (Arndt, EI, 2022). Again, if a different filtering method (i.e. RO or IE) is installed, we may also handle the occurring PFAS contaminated waste streams of such filters. On average we will pick up 3000l of waste stream per filter, totaling 9000l per plant, considering an average of 3 filters per plant (Broeker, EI, 2022). Our service is the first within the industry to specialize on the comprehensive and environmentally friendly annihilation of all trace compounds from water treatment facilities. Combined with the efficient destruction method, our service enables our customers to treat water in a more sustainable way.

1.4.2.4. PFAS Degradation Solution

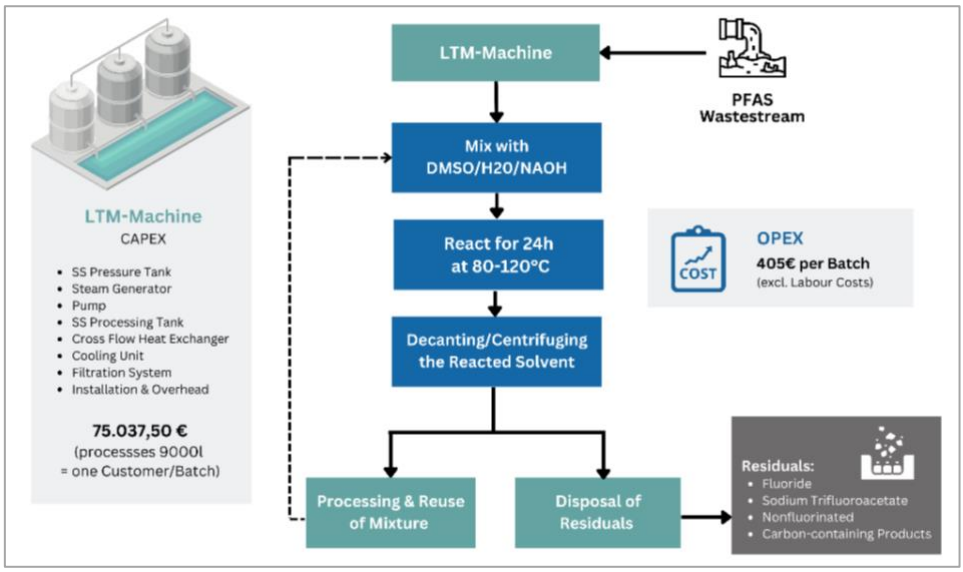


Figure 4: PFAS Degradation Process

The LTM process will not be explained into detail since specifications are still uncertain and subject to R&D progress. The current process has been developed in close collaboration with our mentor T. Broeker from TH-OWL (Broeker, EI, 2022). The LTM process is initiated after we transported the PFAS containing waste stream (i.e. backwash water or waste streams from other filtration methods) from the end customer to our site. At our site, the PFAS waste stream

is then pumped in a stainless steel pressure tank, where it is mixed with DMSO and treated thermally in the presence of NaOH for 24h. To save energy, we will use a cross-flow heat exchanger that transfers thermal energy from the treated mixture to the new waste stream. After treatment, the effluent will be processed by filtration and cooling to recycle and reuse the solvents and separate the exclusively harmless residuals. After our interview with Aquagga we expect the residual quantity to be low, still we are considering 2 options: purification with subsequent sale or appropriate disposal (Woodruff, EI, 2022). This method's advantages will be extensively enlightened in this thesis.

1.4.3. Core of our business

Our hybrid organization (see Strategy section 3) is dedicated to the elimination of PFAS. Still, generating revenue by selling filter systems, filter material and service & maintenance contracts will be our strategy for market entry. Our customers are water treatment facilities such as WWTPs, DWTPs and IWTPs as well as 3rd parties such as engineering firms that act as intermediaries. For all aspects of the filter we rely on field-proven products and technologies from experienced and specialized businesses. A breakdown of our value chain can be found in Appendix 4.3. From 2026 onwards, we will be the first company to offer a thorough and environmentally friendly PFAS degradation service. Compared to the state of the art, our LTM method thoroughly eliminates PFAS without producing harmful byproducts and consumes significantly less energy. As a result, we can create greater benefits at a lower cost to our customers compared to our competitors (see Individual Part Strategy).

We endorse collaboration rather than competition and direct all our passion, knowledge and resources towards the research and development of PFAS remediation strategies to make this world a safer place. How we plan to maximize our impact is further explained in the indivdal part Social Entrepreneurship & Branding.

1.4.4. Organizational Structure

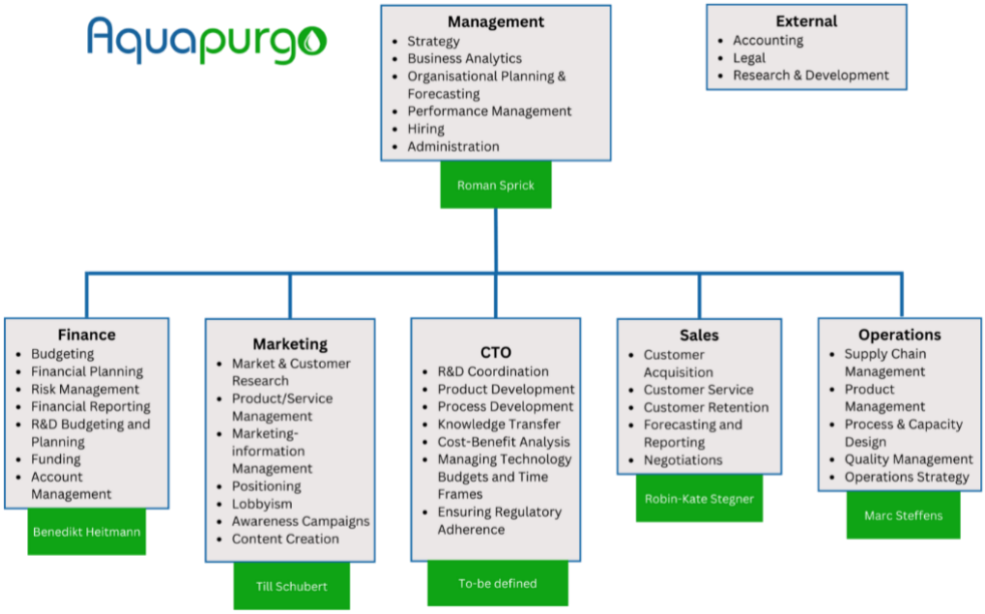


Figure 5: Organigram Aquapurgo (by author)

Aquapurgo will choose a unitary functional structure where the business is divided into distinct divisions (see Figure 5) (Döhler, 2017). This form will assign each of the founders to his/her area of expertise. The objective of this division is an increased productivity and operational efficiency as every division can focus on its distinct tasks. It also generates accountability and clarity for the management. As the business grows, new tasks can be added, or existing divisions can be subdivided without jeopardizing the logic of the structure.

Since we are talking about a start-up, Aquapurgo will have flat hierarchies with divisions reporting directly to management. The benefits of this flat structure will be simple, faster decision-making as the chain of command is shorter, better communication and relationships between different roles and better team spirit as there is less hierarchy. Adding to this alliance will be the CTO. While there hasn't been a CTO appointed yet there are already clear tasks for the executive to fulfill (see Figure 5). Ensuring that these set tasks are met our CTO requires an expert in chemistry who has already worked in an executive position and dealt with PFAS and

chemical process development before. In general, the founders team resembles an alliance of equals. An introduction to all the founders can be found in Appendix 10.

1.4.5. Why this idea makes sense

PFAS have been used in the production of goods since the 1940s, why is it only now that the business case to hugely tackle PFAS gains relevance (EPA, n.d.)? The chapter “Why this idea makes sense?” will showcase one competitor and explore current scientific, political and societal events opening the market. Furthermore, it will explain why starting in Germany is very advantageous for our start-up.

1.4.5.1. Why Now?

Recent scientific research has developed a new method that eliminates PFAS more effectively than previously utilized techniques. This new method eliminates PFAS with low temperatures and simple commercial grade dissolutions (Trang et al., 2022). Keeping in mind that this new method is being commercialized, once developed for industrial use this method will be a promising opportunity to largely tackle PFAS. Another factor that makes current PFAS destruction method inadequate are the high gas prices that had a rise of up to 162% in 2021 (Hofmann & Pöhler, 2022). Incineration is the most common method off destroying trace substances and PFAS and due to rising energy costs it has drastically increased in price and therefore is not feasible anymore (Arndt, EI, 2022). Furthermore, the current political legislation in the EU will require all member states to tackle PFAS by 2023 (ECHA, 2022). The EU “Drinking Water Directive” that became applicable in January 2021 established a limit of 0.5 µg/l for all PFAS (EC, 2020). All member states have two years to apply this limit to their national legislation so by 2023, the measures to tackle PFAS will go into effect. This current legislative transformation makes it evident to propose simple efficient and environmentally friendly solutions. In addition, the ever-rising environmental consciousness in society, which Gen Z has strongly driven, is also raising attention for the environmental impact of PFAS

(Petro, 2021). This mindset in young generations has been building up through worsening climate situations with natural disasters and flora and wildlife extinction combined with ineffective or non-existent political measures and the lack of demonstration of previous generations (Emina, 2021). This environmental consciousness has been able to change legislation in countries before (Weng et al., 2019). Lastly looking at our main competitor, Aquagga, from the US, they have stationary solutions in a pilot and bench testing stage and want to further enhance their product line by 2023 (Aquagga, 2022). Aquagga uses the HALT method (Hydrothermal Alkaline Treatment), that uses an efficient approach of treating PFAS with hot, compressed water to destroy the long bonds completely without leaving short bond PFAS (Wu et al., 2019). Presenting this competitor is largely important for our business case since this strong American competitor validates our idea.

1.4.5.2. Why Germany?

Germany is the European country where most waste water is reprocessed and thus recycled. Over 96 percent of waste water from private households and public facilities is channeled to nearby sewage treatment plants and purified (BMUV, 2017). Every year, Germany's households, industry and commerce generate over five billion cubic meters of waste water. But that's not all: around three billion cubic meters of rain that cannot seep away on roads or surfaces also flows into the treatment plants. In addition, considerable amounts of extraneous water seep into the sewer system through leaks yearly. In Germany, waste water may not be discharged untreated into rivers and lakes, regardless of whether it comes from households, commerce or large-scale industry. The Water Resources Act (WHG) stipulates that the pollutants it contains must be reduced as far as the state of the art allows. The treatment of municipal waste water in Germany is therefore at a very high standard compared to the rest of the world. For some years now, research has been stepped up in Germany (the focus is currently on Baden-Württemberg,

North Rhine-Westphalia and Berlin), the Netherlands and Switzerland on the establishment of stages for the elimination of trace substances at municipal WWTPs (Benstöm, 2017).

Numerous cases of extensive PFAS inputs in surface and groundwater have been reported in Germany. Aside from industrial discharges and the use of extinguishing agents, one of the major causes of overall PFAS contamination in Germany is the shipment of PFAS-contaminated sludges on agricultural land(Bund für Umwelt und Naturschutz Deutschland eV, 2018). The most severe damage in Germany is currently in Central Baden, where PFAS-containing compost was spread, contaminating around 400 hectares of farmland and adjacent drinking water (Edel et al., 2018). Apart from Central Baden, there are several other "hotspots" of PFAS contamination in Germany, such as the chemical park Gendorf or the "Hochsauerlandkreis" (Umweltbundesamt, 2020a).

Unfortunately, to this date there is no major research to be found on general contamination across Europe and standardized testing and measuring of PFAS levels is currently not carried out. However, a study from 2009, researching PFAS levels in rivers across Europe revealed that Germany is probably one of the highest contaminated countries in European comparison. Using log-linear models and climatological averages of river flow, the study predicted that West and South Germany, particularly, emits over 500kg of PFOS and PFOA per year (see Appendix 4.2, Pistocchi et al., 2009). The study however is based on extrapolation, meaning that the reality might look more/less severe than described in the research. The German federal states determine PFAS concentrations at specified measuring points and on occasion related special investigations, e.g. around airports in Northrine-Westphalia, due to high usage if firefighting foams (Umweltbundesamt, 2020a).

The most common method currently used to remove PFAS from groundwater in Germany is activated carbon adsorption (Edel et al., 2018). However, compared to the total number of WTPs in Germany, the implementation of such 4th cleaning stage is still low (see chapter

With several cases of severe contamination across Germany and associated health concerns, the government sees PFAS as a major threat. In that regard, the German Federal Environment Agency recommends several measures to tackle this problem (Umweltbundesamt, 2020a):

- Determine official binding limits and monitor compliance with regulations
- Restrict usage of expensable products under REACH
- Enhance analytics and monitoring on a European scale
- More Research on Rehabilitation and Purification of contaminated areas

With several initiatives being built around the proposed measures, it can be concluded that Germany is currently working towards wanting to better the PFAS contamination in the country and is actively looking for alternatives to current methods of PFAS filtering and destruction. According to our many interviews with experts across Germany, the general consensus amongst all contacts has been that binding requirements on monitoring and filtering PFAS are to be expected within the next five years (see Appendix 2). This tendency in particular is very advantageous for our company, since we would be the first movers to introduce a new method of destruction in compliance with expected regulations.

At last, all founders are born and raised in Germany and already have valuable connections into the industry, enabling easy access to resources, materials and potential business partners. Furthermore, as all founders have German citizenship, we are eligible for not only German scholarships and grants but also European funds, such as the EXIST-start-up fund.

1.4.6. Market Overview

The market overview will guide you through key facts & figures of the industries of interest. An in-depth analysis of our operating markets can be found in section 2 of the strategy part and section 2.2 of the branding part.

1.4.6.1. Key Facts & Figures

In the European Market, Germany is special among it's neighbouring countries when it comes waste water treatment and water supply market value. The German market for water supply currently has a volume of €15.02bn annually with a CAGR of 3.45% (Eurostat, 2022). In 2022 there are 2.099 companies active in the water supply market in Germany. The German water supply market is expected to reach an annual revenue of €17.8bn by 2027. Additional to the water supply market there is also water treatment market with €13.16bn in market value with a growth of 0.5% during 2017-2021 (GlobalData, 2021). The federal government in Germany invests 8bn€ annually to maintain the infrastructure for WWTPs (DWA, 2020). This infrastructure comprises 540.723 kilometers of waste water canals and 9.105 WWTPs (BMUV, 2022a). This infrastructure treats 10,1bn cubic meters of waste water annually. Additionally, 5.729 DWTPs provided a total amount of 4.7bn cubic meters of drinking water in 2019 (UBA, 2022b). One of the main topics that the federal environmental office in Germany currently manages is a strategy for trace substances (BMUV, 2022).

1.4.6.2. Regulatory

In 2015 numerous large manufacturers, like Chemours or BASF, used PFAS in their production (US EPA, 2014). Nowadays the industry trend indicates a discharge of forever chemicals in production facilities in the United States (J. Hayes & Faber, 2021). Still, the manufacturing lobby tries to prevent regulations on PFAS in the European Union (FEC, 2020). Additionally, chemical manufacturers are accused of hiding health implications of forever chemicals in e.g. food packaging from consumers (Perkis, 2021). This section on regulations contains a comprehensive summary of prior and ongoing PFAS policies and initiatives. To enforce a better understanding for the reader this analysis will be divided into global, European, and national levels.

Global Level

The Montreal Protocol, from the United Nations Environment Program (UNEP), bans or severely sanctions the usage of certain chemicals like CFCs and HCFCs that belong to the family of PFAS. This protocol is an important international regulation for chemicals since it is the only UN treaty that all 198 member states have ratified to date. Noting that PFAS are poisonous, bioaccumulative and found worldwide, they meet the requirements for another international regulation, the Stockholm Convention(UNEP, 2019b). Recognizing hazardous chemicals as persistent organic pollutants (POPs), the Stockholm Convention bans or strongly restricts the chemicals for usage and production internationally. The list of POPs includes two types of PFAS called PFOA and PFOS as well as their precursors. Using these PFAS is only allowed in a few application cases (e.g. work clothing for the medicinal and occupational sector). Further recalling limitations of the Stockholm Convention, only the chemicals and their precursors are recognized on the list and lack approaches for product-related regulations as well as considering water circulations when looking at the mobility of POPs. Another United Nations Convention uses the same POP's list, called Basel Convention (UNEP, 2019a). Differentiating from the Stockholm Convention, the Basel Convention regulates the transport of hazardous substances (mostly waste) between borders.

European level

At the European level, the use of PFAS is regulated in the REACH (Registration, Evaluation, Authorization, and Restriction of Chemicals) restrictions. The first restriction proposal concerning PFOS was approved in 2006 and applied for all applications with a few exceptions, including metal chrome plating and a temporary exemption for use in firefighting foams (Bock & Laird, 2022). In 2011 a further categorization of PFOA as a probable carcinogen and presumed reproductive toxicant resulted from Norway's submission of an EU Harmonized

Classification and Labeling proposal leading to PFOAs being classified as substances of "Very High Concern". Therefore, it was added to the EU Candidate List in 2013 since it fulfilled all persistent-bioaccumulative-toxic parameters as stated in the REACH Annex XIII (Bock & Laird, 2022; ECHA, n.d.).

In the following years, further restrictions regarding PFOS followed, prohibiting PFOA in the EU's Persistent Organic Pollutants Regulation in accordance with the Stockholm Convention starting on July 4th, 2020(OJEU, 2017; ECHA, n.d.-b). Thus, out of all the different PFAS, the group of PFOA was the first to be banned at European level. However, other substances are added to the REACH restrictions to be checked (Schulze, EI, 2022).

The European Commission decided to diminish the usage of Perfluorinated carboxylic acids, their salts and precursors from February 2023 onwards (ECHA, n.d.-b). Additional restrictions on certain PFAS (perfluorobutane-1-sulphonic acid and undecafluorohexanoic acid) are currently supervised by the European Commission, whereas a new proposal to restrict a broad spectrum of PFAS is being filed to the European Chemical Agency (ECHA) in January 2023 (ECHA, n.d.-b).

Given the widespread persistence and diversity of PFAS, the EU has only been able to restrict PFAS groups of highest urgency. To pursue an all-encompassing and efficient approach, ECHA recognizes the necessity to investigate a comprehensive group approach to the regulatory assessment and risk management (ECHA, n.d.-b). As a result, the European Commission today only authorizes the use of PFAS in "essential applications," which indicate that it is required for the health, safety, and function of society, and where it has been proven that they are indispensable to society (Arnold et al., 2021; ECHA, n.d.-b).

In 2019 the European Parliament and the Council acknowledged on the recast of the Drinking Water Directive defining a limit of 0.5 µg/l for all PFAS in drinking water and finally adopting it in December 2020 (OECD, n.d.).

As PFAS can also be absorbed through food, the European Food Safety Authority (EFSA) addressed this problem in September 2020. Thus, an upper limit was imposed for the main perfluoroalkyl substances that accumulate in the body. The tolerated weekly intake was defined at 4.4 nanograms per kilogram of body weight which is based on scientific research on the potential health hazards associated with the presence of these chemicals (OECD, n.d.).

National Level

The legislative latitude of EU member states is constrained because the regulatory and prohibition of the use of chemicals is primarily controlled at the European level. According to this, the states initially must abide by European law and only have decision-making power to address issues that the EU has not addressed yet, such as limit and guideline values or individual use and restrictions (Arnold et al., 2021). Within these guidelines the European Food Safety Authority defines a tolerated weekly intake of PFAS requiring the examination of current threshold, limit, test, and guiding values across the media sewage sludge, groundwater, surface water and soil (Arnold et al., 2021). The values for the tolerated weekly intake have decreased as more information regarding the negative effects of PFAS, especially PFOS, have become available. In the period from 2008 to 2020, the values were reduced from 10,500 ng/kg of body weight per week of PFOA and 1,050 ng/kg of bodyweight per week of PFOS to a combined tolerated weekly intake of 4.4 ng/kg of bodyweight per week of PFOS, PFOA, PFNA and PFHxS (Arnold et al., 2021). As a future outlook for national PFAS restrictions the federal environmental office in Germany started in 2021 with regulation proposal and will be submitted in 2023 (Schulze, EI, 2022). Furthermore, our expert interview showed that this proposal will be aligned with concerned institutions in Germany by 2024 and handed in to the European Commission in the same year. Finally, this proposal will be reviewed by the European Commission by 2025 and then implemented latest in 2026 on the national level.

1.4.7. Our Customers

In this section, we will give a first overview of our potential customers and present examples on specific use cases of our business. We identified three approaches (B2C, B2B and B2G) to prevent PFAS entering the environment and protect society. An in-depth customer segmentation on our B2B and B2G customers can be found in the Individual Part Social Entrepreneurship & Branding.

The first approach focuses directly on the end customer (B2C). They can be protected from PFAS intake using private filter systems. Typically, these systems are either installed at the main water pipe filtering all incoming water, placed under the water tap in the kitchen, or installed in water jugs to convert tap water into drinking water. However, the market for private filter systems is already saturated leaving little space for new competitors. Furthermore, such systems can only guarantee protection for one household's family members tackling the absorption via drinking water but not through food.

We consider the problem as a societal problem that cannot be solved on a private level, as only proprietors of such equipment are protected from ingesting these chemicals. In addition, the complete destruction of the filtered PFAS is not yet guaranteed at the private level, which can lead to these substances finding their way back into the environment. For these very reasons, we have decided to focus our main business on tackling the problem directly at the source (industry) and at a critical stage of the environmental cycling of these chemicals (water treatment plants). Nevertheless, the general public is still being targeted with awareness campaigns to further increase the pressure on governmental regulations. An in-depth explanation of the B2C efforts is presented in the *Individual Part Marketing*.

1.4.7.1. B2B

Firstly, our B2B customers are companies which utilize PFAS within their production processes, generating industrial waste water. Especially the paper, textile and kitchenware industries often use high amounts of PFAS in their production processes. Such production facilities often have their own small-scale water treatment facilities on-site to counteract the contamination. On this basis, the need arises for emissions to be reduced in accordance with technical possibilities, e.g. by adsorbing PFAS using activated carbon (Umweltbundesamt, 2020b). Our active carbon filter system supports the industries where PFAS are essential, to purify their water from these substances and reduce emissions. The potential online monitoring technology could provide a more efficient use of the activated carbon to optimize costs and our ACF offers the highest quality on the market. Furthermore, our LTM service offers a complete solution ranging from the appropriate disposal to the periodic refilling of the filters. Additionally, the total emissions of the company's production can be reduced as we use the most energy-efficient method to destroy the PFAS and recycle the activated carbon in the best possible way, contributing to the circular economy. The specific needs of this customer segment "Production facilities" following the B2B approach are to be explained in the Individual Part Social Entrepreneurship & Branding.

1.4.7.2. B2G

B2G customers were identified as a second but most important approach for our product and services. Here we are referring to the three of the four customer segments (WWTPS, DWTPs and small-scale remediation projects) established in the Individual Part Social Entrepreneurship & Branding. In particular, municipalities that are exposed to a high PFAS contamination and must adapt to upcoming regulatory changes, are considered to be the most important customer segments.

Today, there are several places contaminated with PFAS or similar chemicals in Germany. These regions are our main concern for filtering the PFAS chemicals out of the environment and disposing them. The five hotspots for PFAS contamination are in areas of Germany where the fire department constructed drills or real-life scenarios with AFFF foam. The high concentration of PFAS in AFFF foam and the wide spread use of the foam, resulted in an ubiquitous area where PFAS infiltrated into the groundwater (Messner, 2020). Furthermore, textile processing, paper manufacturing, and the photographic and film industries can cause PFAS degradations to soils and groundwater through exhaust air and waste water.

In the following section, four cases, where the contamination is most evident, will be presented. The result of these cases are several potential B2G customers (either WTPs or small-scale remediation projects) Aquapurgo could serve. The specific needs and main concerns of the identified customers segments WWTPs, DWTPs and small-scale remediation products are to be explained in the Individual Part Social Entrepreneurship & Branding.

- Düsseldorf Airport, where firefighting foams contaminated the soil and groundwater. The groundwater reached the Rhine. Currently, the airport takes care of cleaning the soil and has introduced a filter system that filters contaminated groundwater and then discharges it into a canal. The filter system de-ices, filters through gravel, ion exchange, and activated carbon filters before the cleaned water is discharged into the canal (DUS, 2014). The destruction of the collected PFAS chemicals remains a problem.
- In Rastatt, there is contamination of 700 hectares of arable land and groundwater by PFAS. The reason is the mixing of PFAS-contaminated paper sludge, which was mixed with compost and spread as fertilizer on agricultural land (Stadtwerke Rastatt, 2022). The contamination was first detected in drinking water, the extent of contamination only gradually. Closed drinking water wells and an increased effort in drinking water treatment

are the consequences (Stadtwerke Rastatt, 2022). Crops had to be destroyed because of PFAS findings in crops. Today institutions like: District Office Rastatt (LRA) the City of Baden-Baden, the Karlsruhe Regional Council and the PFC staff unit, and the Karlsruhe Regional Council (the PFC staff unit) are dealing with diversion of water and water treatment plants (Rastatt, EI, 2022).

- Large-scale contamination occurred in Arnsberg, Möhnetalsperre, due to the usage of a soil additive that was falsely labeled as a biowaste mixture but comprised sewage sludge from the paper industry (Messner, 2020).
- At the German military airfield in Manching, groundwater contamination took place to a high degree (Messner, 2020). As a result, irrigation using surface and groundwater near the airport is no longer allowed (of farmland and private gardens) (Messner, 2022).

1.5. PESTLE-Analysis

A PESTEL analysis is a strategic framework that is commonly used to evaluate a company's business environment, encouraging critical thinking among decision-makers (Peterdy, 2022). Organizations can analyze any risk unique to their sector and organization by analyzing the six aspects and making educated decisions. Additionally, it may draw attention to potential additional expenses and trends, enabling organizations to make alterations to its current strategy.

In the following PESTEL analysis, the German government, industry, and in some minor instances, the German population as a whole, are the major targets of the factors.

1.5.1. Political Factors

The political situation in Germany is very stable. Foreign investments are possible at low cost due to numerous free trade agreements. While adhering the law, Germany's free market

economy allows independent trade. Consequently, the political risk in Germany is very low (Allianz, 2022). As a federal country, governmental tasks are distributed among the federal government, the states and the municipalities. The Berlin-based federal government is responsible for framework legislation and national water management tasks. Responsible for the drinking water quality, water supply and water conservation are Federal Ministry of Health, Federal Ministry of Economics and Federal Ministry for the Environment, respectively (BMUV, 2001). Still, the governments of the 16 states are responsible under federal law for regulating water supply and wastewater disposal in their territories (BMUV, 2001). The organization and handling of water supply and wastewater disposal is one of the traditional compulsory tasks of the municipalities, in accordance with the state water laws. To cover the costs incurred, the municipalities levy charges (contributions and fees) on users, but are not allowed to charge a profit surcharge (BMUV, 2001).

Besides, more than 1.4 million scientists conduct research in the European Research Area (ERA), who are supported by the world's largest transnational funding program "Horizon Europe" providing €95.5 billion from 2021-2027 (BMBF, 2022a). Germany is one of the most important locations for researchers: Around one-fifth of the ERA's scientists work in Germany (BMBF, 2022b). Until 2025, Germany wants to invest 3.5% of its GDP in R&D, corresponding to more than €100 billion (BMBF, 2022a; Destatis, n.d.). In 2021, 67 of the 128 grants were related to Germany's climate protection targets and, with planned spending totaling €16.2 billion, accounted for around two-thirds of the total volume of grants (Destatis, 2022). This year, the state is providing the greatest subsidies to those areas that are taking measures to combat climate change. Regulatory procedures were previously described in chapter 4.6.2. For a period of 15 years, it is suggested to subsidize 75% of the annual investment expenditures for GK-5 wastewater treatment plants (UBA, 2019a).

Implications: Firstly, it can be concluded that while regulations on PFAS remediation have been set on a European level, the timeframe for the implementation is still to be considered. The harmed parties have until 2026 to put the new PFAS laws into effect after they were institutionalized. Generally, it can be said that Germany is a powerful research-driven nation that makes an effort to invest in sustainable businesses and ideas. Last but not least, it can be conluded that the German government invested heavily in the water treatment industry and is offering subsidiaries to expand the 4th treatment stage, making the buying decision for our customer segments easier.

1.5.2. Economic Factors

The economy of Germany is the largest economy in Europe and ranks fourth in the world behind China, Japan, and the United States. The Institute for Economic Research (Ifo) cuts its 2022 GDP growth prediction to 1.6%, signaling the start of a winter recession. The Munich-based Ifo Institute significantly lowered its GDP projection for this year and the following year: The institution predicts that economic output will only expand by 1.6% this year and contract by 0.3% the following year (ifo, 2022). A decrease in private consumer spending is most likely the primary cause of this. The summertime reductions in Russian gas imports and the ensuing sharp price hikes hindered the economy's recovery after the Covid-19 pandemic. According to the ifo Institute, normalization won't happen until 2024, with 1.8% growth.

Global trade is being hampered by still-broken supply chains, diminished purchasing power due to inflation, and, in some circumstances, extraordinarily expensive input and energy costs (ifo, 2022). At every point along the value chain, environmental constraints and regulatory frameworks will place a greater financial burden on the water industry (Dr. Rehberg & Herkner, 2018). The Federal Statistical Office reports that the inflation rate in Germany increased to 10% in September (Statistisches Bundesamt, 2022). Since the beginning of 1951, this is the biggest annual inflation. The inflation rate will reach its peak in the first quarter of 2023 at about 11%,

as energy suppliers will visibly adapt their electricity and gas prices to the high procurement costs, especially at the beginning of 2023 (ifo, 2022). Real household earnings will sharply decline as a result, and purchasing power will be noticeably lower. Although it is anticipated that the actions taken by the German government as part of Relief Package III will halt this decrease, they will fall well short of doing so.

Overall, the labor market is stable despite the challenging circumstances. As the fall resurgence got underway, unemployment and underemployment decreased. However, while at a very high level, labor demand is easing slightly (Bundesagentur für Arbeit, 2022). Company bankruptcies are rising quickly. The corporate bankruptcies rose significantly in Germany by September. Partnership and corporate insolvencies increased by 34% (IWH, 2022). This is primarily caused by dramatically rising prices for important production components, which is in addition to the worsening economic condition (KPMG, 2022).

Implications: From a financial standpoint, Germany has a lot of influence in the EU and ranks economically very high, making is a strong entry maket for us. Additionally, if the current trend of increasing gas prices will continue, the traditional method of simply incinerating PFAS will become more unattractive, creating an opportunity for our LTM-Service. One major negative implication to be derived, is that resources such as chemical solvents are getting more expensive and scarce, which will ultimately influence the production of our ACF and LTM-Machine.

1.5.3. Social Factors

Germany is one of the best countries in the world to live in terms of money, education, health, and quality of life. It is the second most populous nation in Europe, with a total population of nearly 84 million (Worldometers, 2022). It is a multicultural nation, and diverse lifestyles has formed its society. People in Germany enjoy a high standard of living and are free to choose their own life since it is a welfare state. Compared to other OECD countries, Germany has one of the highest levels of upper secondary education attainment (OECD, 2014). As a result of

this, high degree of education, environmental protection and climate action enjoy high priority among the population (BMUV, 2022b). In their opinion, too little is being done for climate action (BMUV, 2022b). Moreover, many Germans are open to change but demand it from politics and business (BMUV, 2022b). They greatly trust in the municipal water management, which ensures a high quality of drinking water at affordable prices (Göppert, 2022; UBA, 2019b). Additionally, 82% of the citizens would be willing to spend more money to ensure clean water (Ima, 2020). Generally, more than 99% of the population was connected to the public water supply in 2019 (UBA, 2022a). In the same year, each person used an average of 128 liters of drinking water per day, for personal hygiene, cooking, drinking, laundry and cleaning. That is 16 liters less than the European average (EEA, 2018).

More recently, the invasion of Ukraine and price increases became Germany's customers' top two concerns, followed by COVID-19 and climate change (McKinsey & Co, 2022). Although the level of pessimism about the economy's current and future health has decreased, it is still comparable to beliefs in the early months of the COVID-19 pandemic. People reduced their savings and non-essential purchases as their spending on food and gas increased (McKinsey & Co, 2022). Through 2021, 85% of people worldwide are more environmentally conscious in their purchasing habits (Bankrate, 2021). Millennials have the greatest impact, with 24% engaging in eco-friendly living.

Implications: Generally, it can be said that the German population is actively combatting climate change and citizens are striving for more sustainability in their lives, supporting green initiatives to a high degree. Clean drinking water is considered a commodity for German citizens and the population is used to a high quality in European comparison. Furthermore, the german population trusts the municipalities and would be willing to pay more taxes for clean water and a sufisticated water treatment process.

1.5.4. Technological Factors

Germany actively supports innovation, science and technology. They do not only support these categories but host independent laboratories (Bildungsserver, 2022). Both private research and national laboratories exist and are being subsidized by the state. One of numerous research investment campaigns “Forschungs- und Entwicklungsförderung” will deploy 5.6 bn€ of funds from 2020 until 2025 (Federal Ministry of economics and climate change, 2022). The industry supports a number of important areas of research and development. Germany's national scientific and technological programs are overseen and prioritized by the Ministry of Economics and Technology (BMWi, 2022). Government grants in Germany are an effective possibility to raise capital, in the technological field alone the government offers 504 different grants (Förderdatenbank, 2022).

In addition to the governmental influence on the technological research three technology trends have been identified by Deloitte for the German Market (Deloitte, 2019). The three trends are Internet of Things and 5G, Artificial Intelligence and Analytics and XaaS (Anything-as-a-Service). Additionally, a factor that is still relevant nowadays is the very strong innovation tradition in the German car industry, therefore the german technology market still benefits from its “Made in Germany” trademark (Zandt, 2021).

Implications: Regarding technological factors, the PESTLE analysis opened a few opportunities for Aquapurgo. Firstly, Aquapurgo benefits from the large funding landscape of the german government through suitable grants and research initiatives. Furthermore, we can profit from digitalization trends in the industry, providing a perfect infrastructure for a technology-based start-up. Lastly, the german innovation tradition and the international trust in the “Made in Germany” trademark” allows Aquapurgo to gain an advantage in the international market.

1.5.5. Legal Factors

Germany's legislation promotes founding companies as the new way of securing sustainable and green growth for society (BMWK, 2022). Whether the founder is a german citizen or a foreigner does not affect the ability to run a company especially if they are EU citizens, they can start a company without any additional burocratic input (Für-Gründer.de, 2022). Foreigners outside of the EU simply need to apply for a residency permit, and once they have the permit, they have the same legal rights as other citizens.

When founding a company in Germany entrepreneurs have to choose one of eight legal structures that companies can have in the German market (IHK, 2022). These eight different legal structures have different implications and mostly focus on the liability implications for founders. In 2020 Germany had 3.4 million registered companies with a large majority of individual companies with almost 2 million (Destatis, 2020).

Legislation on working rights offers a wide range of security for employees. The country already had a minimum wage for a couple of years already and on October 22nd, 2022 the minimum wage was raised to 12€/hour, the 4th highest value in Europe (BMAS, 2022; Euronews, 2022). Employees in Germany are required to enter the public health system with monthly payments or choose a private health system (BMG, 2022). This health insurance system thereby follows the "solidarity principle" indicating that the monthly contributions are based on the financial capacity of members, but the health benefits are the same for every member. Adding to the minimum wage and the required health insurance, employees in Germany are entitled to 20 days of vacation a year by law. However, depending on the industry and its tariff agreement, they reach from 25 to 30 days a year for full time employees (Destatis, 2018).

Implications: Legislation in Germany provides advantageous conditions for new companies or start-ups, more specifically the government promotes founding as a way to secure green growth

which is a perfect fit for Aquapurgo. The labour laws in Germany are very strict and cost intensive (minimum wage, health insurance,...). These high staff costs in the beginning put pressure on our new start-up.

1.5.6. Environmental Factors

In Germany, organic pollutants are the main reasons why only ten percent of its water bodies are ecologically intact (Umweltbundesamt, 2022c). This alarming figure results from increasing industrial water discharges (United Nations, 2017). Moreover, due to climate change and the increase of (acidic) rainfall over the last 50 years with ascending trend (C2ES, 2022), the cycling process of pollutants is only further accelerated.

Bettina Hoffmann, Parliamentary State Secretary at the Federal Ministry for Environment, Nature Conservation and Nuclear Safety, summarizes Germany's issues and calls for action: "Keeping groundwater clean and available is active protection of the environment and health. 70 percent of our drinking water is groundwater. Whereas we took groundwater for granted in the past, global warming is increasingly causing prolonged droughts that deplete the groundwater level in Germany. More and more substances are entering our waters via wastewater that do not belong there. Chemicals from industry and pharmaceuticals, some of which do not degrade naturally, are rapidly polluting rivers, lakes and groundwater ecosystems. It is the responsibility of society as a whole, end this. It is important to stop the input of pollutants directly at the source wherever possible. The Trace Substances Centre at the German Environment Agency will soon become a central source of information and a driving force for measures to protect our waters."(Umweltbundesamt, 2022b).

Besides politicians, also several NGOs are pressuring authorities not only to monitor effluent of individuals and companies more strictly but also to ban harmful organic pollutants such as PFAS (e.g. ChemTrust who wants to ban PFAS as a group (ChemTrust, 2022)). Still, success is yet to come; therefore, contamination may prolong (Schulze,EI, 2022).

Implications: Several implications for Aquapurgo's way of doing business can be derived. Firstly, the increasing NGO pressure worldwide is advantageous for our business, since regulations on PFAS can be implemented quicker. Furthermore, groundwater protection is highly important in Germany and has gained more relevance in recent years.

1.6. Limitations

Thoughout our research of the topic and creation of our business processes, several limitations had to be considered. Firstly, the current illustration and description of our LTM-Service is based on assumptions that were put together in exchange with our partner research university, our mentor Timo Broeker and through information from our expert interviews. Therefore, during the R&D process, some changes in the method's structure are expected, which will ultimately affect the pricing of our services. Also, the suggested time frames in our roadmap could differ significantly in reality, depending on the success of our R&D and the longevitiy of the validation process. Another limitation in regard to our business activities is that with our current understanding, it is not yet possible to destroy all types of the PFAS group, since new types of short-chained PFAS are constantly being developed and the filtering of such on a industrial scale has not been researched.

Furthermore, it's important to mention that due to PFAS being a worldwide cycling problem, only if all countries work together, there can truly be an impact for the environment as a whole. Since we focused mainly on Germany during this thesis, the implied impact is still limited. Our products & services are focusing on bottlenecks where PFAS are channeled through but in the overall picture we can only target a fraction of the global PFAS contamination.

At last, during our survey analysis, it became apparent that not all German states are equally represented among our participants, making it difficult to classify the study as representative.

2. Individual Part: Research & Development and Entrepreneurial Finance

2.1. Research and Development

Since the late 1980s, the publication of studies examining the impact of R&D has intensified. Frequent attempts have been made to map the strategic effect of R&D on a company's performance (Boiko, 2021; Brenner & Brian M. Rushton, 1989). Ahmedova (2022) describes that R&D actively positively affects a company's competitiveness. Additional studies provide empirical evidence for this assumption, examining competitiveness and general organizational performance (Boiko, 2021). Morbey (1988), for example, demonstrated a correlation between R&D expenditure and increasing sales volumes based on 800 companies he studied. Other studies indicate that the influence of R&D activities can also lead to adverse outcomes under specific conditions. Nevertheless, it is critical for a company confronted with new and emerging technologies that have the potential to change the competitive landscape significantly (Lyne, 2016). Aquapurgo's success, therefore, requires a detailed R&D strategy closely linked to the corporate strategy to establish the company in a position to turn its R&D achievements into business value. For this reason, this chapter deals specifically with R&D.

2.1.1. Assistance & Barriers of R&D

Understanding the connection between R&D activities and the company's success is crucial for management to make strategic decisions. To this purpose, the importance of a successful R&D strategy is outlined, and its impact on Aquapurgo is examined.

For Aquapurgo, developing the LTM method is of utmost importance as it contains a sustainable **competitive advantage** and allows us to establish ourselves in the PFAS destruction market until 2026. As we are currently in the research phase, elevating the LTM method from the laboratory to the industrial scale, R&D has played a critical role from the beginning of the venture. Consequently, the performance of our R&D is inextricably linked to our competitive edge. Further, we will include our stakeholders in our pilot project and R&D

efforts which allows us to comprehend the entire spectrum of stakeholder concerns and needs, yet it will also provide service innovation in operations and practices (Bari et al., 2022). This collaboration facilitates innovative products and services verified by stakeholders, resulting in higher **product differentiation** and a more distinct **corporate sustainability**. It is supported by Parniangtong (2017) that competitive advantage can be sustained if product development follows a stakeholder-centric approach.

With the help of R&D and close cooperation with stakeholders, we can **identify and develop trends** at an early stage and integrate them into our products and services, assisting our Start-Up in being dynamic and adaptive. This is particularly useful considering that the market has yet to develop. Lee and Shim (1995) recognized the linkage between R&D and its advertising opportunities, enabling a company to expand its **marketing abilities**. Wherefore our innovative LTM method will become the centerpiece of our marketing campaign as outlined in the branding part. Therefore, our R&D will subsequently contribute to an increase in Aquapurgo's **market participation**.

Other strategic factors that benefit from our R&D strategy are **finance**, especially **funding opportunities**. Financially, our R&D activities provide the opportunity to create a competitive advantage while better differentiating and advertising the product. Funding opportunities include options such as partnering with customers and vendors, applying for government grants supporting research and attracting VCs and business angels (BA). However, all of these have in common that value is created by achieving predetermined milestones through the R&D process, reducing the investment risk.

We pursue different goals through our R&D strategy, which are closely aligned with our overall business objectives creating value at different business levels, which places R&D in a central position within our Start-Up.

Besides the positive effects, there are also barriers to Aquapurgo's successful R&D implementation. Particularly concerning the management of R&D projects, as the **definition of success metrics** is limited. Performance metrics may be used to evaluate a variety of business objectives, but such indicators cannot be utilized for R&D. The absence of sufficient mechanisms to measure and communicate progress and outcomes as the inability to apply accountability rules, contribute to a loss in value (Brennan Tom et al., 2020). In addition, **competing interests** between stakeholders may arise, which cannot be implemented equally by the R&D team, leading to ineffectiveness within the R&D development (Brennan Tom et al., 2020).

Another barrier is that Aquapurgo suffers from the "**liability of newness**", implying that we have no record of successful R&D research so far, leading to a considerable information asymmetry between potential investors and us (Matricano, 2020). Aquapurgo is, therefore, less attractive to certain investors, limiting the possibilities for obtaining funding. Since Start-Up's already tend to be **limited in resources** and usually do not have access to extensive R&D activities, they mainly depend on external innovation sources and partnerships to achieve their R&D goals (Economics, 2021).

To counteract these risks and exploit the positive aspects of our R&D process, we have created a milestone-centric roadmap and formed strong research partnerships. Due to our partnerships, we can conduct our R&D activities at high standards and in a cost-saving design.

2.1.2. Knowledge transfer and IP strategy

Scientific-technological discoveries in PFAS remediation triggered Aquapurgo's foundation. These insights are now to be translated into a viable economic product, and IP rights must be secured and protected by Aquapurgo. For this reason, we have started a research project in collaboration with TH OWL and developed a joint R&D strategy. The university hereby acts as a self-contractor supporting us with resources such as talent, knowledge, laboratories, and

future research tenders regarding the PFAS destruction. Such cooperation was also a critical success factor for Aquagga's IP generation process, as Chriss Woodruff (EI, 2022) reported. Consequently, the knowledge transfer from the research institution (TH OWL) to our company is of central importance, as insights must now be translated into a commercial product. Hence, Aquapurgo is facing challenges in knowledge transfer regarding the ongoing development of the destruction method by the university and transferring generated research results into a commercial application.

Once the LTM method has been developed, we will examine the findings for patentability. In case a patent is filed, patent applications are submitted and financed in such a way that Aquapurgo reserves the utilization rights. After a dialogue with an IP lawyer and in close discussions with Timo Broeker from TH OWL, we concluded that Aquapurgo would be entitled to the patent, with TH OWL being listed as the inventor of the patent. As the inventor, TH OWL is eligible for an annual license fee of 1% of the revenue generated by this method. For transparency of these payments, we were advised to form a partnership under civil law (GbR) during the patent application with the purpose of patent utilization (Heitmann, EI, 2022). The pilot project starts once the application has been successfully submitted to the patent office since a patent is only protectable if it is new and not publicly to third parties.

The university accompanies the entire pilot project because it is possible to amend or concretize the patent application at a later stage (Heitmann, EI, 2022). As a patent is subject to national law, we must file a patent application for each country individually. Particularly interesting is the European patent, which is applied for at the European Patent Office. After the patent has been granted, the patent holder is free to decide to which countries in Europe this patent should be extended in detail (Heitmann, EI, 2022).

An adequate knowledge transfer can boost Start-Up's in the scale-up process, promoting the dynamics of internationalization and making it easier to attract investors (Economics, 2021).

Furthermore, it aligns with our corporate strategy to preserve ownership of the invention and seek a method to create value for the industry. In cooperation with TH OWL, we have decided to execute the knowledge transfer as illustrated in appendix 9.1. In parallel, Aquapurgo will examine the resulting method for viability, use and feasibility to start constructing the prototype with experts from the industry, researchers and engineers supervised by our CTO. He further accompanies the entire LTM project to ensure that all learnings and insights from the pilot are understood and can be incorporated into the final patent application and the industrial plant. Consequently, the CTO occupies a central position at Aquapurgo to successfully perform the knowledge transfer and to implement our IP into our LTM service.

2.1.3. Realisation Plan

All R&D activities pursue the objective of elevating the PFAS LTM method to an industrial scale. The result should enable us to holistically destroy a wide range of PFAS with a highly energy-efficient process, therefore being more sustainable than the competition.

Critical components of 2022 are the ongoing partnership acquisition as they enable us to carry out R&D activities more efficiently while integrating customer requirements. A continuous flow of information between TH OWL and Aquapurgo allows us to test the viability of initial results while maintaining an overview of the project. In 2023 the key milestones are securing a research grant to finance our R&D activities as well as launching and implementing our knowledge transfer and IP strategy. In the following year, we intend to secure a bank loan to execute our patent activities according to the chapter "Knowledge transfer and IP strategy". As described in the marketing part, R&D insights will be used in our awareness campaign. With the filed IP applications and the LTM method proven, we will start to develop a first LTM pilot plant to be launched in the third quarter of 2024 under the supervision of our CTO.

The pilot will then be tested for nine months to investigate acceptance, economic viability, and to screen for potential technic optimization. Through the first pilot, we will continue proofing

our concept while future LTM service customers are acquired, awareness is generated, and a foundation for future investment is created. In 2025, we will hire two scientists to establish corporate internal research while searching for potential investors to transfer the knowledge and insights gained through our pilot project into the new LTM plant to ensure that the service is as efficient and customer oriented as possible. The objective is to provide a comprehensive PFAS destruction service before stricter regulations regarding PFAS come into place (Q1 2026). Future periods will focus on maturing the destruction method to allow further PFAS to be incorporated into the process.

The Milestone Road Map (Appendix 9.2) clearly and practically represents the R&D's strategic milestones over time. It outlines all activities related to pursuing our R&D strategy, provides credibility, and adds value each time a milestone is achieved, convincing potential investors to trust in a product and the team's abilities (Lenzer & Kulczakowicz, 2021).

2.2. Finances

2.2.1. Funding

Aquapurgo's funding strategy distinguishes between its short-term focused filter systems and the development of our LTM method into a commercially viable product. For both, we have decided to use a non-diluting funding strategy until we start constructing our viable industrial plant, following the idea that "the ideal and ultimate source of capital for any company is a paying customer" (Lenzer & Kulczakowicz, 2021). Here, our funding strategy is divided into the following two stages: *1. Filter systems* & *2. LTM service*

1. Filter systems: In the initial period, generating a first cash flow that will allow us to take out bank loans at more favorable conditions to provide financial support for SG&A and the R&D process is essential. For the production process of our filter systems, we do not rely on equity capital, as it is outsourced to subcontractors. We negotiated a payment term of 90 days after receipt of goods with our partner company KGT (Appendix 4.5). Products are produced on

demand, while customers are asked to pay 50% upfront and the remaining 50% within one month after installation, as customary in the industry. The activated carbon material for the filter system will be ordered after the first payment has been credited, allowing the filter systems to be financed exclusively by customer vendor financing. This strategy helps Aquapurgo cultivate strong credit histories and will enable us to defer bank financing until a first cash flow is generated to obtain favorable credit conditions (Bloomenthal, 2021). In 2023 we record a deficit of €58k (excluding R&D costs, as these are considered in the second stage of LTM Service). The obligation is borne by the founders and is backed by an individual investment of 20.000€ per founder, leaving us with € 42k of cash reserves. Therefore, a bank loan of €150k will be taken out at the beginning of 2024, at prevailing terms and conditions, so that even in the case of the pessimistic scenario Aquapurgo has time to react while continuing to pursue its business activities. Around €60k of this loan will be withheld to pay the IP registration and associated costs independently. Chris Woodruff (EI, 2022) provided insight that Aquagga has raised half a million dollars in angel investment to cover expenses that cannot be covered with grant funding. Therefore, we hold back the remaining money for this type of expenditure, minimizing investment risk for future investors and allowing Aquapurgo to rely mainly on non-dilutive financing.

2. LTM Service: Concerning the second stage, Aquapurgo's top priority is to translate our destruction method from lab scale into a commercially viable product. Therefore, according to Mr Koch (EI,2022), President and Early-stage Investor at ASIF Ventures, Aquapurgo should be focusing on grants and customers for initial funding as Aquapurgo is affected by the "liability of newness", making it less attractive for venture capitalists (VC) to invest. As Aquapurgo is a university spin-off Start-Up, public research institutions and universities are essential sources of knowledge and innovation, which need to be considered in the funding process (Economics, 2021). Governmental grants supplemented by bank loans will mainly finance Aquapurgo's

development of the LTM process and the pilot project. A closer look at various PFAS-related Start-Up reveals that they use research grants as a funding method, as Chris Woodruff (EI, 2022) also confirmed (Appendix 9.3).

Within the first phase, we applied to several support programs for university spin-offs. First, we applied for the EXIST grant, which supports founders with 2.500€ per month and a single investment of up to 30.000€ to pursue their project for a maximum of one year. Our second application addressed the Science4Life Venture Cup, from which Aquapurgo would receive 26.500€ if it succeeded through a competitive procedure (results are published on the 21 April). Participating in this program has secured access to a network of 300 expert advisers and various online coaching sessions, helping us to highlight and address potential problems and apply for further grants. Together with TH OWL, we are currently seeking suitable grants to develop our LTM method and build the prototype.

To create and establish the first pilot, reaching all milestones until Q3 2025, we will submit a grant proposal of €850k. If all our proposals are approved, we will raise up to €920k from non-dilutive funding. Aquapurgo benefits from this funding method as there is no dilution of ownership, and the money does not have to be repaid (Dykeman, 2019). Moreover, grants provide a source to increase credibility and thereby act as a bridge to our seed investors.

In Q3 2025, we plan to raise €600k in a series A financing from BAs to successfully transfer the knowledge gained from the pilot project to our LTM unit, construct the plant and finance investments around the LTM service. Early-stage VCs would also be conceivable but are currently not our preferred choice, as they tend to invest larger amounts of money and therefore require higher equity stakes (A. Hayes, 2022). Since we have already established ourselves in the industry and solely require the investment to finance LTM investments, a BA currently seems to be the better fit for Aquapurgo.

2.2.2. Exit

We are not aiming for an exit from the company, as we are confident that we can successfully position the company in the long term. If we establish our IP, we will focus on becoming the market leader in the German PFAS market. In this case, licensing of our IP is envisaged for the European region as further explained in the strategy part. However, if the R&D process is delayed or incurs unmanageable costs, we would agree to a merger or acquisition by a more prominent industry player (e.g. Lenntech, Puraffinity). In this case, it would be necessary for the founders to maintain the social mission of Aquapurgo.

2.2.3. Market Quantification

For 2023, we are initially focusing on our Beachhead market Baden-Württemberg. This market consists of 106 players, from which we defined 52 as our TAM, as outlined in the operations chapter. As we still need to develop our sales structures, we expect to win three customers (SOM). Consequently, we will be able to gain first market experience in 2023 and start establishing a national sales network. In 2024, this will enable us to win 22 new customers (SOM) in our follow-up market. At this point, we will focus on WTPs, resulting in a total TAM of 14.834 customers. These customers will be served by teams of two mechanics who assemble, connect and test-run the installation. For this, we calculate an average of five days per filter system and three filter systems per plant. In 2025, we plan to attract 40 new clients (SOM), representing 0.27% of our TAM.

From 2026, our ACF distribution will be reduced to strengthen our focus on the LTM service. Having one foot already in the industry, we will henceforth focus on acquiring as many customers as possible for the LTM service. Our main target are still WTPs, which explains why the TAM remains unchanged. In this market, we benefit from new legislation which entitles us to win 4% of the market, equivalent to 590 customers. In the following year, a culminated market share of 9,5% and 1000 new customers will be targeted.

2.2.4. Unit Economics

The revenues and expenditures associated with a single unit of output are referred to as unit economics which, in turn, face five different customer profiles (CP). Two CPs can be served right from the beginning of our venture. The CP-1 only acquires our activated carbon filter system, while the CP-2 additionally subscribes to the annual maintenance service. As our PFAS remediation method is expected to launch in 2026, it will only be included in the financial model from this point on. The CP-3 selects all three units, whereas the CP-4 chooses only the remediation service, and the CP-5 subscribes to our services. The calculations covering all corresponding segments CLVs are presented in appendix 9.4.

Aquapurgo until year 2026 *65 customer*	*Retention rate*	# of customers	portion	purchase Frequency (3 years)	Margin	AOV	CAC	CLV	CLV/CAC Ratio
CP 1	70%	39	60,00%	0,15	2,50%	19.739,45 €	5.127,37 €	9.869,72 €	1,92
CP 2	50%	26	40,00%	3,15	3,03%	24.739,45 €	5.127,37 €	18.588,47 €	3,63

Table 1: Unit Economics until 2026

For the **CP-1**, the three-year AOV amounts to 19.739€, which equals the average order value of three ACFs divided by the expected service life of 20 years. As costs in this industry are measured individually, we refer to moderate prices and service life expectancies from our supplier KGT. With a gross margin of 2,5%, each account delivers a CLV of 9.870€. For this segment, we calculated two different CACs, the first being applicable until 2026 and amounting to 5.127€. The second CACs reduce to 422€ due to a reallocation of the associated sales and marketing costs along the new emerging LTM service customers.

The **CP-2** has a CLV of 18.588€ consisting of the ACF purchase and the DWA maintenance service. This CP represents 40% within the first three years, later dropping to 3,48% of the company's portfolio, generating an AOV of 24.739€ at an order frequency of 3,15 purchases over the three years and 5,15 purchases over a five-year period. Based on the experience of our partner company KGT, maintenance services in this market show a churn rate of 50%. The CACs are identical to those of our CP-1 throughout the years considered.

They were calculated by dividing the cumulated marketing spending until 2026 by our forecasted total number of customers within this period and again amount to 5.127€. Consequently, the CLV/CAC ratio is 1,92 for the CP-1 and 3,63 for the CP-2. This ratio seems very high compared to other industries, although it is appropriate in our industry. Governmental clients are not acquired through expensive marketing campaigns but through public tenders incurring fewer S&M costs. However, this is accompanied by high initial investments leading to long-term loyal customers, leading to a higher CLV/CAC ratio (Mailchimp, n.d.).

Three new profiles will be added from 2026 onwards:

Aquapurgo from year 2026 *1590 customer*	*Retention rate*	# of customers	portion	purchase Frequency (5 years)	Margin	AOV	CAC	CLV	CLV/CAC Ratio
CP 1	100%	75	4,71%	0,25	2,50%	19.739,45 €	421,66 €	9.869,72 €	23,41
CP 2	50%	55	3,48%	5,25	3,03%	24.739,45 €	421,66 €	18.588,47 €	44,08
CP 3 (starting 2026)	70%	6	0,38%	18,6	5,43%	36.079,45 €	421,66 €	46.890,73 €	111,20
CP 4 (starting 2026)	70%	923	58,04%	13,3	90,00%	11.340,00 €	421,66 €	28.302,26 €	67,12
CP 5 (starting 2026)	70%	531	33,39%	18,3	76,23%	16.340,00 €	421,66 €	37.021,01 €	87,80

Table 2: Unit Economics from 2026

CP-3 represents with 0,38% our smallest segment. Nonetheless, within the five years considered, it has the most significant purchase frequency culminating in an average of 18,6 along with the highest AOV of 36.079€. As this customer acquires both services in addition to the filter, the profit margin totals 5,43 %, accompanied by the largest CLV of 46.891€ for Aquapurgo.

CP 4 & 5: Aquapurgo's last two CPs represent 58,04% and 33,39%, respectively, being our most significant segments. Our calculations show that the CP-4s AOV equals 11.340€, with 13,3 purchases over the period considered. CP-5s AOV, on the other hand, adds to 16.340€ at a purchase frequency of 18,3. Consequently, the CP-5s five-year CLV totals 37.021€ and that of CP-4 amounts to 28.302€.

For this period, the CACs were again calculated by dividing the S&M expenditures from 2026 and 2027 by the total number of customers acquired. Due to existing SG&A structures, an expansion of the company portfolio, and our disruptive LTM method, we will be able to gain customers more efficiently, reducing our CAC to 422€ across all CPs. Simultaneously, we increased our CLV to 30.078€, reflecting higher margins of the LTM service, further increasing

the CLV/CAC ratio to 71,33. This development is driven by our strategy to emphasize the LTM service as it contains a higher business value. Nevertheless, this ratio may also indicate that we need to strengthen our S&A structures in the future, as high CLV/CAC ratios may reflect an under-exploited market potential restraining Aquapurgo's growth (Geckoboard, n.d.).

2.2.5. Core Costs and main Assumptions

Staff-related costs include all the necessary equipment for the workplace. The cost amount varies depending on the department, is due in the year of employment and develops as shown in appendix 9.5 and 9.10. Salaries amount to €120k in the first year and will be mainly driven in the following years by new hires in sales and production (Appendix 9.6). Each employee pays 14.6% of their annual salary as an insurance contribution, of which Aquapurgo is required by law to cover 50%. For the period analyzed, legal costs of 4.000€ per year are budgeted, along with a further €61k for legal fees relating to the patent application. The awareness campaign requires €170k in capital, as detailed in the marketing part.

Our office rent was calculated by 15€/ m^2 office space and an area of 10 m^2 per employee. Monthly server costs of 40€ and material costs per office employee of 120€ per year must be added. Our production facility with a size of 2.000 m^2 will be rented from the middle of 2024 at a price of 3,29€/ m^2.

"Purchases from suppliers" are the most significant cost driver as we expect to acquire an average of three filters per customer at a price of €70k each. Additionally, we assume an average of 16.740kg of activated carbon per filter at the cost of 2,95€/kg. Both prices are based on offers from our subcontractors KGT and Unicarb (Appendix 4.5 & 4.7). A 10% profit margin will be added to cover our operating expenses (as explained in the pricing strategy). The DWA maintenance takes place every year and is priced at 5000€. Our mechanics travel around Germany for client appointments; thus, we calculate 1.200€ per mechanic/month to cover travel

expenses and petrol. Furthermore, each mechanic will be equipped with tools worth 700€. Mechanics work in teams of two, travel together and share one car (133€/month).

LTM revenues are calculated at 1,26€/L backwash water, assuming 9000L of water per customer (Broeker, EI, 2022; Appendix 4.8). LTM investment costs cover R&D expenses, including personnel and equipment to carry out trials and amount to €250k per year. Further, we negotiated a licensing fee of 1% from the LTM service revenue, which we are paying TH OWL. Costs for the LTM pilot amount to €75k (Appendix 4.8). The price of the final LTM system results from the pilot project multiplied by a factor of 9.5 (Broeker, EI, 2022). The pilot hypothetically serves 161 customers at 70% capacity utilization. As we serve 1418 total customers in 2027, this results in a factor of approx. nine and thus leaves some leeway. Additionally, three trucks are calculated at a price of 255.000€ to perform the service.

For taxes, we assume the German corporate tax of 15.825% and trade tax of 14,525% (PwC, 2022). Capital costs were calculated with a simple interest rate of 8%, considering a risk-free rate of 1,2% and adding a risk premium for Start-Ups of approx. 7% (Statista, 2022).

2.2.6. P&L

The P&L is based on the aforementioned assumptions and serves as an indicator of Aquapurgo's profitability. For the detailed P&L, refer to appendix 9.7.

P&L Aquapurgo					
Year	**2023**	**2024**	**2025**	**2026**	**2027**
Total Revenue	**1.190.367 €**	**8.732.356 €**	**15.895.056 €**	**16.235.365 €**	**31.881.986 €**
Revenue ACF	1.184.367 €	8.685.356 €	15.791.556 €	9.788.160 €	16.590.101 €
Revenue DWA Maintenance	6.000 €	47.000 €	103.500 €	304.565 €	580.783 €
LTM Service (starting 2026)	n.a.	n.a.	n.a.	6.142.640 €	14.711.102 €
Total Costs of Goods Sold	1.155.861 €	8.342.611 €	15.218.098 €	10.552.843 €	16.928.606 €
Gross Profit	**34.506 €**	**389.745 €**	**676.958 €**	**5.682.521 €**	**14.953.379 €**
LTM Innvestments	250.000 €	385.728 €	1.339.456 €	197.826 €	283.581 €
SG&A	92.786 €	276.783 €	377.290 €	567.131 €	611.256 €
EBITDA	**-308.280 €**	**-272.765 €**	**-1.039.788 €**	**4.917.565 €**	**14.058.542 €**
EBIT	-308.280 €	-272.765 €	-1.039.788 €	4.749.493 €	13.890.471 €
EBT	-308.280 €	-284.765 €	-1.051.788 €	4.737.493 €	13.878.471 €
Net Income	**-308.280 €**	**-284.765 €**	**-1.051.788 €**	**3.299.664 €**	**9.666.355 €**

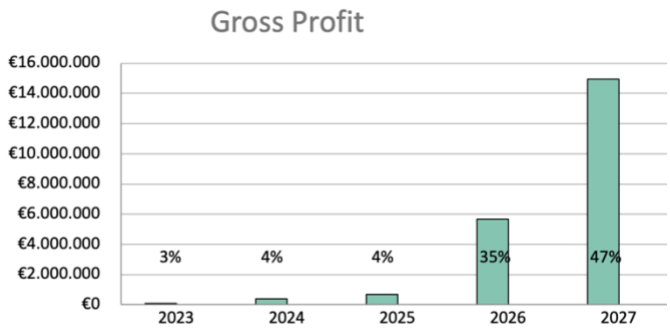
3: Simple P&L

The revenue is primarily driven by ACF sales in the first three years, from 2023 to 2025. It rises from €1.2m to €15.8m. The calculation is simply based on the average price per filter system

times the number of customers acquired. In 2026, the revenue growth rate will flatten to 2% as the percentage of ACF sales decreases, and the focus is shifting to the core business of LTM services. Therefore, ACF accounts for €9,8m, LTM for €6,1m. In 2027, ACF's revenue increased, with the share of the revenue accounting for 52%. In comparison, LTM revenues account for €14,7m (239% growth) and, therefore 46% of revenue. Overall, Aquapurgo has a CAGR of 93% over the period considered.

Aquapurgo's CoGS averaged 90.4% of its revenues in the first three years. Thereof, 94% arose from the costs associated with the ACF business. Introducing LTM services to the market with only 9.5% of COGS enables us to reduce the CoGS to 55% in 2026 and 47% in 2027 of revenues. For additional information on COGS, refer to Appendix 9.9.

The gross profit development depictures that our business will become more profitable from 2026 onwards, following the increased share of LTM services. LTM-related investments will steadily increase until 2025. The peak is caused by investments in the final LTM system and the arising costs for the trucks. In the following years, only license costs are incurred. A detailed overview can be found in the extensive P&L (Appendix 9.7).



	2023	2024	2025	2026	2027
Gross Margin (Gross Profit)	34.506 €	389.745 €	676.958 €	5.682.521 €	14.953.379 €
Gross Profit of Revenue (%)	3%	4%	4%	35%	47%

Table 4: Gross Profit

Our operating expenses as a percentage of revenue decrease from 8% to 2% in the period analyzed. In 2026, SG&A costs will increase by approx. 67% to cope with the number of customers targeted. In summary, however, SG&A is becoming more effective over time yet leaving little scaling capacity due to its small cost size. The EBITDA decreases from -€308k in 2023 to a peak of approx. -€1m in 2026, from where it trends positively over €5m up to €14m in 2027. We applied the liner depreciation method within our projections, whereas our LTM

plant depreciated over five and the trucks over ten years. As previously explained in our assumptions, we used a simple interest rate of 8% over ten years to calculate our interest payments.

EBITDA declines from 308k in 2023 to a peak of 1M in 2026, from where it develops positively over €5m to €14m in 2027. Due to a loss carried forward over the first three business years, no taxes are incurred. Corporation and trade tax of combined 30.35% of the EBT will be deducted from 2026 onwards resulting in a net income of €3.3m and €9.7m for 2027.

2.2.7. Robustness of Financial Analysis

We placed our financial projections to the challenge by constructing three scenarios: one pessimistic, one realistic, and one optimistic. With this, we modified essential variables such as the ACF revenue, the SOM rate (pessimistic -5%, optimistic +5%), and the operating cost for our LTM process (pessimistic -10%, optimistic +10%) and examined the results.

In a bearish scenario, our break-even point would be delayed by half a year. However, more significant changes become visible in the first three years, as the gross profit remains negative, resulting in a negative cumulated net income of €2.8M in 2025. Our equity combined with the bank loan would not cover the shortfall. Although the grants allow R&D costs to be protected and the research project to be maintained, there is still a balance sheet difference of €1.6 million (Appendix 9.11). Therefore, we would rely on additional investments in 2025 to avoid insolvency. Considering an equally weighted optimistic scenario, we would achieve a positive net income of €75k in 2024 yet a negative cumulated net income of only €513k in 2025 (Appendix 9.12). As grants on our LTM investments counteract the negative net income of €920k, we would be profitable and could avoid a BA investment and, thus, ownership dilution. In conclusion, however, with its low margins, the filter business is very susceptible to change and needs to be closely monitored. The other two variables considered are very robust and allow us leeway in our assumptions.

References

Ahmedova, S. (2022). The importance of research and development in strengthening the enterprise competitiveness. *AIP Conference Proceedings*, *2503*(1), 050066. https://doi.org/10.1063/5.0099889

Ahrens, L. (2011). Polyfluoroalkyl compounds in the aquatic environment: a review of their occurrence and fate. *J. Environ. Monit.*, *13*(1), 20–31. https://doi.org/10.1039/C0EM00373E

Allianz. (2022). *Country Risk Report Germany*. https://www.allianz.com/en/economic_research/publications/country-risk/germany.html

Anumol, T., Dagnino, S., Vandervort, D. R., & Snyder, S. A. (2016). Transformation of Polyfluorinated compounds in natural waters by advanced oxidation processes. *Chemosphere*, *144*, 1780–1787. https://doi.org/10.1016/j.chemosphere.2015.10.070

Appleman, T. D., Higgins, C. P., Quiñones, O., Vanderford, B. J., Kolstad, C., Zeigler-Holady, J. C., & Dickenson, E. R. V. (2014). Treatment of poly- and perfluoroalkyl substances in U.S. full-scale water treatment systems. *Water Research*, *51*, 246–255. https://doi.org/10.1016/j.watres.2013.10.067

Arnold, G., Brunn, H., Cohors-Fresenborg, D., Fernandez, M., Große Ophoff, M., Körner, W., Lips, S., Ningelgen, K.-W., Rippen, G., Steinhäuser, K. G., & Valentin, I. (2021). *Fluorochemicals: Persistent, Dangerous, Avoidable background*.

Artioli, Y. (2008). Adsorption. In *Encyclopedia of Ecology* (pp. 60–65). Elsevier. https://doi.org/10.1016/B978-008045405-4.00252-4

Ateia, M., Maroli, A., Tharayil, N., & Karanfil, T. (2019). The overlooked short- and ultrashort-chain poly- and perfluorinated substances: A review. *Chemosphere*, *220*, 866–882. https://doi.org/10.1016/j.chemosphere.2018.12.186

Bari, N., Chimhundu, R., & Chan, K. C. (2022). Dynamic Capabilities to Achieve Corporate Sustainability: A Roadmap to Sustained Competitive Advantage. *Sustainability (Switzerland)*, *14*(3). https://doi.org/10.3390/su14031531

BBC News. (2022, August 22). *Breakthrough over potentially harmful chemicals found in most homes*. https://www.bbc.com/news/science-environment-62561756

Becker, A. M., Gerstmann, S., & Frank, H. (2008). Perfluorooctane surfactants in waste waters, the major source of river pollution. *Chemosphere*, *72*(1), 115–121. https://doi.org/10.1016/j.chemosphere.2008.01.009

Benstöm, F. (2017). *Granulierte Aktivkohle zur Elimination organischer Spurenstoffe aus kommunalem Abwasser* [Dissertation]. Rheinisch-Westfälischen Technischen Hochschule Aachen.

Bildungsserver. (2022). *Forschungseinrichtungen / -netzwerke im Bereich Elementarbildung - [Deutscher Bildungsserver]*. https://www.bildungsserver.de/forschungseinrichtungen-und-netzwerke-2021-de.html

Bloomenthal, A. (2021, August 31). *Vendor Financing*. https://www.investopedia.com/terms/v/vendorfinancing.asp

BMAS. (2022). *BMAS - Mindestlohn*. https://www.bmas.de/DE/Arbeit/Arbeitsrecht/Mindestlohn/mindestlohn.html

BMBF. (2022a). *Daten & Fakten zum Europäischen Forschungsraum (EFR) - BMBF*. https://www.bmbf.de/bmbf/de/europa-und-die-welt/forschen-in-europa/europaeischer-forschungsraum/daten-und-fakten-zum-efr/daten-fakten-zum-europaeischen-forschungsraum-efr.html

BMBF. (2022b). *Daten & Fakten zum Europäischen Forschungsraum (EFR) - BMBF*. https://www.bmbf.de/bmbf/de/europa-und-die-welt/forschen-in-europa/europaeischer-

forschungsraum/daten-und-fakten-zum-efr/daten-fakten-zum-europaeischen-forschungsraum-efr.html
BMG. (2022). *Ratgeber: Gesetzliche Krankenversicherung (GKV) | BMG - Bundesgesundheitsministerium*. https://www.bundesgesundheitsministerium.de/gkv.html
BMUV. (2001). *DER WASSERSEKTOR IN DEUTSCHLAND-METHODEN UND ERFAHRUNGEN*. https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/2751.pdf
BMUV. (2017). *Abwasser | BMUV*. https://www.bmuv.de/themen/wasser-ressourcen-abfall/binnengewaesser/abwasser
BMUV. (2022a). *Abwasser | BMUV*. https://www.bmuv.de/themen/wasser-ressourcen-abfall/binnengewaesser/abwasser
BMUV. (2022b). *Umweltbewusstsein in Deutschland 2020 Ergebnisse einer repräsentativen Bevölkerungsumfrage*. www.umweltbundesamt.de
BMWi. (2022). *Forschung im Bundesministerium für Wirtschaft und Technologie*. https://www.bundesregierung.de/breg-de/themen/forschung-im-bundesministerium-fuer-wirtschaft-und-technologie-474846
BMWK. (2022). *BMWK - Existenzgründungen – Motor der (grünen) Wirtschaft*. https://www.bmwk.de/Redaktion/DE/Dossier/existenzgruendung.html
Bock, A. R., & Laird, B. E. (2022). CHAPTER 1 PFAS Regulations: Past and Present and Their Impact on Fluoropolymers. *Perfluoroalkyl Substances*, 1–21. https://doi.org/10.1039/9781839167591-00001
Boiko, K. (2021). R&D activity and firm performance: mapping the field. *Management Review Quarterly*, 1–37. https://doi.org/10.1007/S11301-021-00220-1/FIGURES/5
Bourzac, K. (2022, May). *PFAS exposure linked to liver disease*. Chemical & Engineering News. https://cen.acs.org/environment/persistent-pollutants/PFAS-exposure-linked-liver-disease/100/web/2022/05
Brennan Tom, Ernst Philipp, Katz Joshua, & Roth Erik. (2020, November 3). *Building an R&D strategy for modern times*. https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/building-an-r-and-d-strategy-for-modern-times
Brenner, M. S., & Brian M. Rushton. (1989). SALES GROWTH AND R&D IN THE CHEMICAL INDUSTRY. *Research Technology Management*, *32*(2), 8–15. http://www.jstor.org/stable/24124679
Brugger, M. (2019). *Alternative Lösungsansätze für die vierte Reinigungsstufe* .
Bund für Umwelt und Naturschutz Deutschland eV. (2018). *Organische Fluorverbindungen in Alltagsprodukten, in der Umwelt und im menschlichen Körper: Bewertung und Konsequenzen für Politik und VerbraucherInnen Praktisch, langlebig und giftig*. www.bund.net
Bundesagentur für Arbeit. (2022). *Monatsbericht zum Arbeits-und Ausbildungsmarkt*. http://statistik.arbeitsagentur.de
Bytingsvik, J., van Leeuwen, S. P. J., Hamers, T., Swart, K., Aars, J., Lie, E., Nilsen, E. M. E., Wiig, Ø., Derocher, A. E., & Jenssen, B. M. (2012). Perfluoroalkyl substances in polar bear mother-cub pairs: A comparative study based on plasma levels from 1998 and 2008. *Environment International*, *49*, 92–99. https://doi.org/10.1016/j.envint.2012.08.004
Connecticut Department of Public Health. (2021). *Per-and Polyfluoroalkyl Substances (PFAS) in Drinking Water: Health Concerns What are these chemicals and where do they come from?*
Cordner, A., Goldenman, G., Birnbaum, L. S., Brown, P., Miller, M. F., Mueller, R., Patton, S., Salvatore, D. H., & Trasande, L. (2021a). The True Cost of PFAS and the Benefits of

Acting Now. In *Environmental Science and Technology* (Vol. 55, Issue 14, pp. 9630–9633). American Chemical Society. https://doi.org/10.1021/acs.est.1c03565

Cordner, A., Goldenman, G., Birnbaum, L. S., Brown, P., Miller, M. F., Mueller, R., Patton, S., Salvatore, D. H., & Trasande, L. (2021b). The True Cost of PFAS and the Benefits of Acting Now. In *Environmental Science and Technology* (Vol. 55, Issue 14, pp. 9630–9633). American Chemical Society. https://doi.org/10.1021/acs.est.1c03565

Crone, B. C., Speth, T. F., Wahman, D. G., Smith, S. J., Abulikemu, G., Kleiner, E. J., & Pressman, J. G. (2019). Occurrence of per- and polyfluoroalkyl substances (PFAS) in source water and their treatment in drinking water. *Critical Reviews in Environmental Science and Technology*, *49*(24), 2359–2396. https://doi.org/10.1080/10643389.2019.1614848

Das, S., & Ronen, A. (2022). A Review on Removal and Destruction of Per- and Polyfluoroalkyl Substances (PFAS) by Novel Membranes. *Membranes*, *12*(7), 662. https://doi.org/10.3390/membranes12070662

Deloitte. (2019). *Deloitte-Studie zu Deutschlands Technologiesektor*. https://www2.deloitte.com/de/de/pages/trends/studie-deutschland-technologiesektor.html

Destatis. (n.d.). *Interne Ausgaben für Forschung und Entwicklung nach Sektoren und Berichtsjahren -Millionen Euro- - Statistisches Bundesamt*. Retrieved November 24, 2022, from https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bildung-Forschung-Kultur/Forschung-Entwicklung/Tabellen/forschung-entwicklung-sektoren.html

Destatis. (2018). *Urlaubsanspruch - Statistisches Bundesamt*. https://www.destatis.de/DE/Themen/Arbeit/Arbeitsmarkt/Qualitaet-Arbeit/Dimension-2/urlaubsanspruchl.html

Destatis. (2020). *Unternehmen nach Rechtsform und Anzahl der Beschäftigten 2020 | Statista*. https://de.statista.com/statistik/daten/studie/237346/umfrage/unternehmen-in-deutschland-nach-rechtsform-und-anzahl-der-beschaeftigten/

Destatis. (2022). *Volkswirtschaftliche Gesamtrechnungen (VGR)*. https://www.destatis.de/DE/Themen/Wirtschaft/Volkswirtschaftliche-Gesamtrechnungen-Inlandsprodukt/Publikationen/Downloads-Inlandsprodukt/produktions-importabgaben-pdf-5811102.pdf?__blob=publicationFile

Deutsche Bundesstiftung Umwelt. (2020). *Aus dem Mittelstand: Schadstoffen auf der Spur – Online-Messsystem detektiert Spurenstoffe im Abwasser*. https://www.dbu.de/708ibook83029_38691_2486.html

di Nisio, A., Sabovic, I., Valente, U., Tescari, S., Rocca, M. S., Guidolin, D., Dall'Acqua, S., Acquasaliente, L., Pozzi, N., Plebani, M., Garolla, A., & Foresta, C. (2019). Endocrine disruption of androgenic activity by perfluoroalkyl substances: Clinical and experimental evidence. *Journal of Clinical Endocrinology and Metabolism*, *104*(4), 1259–1271. https://doi.org/10.1210/jc.2018-01855

Dickenson, E., & Higgins, C. (2016). *Treatment mitigation strategies for poly-and perfluoroalkyl substances.* .

Döhler, M. (2017). The Bias of Structures: How Multidivisional Organizations Work in the Public Sector. *Public Organization Review*, *17*(1), 83–100. https://doi.org/10.1007/s11115-015-0329-8

Domingo, J. L., & Nadal, M. (2019). Human exposure to per- and polyfluoroalkyl substances (PFAS) through drinking water: A review of the recent scientific literature. *Environmental Research*, *177*, 108648. https://doi.org/10.1016/j.envres.2019.108648

Dr. Rehberg, J., & Herkner, T. (2018). *BDEW zur Preisentwicklung beim Trinkwasser*.

DUS. (2014). *Bürgerinfomationsveranstaltung zu Perfluorierten Tensiden (PFT)*.

DWA. (2020). *PROFILE OF THE GERMAN WATER SECTOR*.

Dykeman, D. J. (2019, July 30). *Funding Tips To Help Medtech Startups Cross The 'Valley Of Death' | Medical Product Outsourcing*. https://www.mpo-mag.com/issues/2019-07-%2025/view_columns/funding-tips-to-help-medtech-startups-cross-the-valley-of-death/

ECHA. (n.d.-a). *Candidate List of substances of very high concern for Authorisation - ECHA*. Retrieved October 2, 2022, from https://echa.europa.eu/candidate-list-table

ECHA. (n.d.-b). *Perfluoroalkyl chemicals (PFASs) - ECHA*. Retrieved October 2, 2022, from https://echa.europa.eu/hot-topics/perfluoroalkyl-chemicals-pfas

Economics, B. A. (2021). *Startup-Ökosystem in der Schweiz: Schnellere Nutzung wissenschaftli-cher Erkenntnisse in der Wirtschaft Schlussbericht Studie im Auftrag des SBFI*.

Edel, Dr. H.-G., Klopp, D.-I. D., Drubel, B. Eng. J., Korte, B. E. D., Kellner, D.-I. C., & Rehnig, D.-I. U. (2018). *Sonderdruck aus Handbuch Altlastensanierung und Flächenmanagement (HdA) PFC-Grundwassersanierungen: Stand der Technik und Kostenvergleich*.

EEA. (2018). *Wassernutzung in Europa – Quantität und Qualität stehen vor großen Herausforderungen — Europäische Umweltagentur*. https://www.eea.europa.eu/de/signale/signale-2018/artikel/wassernutzung-in-europa-quantitaet-und

EFSA. (2020, September 17). *PFAS in food: EFSA assesses risks and sets tolerable intake | EFSA*. https://www.efsa.europa.eu/en/news/pfas-food-efsa-assesses-risks-and-sets-tolerable-intake

Eurostat. (2022, August). *Wasserversorgung - Deutschland | Statista Marktprognose*. https://de.statista.com/outlook/io/wasserversorgung-abfallwirtschaft/wasserversorgung/deutschland

FEC. (2020). *FEC Position Paper related to the consultation on PFAS*.

Federal Ministry of economics and climate change. (2022). *BMWK - Innovationspolitik*. https://www.bmwk.de/Redaktion/DE/Dossier/innovationspolitik.html

Förderdatenbank. (2022). *Förderdatenbank - Fördersuche*. https://www.foerderdatenbank.de/SiteGlobals/FDB/Forms/Suche/Startseitensuche_Formular.html?resourceId=86eabea6-8d08-40e7-a272-b337e51c6613&input_=285abce9-4339-43b9-9e4d-b1cac15665f4&pageLocale=de&filterCategories=FundingProgram&templateQueryString=technologie&submit=Suchen

Für-Gründer.de. (2022). *Existenzgründung als Nicht-EU-Bürger: was zu beachten ist*. https://www.fuer-gruender.de/wissen/existenzgruendung-planen/recht-und-steuern/genehmigungen/nicht-eu-buerger/

Geckoboard. (n.d.). *LTV:CAC Ratio*. Retrieved November 19, 2022, from https://www.geckoboard.com/best-practice/kpi-examples/ltv-cac-ratio/

GlobalData. (2021). *Market value of Wastewater Treatment in Germany (2017 - 2025, USD Millions) - GlobalData*. https://www.globaldata.com/data-insights/environment-waste-management/market-value-of-wastewater-treatment-in-germany-2080799/

Goldenman, G., Fernandes, M., Holland, M., Tugran, T., Nordin, A., Schoumacher, C., & McNeill, A. (2019). *The cost of inaction*. Nordic Council of Ministers. https://doi.org/10.6027/TN2019-516

Göppert, V. (2022). *"Wasser ist ein öffentliches Gut und muss es bleiben": Deutscher Städtetag*. Deutscher Städtetag. https://www.staedtetag.de/presse/pressemeldungen/2022/wasser-ist-ein-oeffentliches-gut-und-muss-es-bleibe

Grandjean, P., Andersen, E. W., Budtz-Jørgensen, E., Nielsen, F., Mølbak, K., Weihe, P., & Heilmann, C. (2012). *Serum Vaccine Antibody Concentrations in Children Exposed to Perfluorinated Compounds*. https://jamanetwork.com/

Hamashige, H. (2022). *Synthetic "forever chemicals" known as PFAS linked to liver damage*. https://keck.usc.edu/synthetic-forever-chemicals-known-as-pfas-linked-to-liver-damage/

Hamid, H., & Li, L. Y. (2016). Role of wastewater treatment plant in environmental cycling of poly-and perfluoroalkyl substances. *Ecocycles*, *2*(2), 43–53. https://doi.org/10.19040/ecocycles.v2i2.62

Hayes, A. (2022, May 31). *Venture Capital: What Is VC and How Does It Work?* https://www.investopedia.com/terms/v/venturecapital.asp

Hayes, J., & Faber, S. (2021, July). *UPDATE: Thousands of Industrial Facilities Likely Discharging Toxic 'Forever Chemicals' Into Air and Water | Environmental Working Group*. https://www.ewg.org/news-insights/news/update-thousands-industrial-facilities-likely-discharging-toxic-forever

Hofmann, N., & Pöhler, D. (2022, November 23). *Gaspreise 2022: Warum der Gaspreis so hoch ist und was die Regierung dagegen tut – Forbes Advisor Deutschland*. https://www.forbes.com/advisor/de/energie/gas/gaspreis/

ifo. (2022). *Economic Growth and Sustainability | Dossier | ifo Institute*. https://www.ifo.de/en/topics/economic-growth-and-sustainability

IHK. (2022). *Welche Rechtsform ist für mein Unternehmen richtig? - IHK Rhein-Neckar*. https://www.ihk.de/rhein-neckar/recht/wirtschaftsrecht/gesellschaftsrecht/unternehmensformen-rechtsformen-938792

Ima. (2020). *Die Zukunft der deutschen Landwirtschaft*. www.ima-agrar.de

IWH. (2022). *IWH Bankruptcy Research – IWH - Leibniz-Institut für Wirtschaftsforschung Halle*. https://www.iwh-halle.de/en/research/data-and-analysis/iwh-bankruptcy-research/

Kempisty, D. M., Xing, Y., & Racz, L. (2019). *Perfluoroalkyl Substances in the Environment Theory, Practice, and Innovation*. https://www.crcpress.com/Environmental-and-

Klatt, P. (2018). Der PFC-Skandal in Mittelbaden. In *Heimatbuch 2018: Aktuelles und Wissenswertes* (Vol. 57). Landkreis Rastatt Und Landrat Jürgen Bäuerle.

Klatt, P. (2020). PFC in Mittelbaden: In *Heimatbuch Landkreis Rastatt 2020* (Vol. 59). Landkreis Rastatt Und Landrat Jürgen Bäuerle.

Kotthoff, M., Müller, J., Jürling, H., Schlummer, M., & Fiedler, D. (2015). Perfluoroalkyl and polyfluoroalkyl substances in consumer products. *Environmental Science and Pollution Research*, *22*(19), 14546–14559. https://doi.org/10.1007/s11356-015-4202-7

KPMG. (2022). *Economic Key Facts Germany* . https://home.kpmg/de/en/home/insights/overview/economic-key-facts-germany.html

LANUV. (2019). *Aktualisierte Verzehrempfehlungen für Fische des Ruhreinzugsgebiets*. https://www.lanuv.nrw.de/verbraucher/aktuelles/verbraucherwarnungen/aktualisierte-verzehrempfehlungen-fuer-fische-des-ruhreinzugsgebiets

Lee, J., & Shim, E. (1995). Moderating effects of R&D on corporate growth in U.S. and Japanese hi-tech industries: An empirical study. *Journal of High Technology Management Research*, *6*(2), 179–191. https://doi.org/10.1016/1047-8310(95)90013-6

Lenzer, J., & Kulczakowicz, P. (2021). Fueling Spin-offs: Case Studies of University-based Technology Start-up Funding. *Technology & Innovation*, *22*(1), 29–40. https://doi.org/10.21300/21.4.2021.4

Magureanu, M., Bradu, C., & Parvulescu, V. I. (2018). Plasma processes for the treatment of water contaminated with harmful organic compounds. *Journal of Physics D: Applied Physics*, *51*(31), 313002. https://doi.org/10.1088/1361-6463/aacd9c

Mailchimp. (n.d.). *What is a CRM? A Marketer's Guide to Customer Relationship Management*. Retrieved November 19, 2022, from https://mailchimp.com/clv/

Masoner, J. R., Kolpin, D. W., Cozzarelli, I. M., Smalling, K. L., Bolyard, S. C., Field, J. A., Furlong, E. T., Gray, J. L., Lozinski, D., Reinhart, D., Rodowa, A., & Bradley, P. M. (2020). Landfill leachate contributes per-/poly-fluoroalkyl substances (PFAS) and pharmaceuticals to municipal wastewater. *Environmental Science: Water Research and Technology*, *6*(5), 1300–1311. https://doi.org/10.1039/d0ew00045k

Matricano, D. (2020). The effect of R&D investments, highly skilled employees, and patents on the performance of Italian innovative startups. *Technology Analysis and Strategic Management*, *32*(10), 1195–1208. https://doi.org/10.1080/09537325.2020.1757057

McKinsey & Co. (2022, July 14). *Consumer sentiment in Germany during the coronavirus crisis | McKinsey*. https://www.mckinsey.com/capabilities/growth-marketing-and-sales/our-insights/survey-german-consumer-sentiment-during-the-coronavirus-crisis

Merino, N., Qu, Y., Deeb, R. A., Hawley, E. L., Hoffmann, M. R., & Mahendra, S. (2016). Degradation and Removal Methods for Perfluoroalkyl and Polyfluoroalkyl Substances in Water. *Environmental Engineering Science*, *33*(9), 615–649. https://doi.org/10.1089/ees.2016.0233

Messner, D. (2020). *PFAS Gekommen, um zu bleiben.*

Morbey, G. K. (1988). R&D: Its Relationship to Company Performance. *Journal of Product Innovation Management*, *5*(3), 191–200. https://doi.org/10.1111/1540-5885.530191

Mueller, R., & Yingling, V. (2018). *Remediation Technologies and Methods for Per-and Polyfluoroalkyl Substances (PFAS)*.

Municipality Baden-Baden. (n.d.). *SenSOS-Projekt Konzeption eines Sensor-Systems zur Online-Erfassung von organischen Spurenstoffen im Bereich der Trinkwasseraufbereitung und Abwasserbehandlung*. Retrieved October 23, 2022, from https://www.baden-baden.de/mam/files/aktuell/pfc/5._sensos-projekt.pdf

OECD. (n.d.). *Country information - OECD Portal on Per and Poly Fluorinated Chemicals*. OECD Portal on Per and Poly Fluorinated Chemicals. Retrieved October 3, 2022, from https://www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals/countryinformation/european-union.htm

OECD. (2014). *Germany Most people in Germany attain upper secondary education….*

OJEU. (2017). COMMISSION REGULATION (EU) 2017/ 1000 - of 13 June 2017 - amending Annex XVII to Regulation (EC) No 1907 / 2006 of the European Parliament and of the Council concerning the Regis tration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regard s perfluorooctanoic acid (PFOA), its salts and PFOA-related substances. *Official Journal of the European Union*. http://echa.europa.eu/documents/10162/e9cddee6-3164-473d-b590-8fcf9caa50e7

Page, D., Vanderzalm, J., Kumar, A., Cheng, K. Y., Kaksonen, A. H., & Simpson, S. (2019). Risks of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) for Sustainable Water Recycling via Aquifers. *Water*, *11*(8), 1737. https://doi.org/10.3390/w11081737

Parniangtong, S. (2017). Gaining Sustainable Competitive Advantage. In *Competitive Advantage of Customer Centricity* (pp. 1–18). Springer, Singapore. https://doi.org/10.1007/978-981-10-4442-7_1

Perkis, T. (2021, May 12). *Chemical giants hid dangers of 'forever chemicals' in food packaging | Pollution | The Guardian*. Article. https://www.theguardian.com/environment/2021/may/12/chemical-giants-hid-dangers-pfas-forever-chemicals-food-packaging-dupont

Peterdy, K. (2022). *PESTEL - Overview, Factors, Examples, Financial Analysis*. https://corporatefinanceinstitute.com/resources/management/pestel-analysis/

PwC. (2022). *Germany - Corporate - Taxes on corporate income*. https://taxsummaries.pwc.com/germany/corporate/taxes-on-corporate-income

PWP. (2022a). *How Backwashing Filters Work*. https://www.purewaterproducts.com/articles/how-backwashing-filters-work

PWP. (2022b). *How Backwashing Filters Work*. https://www.purewaterproducts.com/articles/how-backwashing-filters-work

Rahman, M. F., Peldszus, S., & Anderson, W. B. (2014). Behaviour and fate of perfluoroalkyl and polyfluoroalkyl substances (PFASs) in drinking water treatment: A review. In *Water Research* (Vol. 50, pp. 318–340). Elsevier Ltd. https://doi.org/10.1016/j.watres.2013.10.045

Reach-clp-biozid-helpdesk. (2021). *2nd Stakeholder Consultation on a Restriction for PFAS*.

Ross, I., McDonough, J., Miles, J., Storch, P., Thelakkat Kochunarayanan, P., Kalve, E., Hurst, J., S. Dasgupta, S., & Burdick, J. (2018). A review of emerging technologies for remediation of PFASs. *Remediation Journal*, *28*(2), 101–126. https://doi.org/10.1002/rem.21553

Sexton, C. (2021). *Polar bears threatened by toxic chemicals in melting sea ice • Earth.com*. https://www.earth.com/news/polar-bears-threatened-by-toxic-chemicals-in-melting-sea-ice/

Stadtwerke Rastatt. (2022). *So schützen wir unser Trinkwasser in Rastatt*. https://www.stadtwerke-rastatt.de/pfc

Stanford Childrens Health. (2017). *Low birth weight*. https://www.stanfordchildrens.org/en/topic/default?id=low-birthweight-90-P02382

Statista. (2022). *Average risk free rate (RF) of investment in Germany from 2015 to 2022*. https://www.statista.com/statistics/885774/average-risk-free-rate-germany/

Statistisches Bundesamt. (2022, September). *Inflation rate at +10.0% in September 2022 - German Federal Statistical Office*. https://www.destatis.de/EN/Press/2022/10/PE22_438_611.html

stmuv. (2022). *Spurenstoffe und vierte Reinigungsstufe für Kläranlagen*. https://www.stmuv.bayern.de/themen/wasserwirtschaft/abwasser/spurenstoffe.htm

Stoiber, T., Evans, S., & Naidenko, O. v. (2020a). Disposal of products and materials containing per- and polyfluoroalkyl substances (PFAS): A cyclical problem. In *Chemosphere* (Vol. 260). Elsevier Ltd. https://doi.org/10.1016/j.chemosphere.2020.127659

Stoiber, T., Evans, S., & Naidenko, O. v. (2020b). Disposal of products and materials containing per- and polyfluoroalkyl substances (PFAS): A cyclical problem. In *Chemosphere* (Vol. 260). Elsevier Ltd. https://doi.org/10.1016/j.chemosphere.2020.127659

Tansel, B. (2022a). PFAS use in electronic products and exposure risks during handling and processing of e-waste: A review. In *Journal of Environmental Management* (Vol. 316). Academic Press. https://doi.org/10.1016/j.jenvman.2022.115291

Tansel, B. (2022b). PFAS use in electronic products and exposure risks during handling and processing of e-waste: A review. In *Journal of Environmental Management* (Vol. 316). Academic Press. https://doi.org/10.1016/j.jenvman.2022.115291

Technologiezentrum Wasser. (n.d.). *Konzeption eines Sensor-Systems zur Online-Erfassung von organischen Spurenstoffen (SenSOS) | TZW*. Retrieved October 23, 2022, from https://tzw.de/projekte/projektdetails/detail/konzeption-eines-sensor-systems-zur-online-erfassung-von-organischen-spurenstoffen-sensos

Teymourian, T., Teymoorian, T., Kowsari, E., & Ramakrishna, S. (2021). A review of emerging PFAS contaminants: sources, fate, health risks, and a comprehensive assortment of recent sorbents for PFAS treatment by evaluating their mechanism. In *Research on Chemical Intermediates* (Vol. 47, Issue 12, pp. 4879–4914). Springer Science and Business Media B.V. https://doi.org/10.1007/s11164-021-04603-7

Trang, B., Li, Y., Xue, X. S., Ateia, M., Houk, K. N., & Dichtel, W. R. (2022). Low-temperature mineralization of perfluorocarboxylic acids. *Science (New York, N.Y.)*, *377*(6608), 839–845. https://doi.org/10.1126/SCIENCE.ABM8868

Tsang, W., Burgess, D. R., & Babushok, V. (1998). On the Incinerability of Highly Fluorinated Organic Compounds. *Combustion Science and Technology*, *139*(1), 385–402. https://doi.org/10.1080/00102209808952095

UBA. (2019a). *Trinkwasserqualität | Umweltbundesamt*. https://www.umweltbundesamt.de/themen/wasser/trinkwasser/trinkwasserqualitaet#mikroorganismen

UBA. (2019b). *Trinkwasserqualität | Umweltbundesamt*. https://www.umweltbundesamt.de/themen/wasser/trinkwasser/trinkwasserqualitaet#mikroorganismen

UBA. (2022a). *Öffentliche Wasserversorgung | Umweltbundesamt*. https://www.umweltbundesamt.de/daten/wasser/wasserwirtschaft/oeffentliche-wasserversorgung#grundwasser-ist-wichtigste-trinkwasserressource

UBA. (2022b, October 13). *Öffentliche Wasserversorgung | Umweltbundesamt*. https://www.umweltbundesamt.de/daten/wasser/wasserwirtschaft/oeffentliche-wasserversorgung#grundwasser-ist-wichtigste-trinkwasserressource

Umweltbundesamt. (2020, September 4). *Einsatz von PFC in der Papierindustrie | Umweltbundesamt*. https://www.umweltbundesamt.de/einsatz-von-pfc-in-der-papierindustrie

Umweltbundesamt. (2022a). *Das Magazin des Umweltbundesamtes*.

Umweltbundesamt. (2022b, March 22). *New measures to protect natural groundwater against trace substances*. https://www.umweltbundesamt.de/en/press/pressinformation/new-measures-to-protect-natural-groundwater-against

Umweltbundesamt. (2022c, October 22). *Only ten percent of Germany's water ecologically intact, despite progress made*. https://www.umweltbundesamt.de/en/press/pressinformation/only-ten-percent-of-germanys-water-ecologically

UNEP. (2019a). *BASEL CONVENTION ON THE CONTROL OF TRANSBOUNDARY MOVEMENTS OF HAZARDOUS WASTES AND THEIR DISPOSAL PROTOCOL ON LIABILITY AND COMPENSATION FOR DAMAGE RESULTING FROM TRANSBOUNDARY MOVEMENTS OF HAZARDOUS WASTES AND THEIR DISPOSAL TEXTS AND ANNEXES REVISED IN 2019*.

UNEP. (2019b). *STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS (POPS) TEXT AND ANNEXES REVISED IN 2019*.

United Nations. (2017). *The United Nations World Water Development Report 2017. Wastewater: The Untapped Resource*. UNESCO.

United States Environmental Protection Agency. (2014). *Climate Change Adaptation Technical Fact Sheet: Landfills and Containment as an Element of Site Reme- diation.* https://semspub.epa.gov/work/11/175853.pdf

US EPA. (2014). *2010/2015 PFOA Stewardship Program - 2014 Annual Progress Reports*. https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/20102015-pfoa-stewardship-program-2014-annual-progress

US EPA. (2018, August 23). *Reducing PFAS in Drinking Water with Treatment Technologies | US EPA*. https://www.epa.gov/sciencematters/reducing-pfas-drinking-water-treatment-technologies

Vieira, V. M., Hoffman, K., Shin, H. M., Weinberg, J. M., Webster, T. F., & Fletcher, T. (2013). Perfluorooctanoic acid exposure and cancer outcomes in a contaminated community: A geographic analysis. *Environmental Health Perspectives*, *121*(3), 318–323. https://doi.org/10.1289/ehp.1205829

Vinny, L., & Casey, M. (2021). *PFAS as Part of Environmental Due Diligence | EBI Consulting*. https://www.ebiconsulting.com/resources_news/pfas-as-part-of-environmental-due-diligence/

Wanninayake, D. M. (2021a). Comparison of currently available PFAS remediation technologies in water: A review. In *Journal of Environmental Management* (Vol. 283). Academic Press. https://doi.org/10.1016/j.jenvman.2021.111977

Wanninayake, D. M. (2021b). Comparison of currently available PFAS remediation technologies in water: A review. In *Journal of Environmental Management* (Vol. 283). Academic Press. https://doi.org/10.1016/j.jenvman.2021.111977

Washington, J. W., & Jenkins, T. M. (2015). Abiotic Hydrolysis of Fluorotelomer-Based Polymers as a Source of Perfluorocarboxylates at the Global Scale. *Environmental Science & Technology*, *49*(24), 14129–14135. https://doi.org/10.1021/acs.est.5b03686

Werdohl, U. H. (2002). *Performance of Stainless Steel in Waste Water Installations* (Volume 13). Euro Inox.

Worldometers. (2022). *Germany Population (2022)* . https://www.worldometers.info/world-population/germany-population/

Zandt, F. (2021, December 16). *Infografik: "Made in Germany" behält guten internationalen Ruf | Statista*. https://de.statista.com/infografik/26411/vertrauen-in-produkte-aus-ausgewaehlten-laendern/

Zhao, F. F. (2016). *Anwendung von Mikrowellen zur Reaktivierung von granulierter Aktivkohle aus der Abwasserbehandlung*.

Appendix

Appendix 1 Document Navigation

1.1 Table of Contents

1.2 List of Abbreviations

AFFF	Aqueous film foaming foam
ACF	Active Carbon Filter
C-F	Carbon-Fluorine
CFC	Chlorofluorocarbon
CSR	Corporate Social Responsibility
CTO	Chief Technology Officer
BA	Business Angel
DEM	Disciplinary Entrepreneurship Model
DWA	The German Association for Water, Wastewater and Waste
DWTP	Drinking Water Treatment Plant
EEA	European Economic Area
EI	Expert Interview
EU	European Union
GAC	Granular Active Carbon
GmbH	Gesellschaft mit beschränkter Haftung
HCFC	Hydrochlorofluorocarbon
HQ	Head Quarter
IDE	Innovative Driven Enterprise
IGC	Impact Gap Canvas
IP	Intellectual Property
IWTP	Industrial Water Treatment Plant
KPI	Key Performance Indicator
LTM	Low Temperature Mineralization
PFAS	Per-and polyfluoroalkyl substances

PFOS	Perfluorooctane sulfonate
PFOA	Perfluorooctanoic acid
PBT	Persistent, bio accumulative and toxic substances
POP	Persistent Organic Pollutants
R&D	Research and Development
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RO	Reverse Osmosis
SCM	Supply Chain Management
TAM	Total Addressable Market
TH OWL	Technische Hochschule Ost-Westfalen Lippe
TLR	Technology Readiness Level
TWI	Tolerable weekly intake
UBA	Umweltbundesamt
UN	United Nations
USP	Unique Selling Point
VC	Venture Capital
WTP	Water Treatment Plant (incl. WWTPs + DWTPs)
WTEM	Water Treatment Equipment Market
WWTP	Waste Water Treatment Plant

Appendix 2 Expert Interviews

2.1 Chris Woodruff, Aquagga

Name: Chris Woodruf
Date: 18.10.2022
Company**:** Aquagga Co-Founder & COO

After a brief introduction of both sides, we immediately jumped into the questions we sent beforehand. The first topic was the recent study that came out, which serves as a basis for Aquapurgo. It was already familiar to Mr. Woodruf. He told us that that approach is pretty similar to what Aquagga is doing, with some key differences in temperature and pressures.

Early Stages:

The business idea for Aquagga came up with a funding from a program iCore funded by the National Science foundation for customer discovery. 50 000 dollars for them to travel around to conferences, speak with customers and see the pressing needs in environmental mediation. At the time they were exploring sewage sludge to energy conversion. They went with the thesis that they could start a company doing onsite energy conversion. However, they found out during their talks, that PFAS destruction was the major topic, so they shifted. Spent first year of covid chasing funding, small business innovation research" program in the US, secured three of those through EPA, National Science foundation and Airforce and within 4 months they did chemistry R&D, material science to validate their equipment. In general, they used a very problem-centered approach to their business.

Validation:

The EPA did an "innovative ways to destroy PFAS" challenge, where they got first place and gave them a technical validation and inbound customer interest. Secured a couple phase-2s. Also, they secured half a million dollars in Angel Investment to cover some of the costs that can't be used with grant funding. They have a couple of universities as self-contractors to use their equipment and resources and acquired grad students to do some of the technical work. Some IP has been done in-house some is still owned by the universities and they developed licensing agreements. The universities do the lab scale research, and they try to find a way to industrialize the results. Currently, they have seven patents in their portfolio. It's a combination of patents that they own exclusively, patents that they license exclusively and trade secrets.

Milestones:

Their first paying customer was a very small project for a study involving only 50ml sample batch configuration, they treated some landfill to get data back showing this process works, which was very significant to use for grants, proposals to investors, water treatment providers, etc.
Next milestone was building a standalone system outside of a lab environment. Build it in a 10 ft shipping container, showing that doing it outside the lab works. TRL (Technology Readiness level) was going from TRL1 to TRL5 in two years, which is quite quick.

Business Model:

According to Chris, the business model of Aquagga is always learning and adapting and is currently changing. Two years ago, customers would've preferred in normal CAP sales, now there's more interest in system leasing. They have more like a project-based approach, so they provide a service to contactors. They are constantly on the look-out for new destruction and filter techniques though, since the market is currently changing a lot.
Their process uses a Pump and Treat technique and then filter and destroy the PFAS. It has shown to effective on anything they can test for today. To date, there's 45 compounds that can be measured analytically. Measuring fluoride recovery is the best way to measure the full destruction of compounds and their process has proven to be effective on both short and long-chain compounds.
The system is operating in Alkaline conditions, so they produce a small amount of salt on the back end, a chemical that is used in toothpaste for example. According to him, it's such a small amount though, because PFAS are in such dilute concentrations. They are things that don't get broken down in the process like heavy metals, but they are currently searching for secondary treatments for that. Their focus lies only on PFAS, because they saw the biggest need there.

Current Stage:

They are not in a position where they are out cold-calling customers, they don't have enough systems available to take on multiple projects at a time. They've gone to wastewater and environmental trade shows, which have a big impact in the industry. They aren't really chasing wastewater treatment plans as a customer, they are more of a tech provider to consulting firms, engineering contractors that are managing projects on-site. According to Mr. Woodruff, they are not big enough to be a prime contractor on federal work yet. Currently they are building out their funding and research system, and meanwhile securing some private investment to expand not only technical team but also the business side.

PFAS Awareness & Market:

Because of industrial discharge requirements that were not set previously, they saw remediation as a beach hat market because the USA Department of Defenses has spent a lot of work on environmental restoration technologies. The awareness for the topic has been changing in the last couple of years. 20 years ago, there was a big push to get rid of Teflon, but it wasn't really associated with PFAS per se. For the public, the idea of this large group of chemicals that fall under PFAS is hard to grasp. In the last few years though, there was increasing coverage on the effect of PFAS on communities and media coverage really increased public awareness.
Aquagga hopes that the government will increase spending even further on remediation. It is expected that the US Department of Defenses will increase its spending on PFAS to 4 billion dollars a year by 2025, because it is centric to firefighting equipment and Airforce Bases. The industry still uses a lot of PFAS and despite regulations, the market will still grow. PFOS and PFOA is expected to be declared as hazardous waste in the next year. Some of the shorter-chain compounds that aren't regulated today will get tighter regulations over-time. The approach thus far for manufactures is to replace PFOA with Gen X. It is important that the technology needs to be effective on short-chain and long-chained compounds as well.

Internationalization:

They are exploring international markets a little bit; Australia has been active with acquiring new technology and in Europe some of the Scandinavian countries have been most active in PFAS research. There is currently enough need in the US to keep them busy for a few years.
When they started the company there were guideline from the EPA, maximum contamination etc., their levels at the time were higher than now. They didn't expect it to change that significantly that quickly.

It was concluded on both sided that Germany is now in a similar stage that the US was in 2019, when PFAS slowly came up.

Pricing:
They have a good understanding of their costs but are not sure of what customers will pay yet. Cost per gallon is a standard metric and they have an understanding what they are paying for that now, without regulations, so there will be a multiplier for that. But they are not confident what customers will pay yet. Also changing, with supply change changes. They are still refining, and all the projects were just demonstration projects thus far. They have six big customers that express willingness to pay from 3 to 7 dollars per gallon for treatment and disposal, which is much higher than the average gallon treatment costs for waste and drinking water treatment. It's just speculation for now though.

2.2 Brittany Trang

Name: Brittany Trang
Date: 11.10.22
Description: Head scientist of the lab group who discovered the new PFAS destruction method

In which development stage is the discovered method?
The research is currently working on lab scale only and is as of today not suitable for industrial application. The method needs optimization. To achieve this, the method needs to be studied further to make it more industrially friendly (e.g. minimizing the amount of DSMO solvent used and potentially replacing it). Therefore, she thinks that an actual solution for industrial application could look different than their discovered method.

Where could it be applied?
"Our method, if even implemented industrially, would not be integrated into a water treatment plant. It would operate on concentrated PFAS-containing waste streams from reverse osmosis or ion-exchange regenerant solution or carbon adsorbent regeneration solutions, not on wastewater or drinking water directly, and would likely be operated at a separate site (like how drinking water activated carbons are currently regenerated off-site). […] The destruction method will have to take place after the PFAS has been removed from the water by filtration or reverse osmosis or another removal method."

What is your opinion about current PFAS waste disposal?
"Currently, the way activated carbons are regenerated is incineration--the more-flammable pollutants are burned off the carbon surface in a kiln. However, incineration has been shown to be difficult to implement for complete PFAS destruction, since PFAS are thermally stable and need to be incinerated at higher temperatures than most incinerators are equipped to handle."

2.3 Heiko Heinrichs, Bureau Veritas

Name: Heiko Heinrichs
Date: 18.10.2022
Description: Director Technical Service Europe Middle East Africa. Chemist by education and has been in the business for about 30 years, dealing with chemical requirements within the EU, but also worldwide. He deals with chemical compounds and regulations for our customers.

Have you ever heard of per- and polyfluorinated chemicals (also called PFAS, PFC or forever chemicals) ?

Yes, there are some legal regulations in different areas, once in the area of food contacts and then for example also in the area of textiles are limited in the REACH and in the POP regulation.

Do these substances get into the waste water also in Germany?

I don't know whether these chemicals actually still end up in wastewater in Germany to a large extent, because a large part is already restricted. In fact, however, this happens in many other producing countries. It is a question of which products you really look at. In Asia, there are still plenty of per fluorinated compounds entering the environment. There are studies by Greenpeace that comment on this. In Germany it is still a topic, because we have in Germany also still some old loads, often then at the airplane places where this fire-brigade foam was used. Which contains PFAS!

Would you say that the current handling of the chemical is appropriate, with background on the new drinking water regulation?

If we talk about the firefighting foams. Of course, you can immediately say that we'll do without them, but if we don't have any reasonable alternatives, I still don't want to burn them at the airport, just because we'll be protecting the environment. So, in that respect, it certainly needs to be looked at in more detail. Nevertheless, something must be done, and we can already see that it has taken quite a while to enforce regulations. PFOS & PFAS were developed in 1940, so that's a long time ago. Now 80 years later we are starting to see that these chemicals are not that great. That's why we must do something, and we have 2 different approaches. In Europe, we have this approach that we want to regulate specific chemicals and ban them. In the U.S., we have more of a global approach, where the entire floor content is banned.

You just said that such substances are also examined and that there is advice on this, do you also provide impetus for the regulations?

Yes, it is always the easiest thing for the testing agency to say that it should be tested, because there is a legal regulation on this, and you are not allowed to use the substances. In this respect, it is easy for us to say that there are legal regulations.

How easy would it be for companies to derive alternatives to these per fluorinated substances?

So, what I see is that companies are looking for alternatives. Some try to ban the substances completely, i.e. not to use per fluorinated substances, and others first try to say which compounds are really banned. Then they don't use them anymore, but maybe still short-chain compounds. However, the market we customers demand a great water repellency on our rain jacket but on the other hand there are not always so many alternatives that you can use that have just the same performance.

How effective are oxidation and reduction with PFAS substances? So biological remediation and ultrasonic treatments to destroy these trace substances?

There, I don't know exactly how well that works. On the one hand, per fluorinated compounds are relatively stable. We can see that they are persistent. In other words, we have nothing other than substances that are difficult to biodegrade. That is why they accumulate in nature. It may be possible to destroy the CF bond by oxidative cleavage, if you can then create other compounds, but you still have flour compounds, which may be better degradable or better to filter than per fluorinated compounds. The concentrated PFHS are mixed in the presence of a sodium hydroxide solution in DMSO solvent, and this mixture is then heated to 80 -, 120 degrees and there the PFAS dwell and are converted from fluoride to florid.

We would like to hear your opinion on solvents such as sodium hydroxide, whether these substances are dangerous or harmful to the environment?

No, so you always must be careful with the whole thing, the concentration makes the toxicity of the product. Sodium hydroxide is of course very corrosive, a strong base. You can handle it properly, the other way around you can't throw tons of sodium hydroxide into the sea, that's also crap, but it's certainly not as toxic as per fluorinated compounds.

How do you rate dimethyl sulfoxide (DMSO)? Is the solvent dangerous?

Yes, dimethyl sulfoxide (DMSO) is also a common solvent. We also have it from time to time in creams, for example. DMSO, now is also in principle no great solvent, but in contrast to the to the per fluorinated compounds is also rather a weak means. If the whole thing works, the two chemicals are certainly not as worrisome as per fluorinated compound.

If we have now managed to convert per fluorinated compound into florid, we have already combated PAFS, but this solution remains. Would we have to dispose of it in a proper way?

First, we have a higher amount of florid which is relatively harmless, which is a water-soluble anion, that is not insanely dangerous, we have other anions like chloride, so sodium chloride, table salt that is then relatively harmless. The DMSO, that must then be disposed as organic solvent.

Are there any special requirements for the operation of these chemical processes?

In any case, this is a conglomerate of many laws that must be considered to be able to say that I can now operate this thing.

I have also seen on the website that many companies offer cooperation or assistance in quality management or plant engineering. What does such a cooperation look like and how does it work?

I work at CPS Consumer Products Services. We deal with testing consumer goods, i.e., products used in everyday life, for chemical, physical and mechanical resistance. We also do a lot of certification work.

How does the water testing for PFAS proceed at Bureau Veritas?

We do it mainly in Asia. There are production chains and there we do a lot of wastewater testing for a whole range of compounds because there are requirements, firstly of a legal nature, but also for zero discharged hazardous chemicals (ZDHC), which is an organization that deals with making textile production cleaner and cleaner is also defined by the wastewater that is discharged into rivers and in that context we also do, for example, on these per fluoride compounds. PFAS chemicals are also regularly tested in the wastewater.

How far have the investigations progressed and can almost all the different PAFS compounds now really be detected and identified, because it is always difficult to say in which constellation they occur? And if they are in very low concentrations, can they almost no longer be detected?

That is still very difficult here is the simple answer is no! The UN has once brought out a list, there were 10000 different compounds that are possible, and it is not possible to test them all. Some of them are not relevant and some of them cannot be detected with the measuring instruments. In addition, there are detection limits that are reaching their limit. Now, PFAS are still being used in higher quantities, so the mountain has to be skimmed off first.

What does the current analysis process look like?

A wastewater sample is analyzed for per fluorinated compounds. Then this sample is taken, and a solvent is used to dissolve out the per fluorinated compounds. Then you concentrate it a little bit so that you have as much as possible of these per fluorinated compounds in this solvent and then there is a so-called liquid chromatography-mass spectrometry (LC MS MS) and with this thing you can then analyze which compounds are in there. The chemicals pass through this column at different speeds. That means at the end of the column have the chemicals separated from each other because they pass through at different rates Sau. And then, when they are clean at the end, separated from the others, they go into a second device in the mass spectrometer. There they are bombarded with electrons and then they fall into fragments. These fragments are electrically charged and have a certain mass and this can be measured and on the basis of this you can then say ok, that was this compound. And the higher the signal is, the more is in it and you can measure how much is really in it. There is a second analysis, which refers to the total per fluorinated compounds. For this purpose, samples are taken from the water or textile and filled into a kind of bomb, where oxygen is added. The bomb is sealed and ignited, which burns everything that is produced, including fluoride. The fluid is then discharged and collected in a filter, then another device can be used to measure how much fluoride is in it.

2.4 Prof. Dr. Claudia Bünte

Name: Prof. Dr. Claudia Bünte
Date: 21.10.2022
Description: Prof. Dr. Claudia Bünte is a recognized international marketing and branding professor and expert. As an executive, she developed and managed brands on a global level: As Associate Principal at McKinsey & Company, Global Vice President of Brand and Marketing Strategy at Volkswagen AG, Director of Knowledge and Insights Europe at The Coca-Cola Company. Other tasks included working with top brands such as NIVEA, Apple and Siemens.

Before starting the interview, we asked Ms. Bünte if she ever heard of the term PFAS, and she didn't. Then we explained our business model and our identified customer segments. The major takeaways are as follows:

B2B Marketing

She recommended us to start creating a strong Marketing Funnel and putting into focus why our product is the right one and why we can say we have the best product, especially when it comes to science-based startup. How do the target groups tick? Do WWTPs have different concerns than DWTPS? Do we need to create several marketing materials for them? Lobbying, PR especially in our sphere is extremely important according to her.

In regard to frameworks, she said that most B2C frameworks can be applied to B2B as well. The problem is that the impacts of marketing activities in B2B are not as quickly converted into numbers, since B2B Marketing usually deals with more complicated products such as ours, which requires lots of explaining. The major differences to normal B2C brands and Aquapurgo, are that we have a long customer lifecycle, and we have a hard purchase decision for our customers. The fact that we are still a start-up, meaning for the customer there is always the risk that he might think our company could go bankrupt and then the customer is left with an active charcoal filter with no service around it. In her opinion, we are working in an area, where there is a long persuasion process, therefore we need a strong B2B Funnel combined with an excellent sales pitch. Her recommendation was to find a pilot customer, who we can then use as a "reason to believe" for the main target group, especially since large production

factories are very cautious when implementing something into their existing processes. Our goal is to take away the fear to commit to us. We should then prioritize our customers, e.g. start with the WWTPS in states that have the Green Party in their state parliament.

B2C Marketing

After explaining the results of our survey, we switched the conversation to the awareness campaign. Our main concerns that we asked questions about was how we can effectively access the public with cost-effective marketing, since our major revenue stream will only arrive in 2026, due to the R&D of our destruction process. She gave us a lot of ideas about capital-defensive marketing strategies: Firstly, she strongly recommended to us Guerilla Marketing, which involves lots of creativity. We should develop 4-5 ideas that create lots of media coverage and she gave us an example about a German animal protection company and their approach. They did an announcement in the newspaper that they will kill a dog at the main square. Lots of people came and of course they didn't kill a dog, but they then lectured them about animal protection. The crux is that having a good idea isn't enough, we need to create a buzz around the topic and the specific Guerilla Marketing campaign.

Social Entrepreneurship:

The major question was how we can ensure that our customers know that we are a social Entrepreneurship, and how we can manage that our environmental mission stands in the foreground despite us being a for-profit company. Ms. Bünte thinks that this will come automatically since our product serves the natural purpose of making the environment cleaner. Our topic automatically says, because of us, the earth is a better place. Our message should be clear in this case and always said with every sale. The whole topic "better world" should stand in the foreground. The great thing according to her is that we don't have to come up with a "better world" statement artificially.

2.5 Dr. Alexander Kämpfe - UBA

Name: Dr. Alexander Kämpfe
Date: 25.10.2022
Description: Chemist, employed at UBA since 2015. Specialist in the area of swimming & bathing pool water and also PFAS.

Are these substances dangerous in your opinion?

Not all of the substances are dangerous, but they do have negative influences on processes. However, they are used because they also have very positive properties. These positive properties are due to certain processes and therefore the occurrence of the trace substances also has a background for quality of life. However, the substances have been handled with a naive approach and the negative effects on the environment have been neglected. However, industry also has a responsibility to participate in education about certain substances.

The subject of education:

This is a rather sensitive topic because the population is largely unaware of the effects of the various trace substances. The media have a lot of momentum here, but often polemicise the effects, which leads to fear and uncertainty. I advocate scientific knowledge transfer in order to eliminate misunderstandings and fear. Uncertainty and fear will not achieve anything in the population.

When did you first come into contact with PFAS?

I have been dealing with the issue since I started working at UBA in 2015. However, UBA has been dealing with the issue since the turn of the millennium (...)

(Our colleagues in chemicals regulation know more about the subject of substitutes).

The production of further PFAS (mostly short-chain) is brought about by regulation. What do you say to this?

There are already thousands of substances that are difficult to regulate. Even if the short-chain substances may have less impact on the environment, the industry will continue to try to circumvent the regulations.

Substitutes?

Industry should determine the substitutes itself and enter into a cooperation with the UBA in which the UBA examines the toxicological properties of the substitutes.

How can the introduction of harmful substances be prevented?

It is very difficult, because in fact every smartphone owner carries PFAS substances in his mobile phone and users would have to boycott such products. I would also like to see consumers given more rights of co-determination.

How long do UBA regulations take?

First of all, European votes are required, which in turn become binding for German legislation. Currently, this is the Drinking Water Directive, which was passed on 12.01.21 and is now being incorporated into German law as a parameter. However, it will take several years before the infrastructure can comply with these directives. This will require a retrofitting of the plants and an adaptation of the laboratory infrastructure. The measured values of 0.5 or 1.7 nano grams per litre will be an extremely big task for drinking water control stations.

Is there already sensor technology or do you know of anything in this area?

Currently not feasible. At the moment, EC-MS-MS (not sure if I understood that correctly) laboratory tests are being done with sample name and subsequent evaluation in the laboratory.

Do you see the current disposal of PFAS as appropriate?

Many research groups are currently working on this and there is great potential in the area of PFAS regeneration. However, PFASs can already be mineralised very well through incineration.

What is the handling of counties and offices that suffer from severe PFAS contamination?

There are still many unanswered questions in the hotspots in Germany. In the meantime, however, a very good way of dealing with them has been found. Good information is also being passed on to the population. However, more support is needed for the districts.

Are PFASs neglected through the use of "umbrella filters" such as activated carbon filters?

Partly yes. Remobilisation of trace substances is possible due to overuse of activated carbon filters.

DMSO study (our study) known?

I am aware of this study, but there are many more approaches and possibilities to degrade PFAS.

Future of PFAS handling?

PFASs will decrease in hotspots, but in general they will spread further in the environment and their concentrations will increase. This will happen mainly through emissions into the oceans and then through fish eaten by humans that will re-enter our cycles. It is therefore absolutely necessary to help reduce these emissions.

Regulatory changes in the coming years?

Not my department. However, trace substances will definitely be regulated and restricted. (Forwarded to department 4.23). It is important to increase regulation outside of Europe. It is already laid down in the Stockholm Convention under POPs but it must continue to be strengthened worldwide.

2.6 Jona Schulze – UBA

Name: Jona Schulze
Date: 01.11.2022
Description: UBA Department Chemical Safety – REACH execution. Job and responsibilities: Research on Chemicals, Restriction of chemicals, Investigation of companies dealing with chemicals, Push innovation. Working in this area since 2020

Opinion about PFAS:

He first heard about PFAS in 2015. In terms of environmental protection, he confirms that the handling of the chemicals is “unsatisfactory”. He thinks that they bring benefits to industries, but stronger regulation is desperately needed.
He would desire a sustainable and viable destruction method to push regulations faster, since they are always aligned with the state of the art of the technology. He confirms that the current incineration is the wrong way considering the trend towards circular economy and the energy intensiveness.

New LTM Method for destruction:
He heard about the new destruction method and sees the potential of this idea.

European regulations:
In his opinion, regulations are not sufficient. Still novelties are not simple since decisions are made on EU level. He lastly worked on restricting the usage of a PFAS sub-group. Over the years he has seen that the result of forbidding single PFAS results in companies shifting to PFAS alternatives. The ultimate goal is to forbid all PFAS chemicals.

Role of Umweltbundesamt and Germany:
Play a crucial role in pushing the research and regulations for PFAS. They are leading the approaches to forbid PFAS on the EU level. Still, they can't decide without approval of all European countries.

Time frame for regulations:
Exemplified with the current proposal to restrict the entire PFAS Group:

1. Started in 2021 with developing the regulation proposal
2. Submitting the proposal in January 2023.
3. ECHA consults and discussed the proposal
4. In 2024, publication of results and concerned institutions can request adaptation of details if something is missing
5. Hand final proposal to European commission for approval
6. Results of European commission in 2025
7. Implementation of restrictions in 2025-2026

In total, the time frame from ideation of a regulation until implementation is approximately 5-7 years.

PFAS monitoring:
In Germany, governmental guidelines differ from state to state. There is no frequent monitoring and no regulation. Regulations are missing since the technology is not advanced yet. Regulation for frequent monitoring is desired but not planned yet.

Implications of new methods:
New methods need to be considered in formulating regulations.

2.7 Dr. Jürgen Oles - Oswald Schulze Umwelttchnik GmbH

Name: Dr. Jürgen Oles
Date: 14.10.2022
Description: Managing Director of Oswald Schulze Umwelttchnik GmbH. OSWALD SCHULZE Umwelttechnik GmbH represents more than 90 years of experience in wastewater engineering for municipal and industrial wastewater treatment, sludge treatment, sewage gas utilization (energy recovery) and the supply of special built-in components. The range of services includes planning, delivery, assembly, commissioning, and maintenance of environmental engineering plants for water/wastewater treatment. Dr. Jürgen Oles has been working in this industry for about 32 years.

Already in 2006, Dr. J. Oles heard about PFAS substances in connection with first treatment recommendations of the Drinking Water Commission of the German Federal Environment Agency. However, he emphasizes that to this day there are no clear laws, only guidelines concerning these substances. It is particularly important, however, to differentiate between drinking water and wastewater, as the drinking water ordinance already defines upper limits, but these do not apply to wastewater. Thus, the removal of anthropogenic trace substances in the wastewater sector is not obligatory and is currently not implemented across the board, but is carried out exclusively by individual

plants (e.g. specially funded plants, in particularly polluted areas). At this point in time, wastewater companies are in the starting blocks to expand their systems with a fourth treatment stage, but the exact specifications from the legal side are missing. Furthermore, the operators of wastewater plants are particularly in favor of limit values in wastewater discharge, which means that the industry will have to treat its wastewater even more extensively in the future, especially with regard to PFAS. Nevertheless, Dr. J. Oles sees a comprehensive fourth treatment stage in wastewater plants as obligatory in the medium term and predicts binding requirements within the next five years.

Effective methods to remove trace substances from water

The expert emphasized that currently activated carbon filters are both the most effective and safest method. Moreover, in principle, any wastewater treatment plant can be retrofitted with such a filter system. Besides activated carbon filters, there are membrane separation processes that can also separate PFAS, but this method leaves a concentrate that has to be incinerated, so this process is not an option for regional/municipal wastewater streams.

Opinion about Incineration and Remediation of PFAS

In general, Dr. J. Oles describes the incineration of anthropogenic trace substances as not particularly forward-looking, as very high temperatures must be reached to destroy PFAS. However, this is currently the most widely used method. Another factor that significantly influences the attractiveness of disposing of such substances is the reuse of the activated carbon. There are two options: to dispose of the activated carbon or to reactivate and reuse it. However, wastewater treatment usually does not think about this, as the work is done for them with the absorption of the substances.

In addition, the interviewee emphasizes that at this point only a few wastewater treatment plants are in favor of targeted purification of PFAS, as they can be filtered out together with other anthropogenic trace substances. Individual purification is therefore superfluous as activated carbon filtration has an elimination rate for all anthropogenic trace substances. According to Dr. J. Oles, these substances have only become the focus of attention in recent years, as analysis has improved and made detection possible. If we look at the next few years, Dr. J. Oles describes that public pressure will first increase on producers and industry and then on the state and wastewater treatment plants to filter these pollutants effectively.

2.8 Joris Koch – ASIF Ventures

Name: Joris Koch
Date: 24.10.2022
Description: President & Early-stage investor. ASIF Ventures invests in students and graduates at a very early stage in their startups. ASIF Ventures takes care of the pre-seed phase and has a small ticket size. (You would need several founding rounds because as an innovative startup you need a lot of capital. With you, a lot would go into working capital and money for R&D).

What are approaches in evaluating business models?

When we look at a business model, especially at an early stage, the team is the most important. Does the team has the skills to bring the idea and venture forward. Skillset and vision in the team must be coherent to execute the business idea. One of my first questions would be who has the technical knowhow for the idea and who takes what role in the team. Is the team complementary? What different skill sets do you have? Then they look at the cap table and who has how many shares in the company. Then the product is looked at second. The team comes first because as long as the will, the passion and the expertise are there, the product can

still be pivoted. What is the problem and how do you solve it? An overview of the product and how it works.

What do VCs look for when they are presented with a new technology?

Most of the time the processes are new. We let them tell us everything and then we have validation due conversations where we ask industry expert questions or talk to other VCs who are investing in a similar direction. There is still external validation and research done. If the technology is really new, I would try to find someone who knows the area.

What are the requirements for funding?

Startups need to consider in the first step how much money is needed and for how long this budget should last. In the second step, the startup needs to consider what terms it wants to enter into for the investment. Where does the pre-seed valuation come from? At such an early stage, a "convertible" is used, i.e. a wage-out (loan) is given first and at the second funding round (where the idea is validated) the loan is converted to the first investment.

Two methods for wage-agreement:

The wage converts to equity with a discount (by taking more risk in the early investment, the CV gets more equity for the same price than the next investor) e.g. one pays only 20K for 1% of the company shares the next one would have to pay 40K for the same share.

Angel syndicate: We can invest 25K of ourselves but then we try to get rich people who also want to invest money can invest with the same conditions.

In most cases two or three VCs make the ticket size full, especially in pre-seed there are business angels or individual investors. Therefore, it can be good that the expertise comes from two different VCs and then also money from a business angel.

Where do we get funding other than money?

Depends on the VC. Generally, there are VCs that specialize in certain industries or have a certain expertise. So it can also happen that VCs provide expertise instead of money. But we don't have any contacts to the Research Institute at all, although we are of course linked to the VC scene. And if we as a VC want to place someone, this person should also be good in the required area. It is very common that VCs make co-investments. Especially with our small ticket size. I rarely see investments where a single VC fills the whole round.

What metrics do you pay attention to?

We're specific on that too, but when funds are pre-seeded, it's relatively difficult to figure out metrics. Part of pre-seed investing is coming to a conviction with just a few numbers. What is then important is a pilot project. From this pilot project, relevant figures for the later funding rounds should emerge. In your case it depends on who you talk to, because climate CVs have a lot of insides in your case, but basically the key figures always depend on the unit economics. Then there are production costs, customer lifetime value, where you can also build up financial projections by specifying how often your filter system has to be replaced. (Your costs are X, your revenues are Y).

How do we shoot in which milestones we need how much money?

It's often the case that startups work with Grands and Substitutes, at least in this step. Because on the one hand VCs don't know if the technology works that way and they don't want to take that much risk. If VCs do that, they want to have a lot of equity for it. But for us it is relatively typical that our customers calculate and indicate approximate milestones until when they spend how much money and how much money they need until when. To make the runway more tangible, we list what will be achieved and by when with how much money. But there you need to read more about how tech focused VCs do it. Because I'm not sure about R&D and IP and patents. But there are VCs that are specialized in that.

Do you think it makes sense to introduce yourself as a social startup?

Yes it does but then you have some other implications. If you have the numbers and you can show them, it's exciting for Grands and Substitutes of course, but also for other VCs that go more in that direction. The VCs that have a commercial mission but also invest socially oriented. I have to show that you are solving a social problem and at the same time working profit oriented is clear for all VCs the problem solution fit and moreover you have a wider reach of VCs you can address.

2.9 Rastatt

Name: Liane Sandbühler, Lisa Marquart
Date: 07.11.2022
Description: Liane Sandbühler, Lisa Marquart both work at the PFC staff unit for the Karlsruhe Regional Council. They organize and coordinate the regulations for PFAS in the region of Mittelbaden and advise the sewage treatment plants and other public stakeholders with the handling of PFAS.

Briefing and introduction:
Currently, we are both here in the staff unit, I am a lawyer by profession and also have to deal with legal aspects. That's why I've been in the staff position for almost 2 years, and Dr. Hoffmann is responsible for the professional, technical part.
I am a geologist by training, which means I also have a background in the natural sciences. I've been in the department for three quarters of a year, so I'm still relatively new here, and we take care of communication on the subject of PFAS, we accompany the projects that take place elsewhere locally.
We have a few areas of application for the activated carbon filters and perhaps we can also give you a few tips on where you can ask further questions about the individual projects that have more concrete experience. The public utilities of Rastatt, which make drinking water from groundwater, have this activated carbon filter system simply so that the water is drinkable. There are farmers who clean the water with activated carbon filters before they use it. These are the topics that we are most concerned with and where I would have seen at first glance where this might fit into your project. Thereby we take care of an overall coordination. The polluted areas have to be dealt with systematically, so my colleague means agriculture, drinking water supply, of course, and then also landfill - these are different areas that are affected there. At the ministerial level, we have the Ministry of Social Affairs, the Ministry of Agriculture, and the Ministry of the Environment. We have here the regional council, at the administrative structure we are a middle authority and then there are the lower responsible authorities for example soil protection, health department and because the case was just as large and complex, we were founded as a staff office for coordination.
Perhaps we can then start with the authorities with which they mainly cooperate. You have already mentioned the soil protection authority and the Federal Environment Agency. Who is mainly responsible for filtering and disposing of PFAS?
If we have PFAS in the drinking water, then the public health department is responsible, and the public utilities are usually in municipal or private hands. They take care of the installation of the filtering equipment, the extent that is necessary and the treatment of the plant. In the case of the landfill, it is the waste authorities who take care of this. For concrete local planning, the PFC office in the district of Rastatt is a good contact, and in the city of Baden-Baden there is an exchange with the city council.
Which methods do you see as future-oriented for the coordination of the individual offices?

The problem with PFAS will not be solved in the next few years because the amount of PFAS is too large. There we see it as trend-setting to invest more in research in order to find better solutions. That is why we, as a staff unit, have a lot to do with research projects that specialize in the detection and filtering of PFAS. In addition, how to wash the soil with surfactants. At the moment, PFASs are taken to incineration after filtering. However, the precursor compounds cannot be filtered from the soil yet. Therefore, we are looking at filtering the water where it will be used. We coordinate these places with the offices, which can then provide support.

How are these projects funded?

The funding comes from the regional council or the Ministry of the Environment. Projects are created together with different actors. The WW+ projects were coordinated and funded by the Ministry of the Environment, and LUBW conducts its own research on PFAS topics and has its own funding.

Where do you still see approaches for our LTM service?

What is also a big problem is the landfilling of PFAS containing material. There the leachate would have to be treated, which contains PFAS and that would also be another area for your startup. Also the municipalities have to deal with their PFAS waste streams and would benefit from this service.

Will the fields that are contaminated with PFAS still be used or taken out of cultivation?

The fields will still be used, and care will be taken to filter the water for cultivation. Consumer protection must be taken into account. There is a monitoring that ensures that the PFAS load is not too high so that PFAS does not get into the food cycle. The areas are used but only in a controlled way. With the composting it is rather looked that there no PFAS loaded materials are used. Since the PFAS contaminated area is too large, we are more concerned with consumer protection but not with the general destruction of PFAS.

Are the costs for the undertakings recorded?

All costs are recorded in an interim balance sheet, but not all costs are recorded there because there is still a large number of unreported cases.

2.10 Richard Arndt – Unicarb

Name: Richard Arndt
Date: 19.10.2022
Description: M. Eng. Richard Arndt is the co-founder and CEO of LSR Materials (Lean Supply of Raw Materials) and Unicarb Activated Carbon. He has been working in this area for more than 15 years and has acquired vast knowledge about carbon in the field of environmental technology. Unicarb will be our main supplier of activated carbon.

Market assessment

Arndt sees the activated carbon market as an established market with little to **no production capacity** left in Europe. Due to globalization the majority of carbon is coming from outside of Europe and most of the carbon specialists **outsource** their production. Most companies that were producing in the beginning are now only trading. Still, due to the diversity of the scope of application all the activated carbon players in the market have a niche they focus on. Currently, Arndt and his team are pursuing an innovative paradigm shift from fossil-based carbon to renewable resources that have similar characteristics to the fossil resource. He even confirms the viability of this **regenerative "carbon".**

PFAS:

The first time he heard about PFAS was in 2017 and he conducted first experiments with his products in 2018. Now he has activated carbon specialized in treating PFAS. In his opinion, trace substances and PFAS are often handled as one. This topic is gaining visibility because it was simply not measurable. Now, as **technology is enhancing**, we are able to treat this delicate topic. He also says that the advantages of PFAS should not be neglected. Still, he endorses the Polluter Pays Principle and thinks that this topic is not handled correctly. In this context he is convinced that with the emergence of new technologies, **stricter regulations will be enforced**. He says that the market in the US is 3-5 years ahead of the European market in terms of regulations, limits and technology. In general, he **predicts a rising awareness about PFAS in Europe**.

Regulatory
He says that if the treatment of trace substances (4. Reinigungsstufe) becomes **mandatory** for class 5 WWTPs (WWTPs for more than 100.000 inhabitants) (As proposed in a draft by UBA) the **activated carbon demand in Germany will increase by 35.000t/year**. As a result, this **transition will require years** in order to meet the huge amount of activated carbon.

Activated carbon:
He says it's simple technology and very effective for PFAS and trace substances. Direct and easy implementation and maintenance.

Reactivation:
ALWAYS powered with gas. There is always a loss of material (10-15%). 70% of the adsorption potential can be reactivated, but it depends on the adsorbed materials. It was viable with low gas prices but is now more expensive than new activated carbon. He says the lifetime of used activated carbon can be extended by selling it, since it still has a significant calorific value. Reactivation usually happens at 700°C.

Washing of activated carbon:
There are several washing techniques to “re-adsorb” the PFAS from the activated carbon.

Customers:
Industry customers show less interest in trace substances than WWTPS.

WHO pays for the PFAS disposal:
He says the plant (e.g. WWTP) pays for the disposal.
It is mandatory for plants to keep up with the state-of-the-art technology.

2.11 Klärgastechnik Deutschland GmbH

Name: Julia Böttcher - Executive Assistant
Date: 22.11.2022
Description: Klärgastechnik Deutschland GmbH is a leading filter and gas treatment equipment manufacturer. After several talks with them we agreed on a partnership that includes the retailing of their filters.

Market:

In Germany the choice of suppliers is significantly limited. If KGT competes in a tender, there are mostly just 0-3 competitors. Sometimes there is no competition since demand often exceeds supply. Hereby, customers' decision is based on 1. price, 2. regulatory adherence, 3. business validation/reliability. Many competitors have been in the market for a long time already but so are their products. Most installed technology is old and outdated and lacks innovation. Generally speaking, there is not a lot of IP protection as incumbents feel the threat of imitation that patents may create. The main focus in designing a product is functionality. Only a few players, like KGT she says, understand the interconnectedness of the plant as a whole. Besides, she points out the relevance of long-term contracts which many customers enter for simplification. Most importantly, experience has shown that WTPs are not price sensitive as they are not spending "their own" money. Competition is largely based on product performance, reliability and innovativeness of products, services and solutions, application expertise and process knowledge, brand reputation, energy and water efficiency, product compliance with regulatory and environmental requirements, product lifecycle cost, scalability, timeliness of delivery, the proximity of service centers to customers, effectiveness of distribution channels and price. Furthermore, incumbents struggle to differentiate. They often have to diversify their product portfolio either through vertical integration or their own R&D

Quality of filters:

With more than 20 years of experience, KGT has established themself as a filter specialist. Their filter is highly durable, field proven and easy to maintain. Many competitors use cheap steel to produce at a lower cost, but KGT only offers stainless steel filters that last longer. Due to economies of learning, KGT can offer the filter at a lower price than its competitors. Still, since projects are individual and complex, price levels vary. With this competitive pricing they are able to win many tenders leaving little room for extra capacity to enter a new market. In general, they think it is possible to offer the filter to us ≈10% below market value.

Technicalities:

On average WTPs have 3 ACFs. Still, they can vary from 1-12 depending on their size. KGT offers DWA maintenance of filters for ≈5000€ depending on amount and size of filters. For the disposal of the filter mass, KGT charges its customers 0,50 cents/kg but due to rising gas prices, these charges might increase indefinitely.

Marketing:

Extensive marketing is not usual for this industry. KGT's main marketing activities are fairs (exhibitions), where competitors, customers and decision makers meet to examine companies, their products and services. They represent the most effective way to reach customers and generate brand reputation.

2.12 Dr. Brigitte Haist-Gulde

Name: Dr. Brigitte Haist-Gulde
Date: 21.10.2022
Description: Dr. Brigitte Haist-Gulde works at the Water Technology Centre in the field of activated carbon applications and trace substance removal and has been involved in these topics for over 20 years. She has gained her experience both theoretically in the form of research projects and publications and practically in consulting activities for water treatment companies.

You said that you have been working with adsorption methods for a long time. When did you first hear about PFAS and in what context?

We have an in-house analytics department that has been dealing with these substances for a very long time. Not because there were cases of damage, but because PFASs were already found in the meat of polar bears at the North Pole, so I first heard about them through the analytics department, not at all in terms of processing, it wasn't an issue then, but that was certainly 20 years ago. Exactly, and then we investigated it, and they thought: yes, the analysts are now dealing with some substances again, they always find something. However, the need to act in terms of treatment technology only arose when the first case became known, on the Möhne, i.e. in the Ruhr, about 15 years ago.

What is currently the most effective method of filtering PFAS out of the water, according to your knowledge?

So far, the Federal Environment Agency has assessed the toxicity of the individual substances. However, there are long-chain and short-chain PFASs, whereby the long-chain ones are the ones that were toxicologically relevant because they accumulate in the body and limit values have already been set for them. And the other short-chain PFASs in this group of substances have comparatively very high limit values. Health orientation values were set, which were in the mycrogram per litre range. And this was also adhered to in water treatment. This means that the treatment requirement was only necessary for these toxicologically relevant substances, which include the long-chain substances, and these can be adsorbed very well on activated carbon. This means that the waterworks affected by PFAS have already been using activated carbon, because PFOS and PFOA are all easily absorbed by activated carbon.With the upcoming EU Drinking Water Directive, which will be implemented into national law in Germany next year, all PFAS will be treated equally, and the current value will no longer apply, which will be the big problem in the future. In the future, there will be a total value and the problem will be that short-chain PFASs can also slip through the filter. The challenge will be to filter these short-chain PFAS effectively. Currently, activated carbon is used to filter the long-chain PFASs as well as the short-chain PFASs, as there are no alternatives yet. However, this shortens the filtering time.
Ion exchange is another possibility that is currently being investigated. However, these have to be regenerated and we have to see what happens to the regeneration solution. How do I destroy these PFAS in the solution? But this method is somewhat better for the short-chain PFAS compared to activated carbon. However, so far we had not found that one said, let's use that now, that has other weaknesses at the moment.
Reverse osmosis could be used, of course anything goes. With reverse osmosis you can remove everything. But there is the problem that, first of all, you need more water, because if you use reverse osmosis in water treatment, for example to soften water, then you have treated 80% to drinking water, but the other 20% is toxic concentrate, which then also has to be treated again,

so that the impurities are deposited here. These must not be discharged into the surface water or sewage treatment plants. This means that you don't actually gain anything if you have to do it in full flow, and of course this is not negligible in terms of energy. This is of course not negligible from an energy point of view.

PFAS are not yet banned as a group, which is also due to the fact that not all PFAS can be filtered out in the same way. Could one future problem be that we don't know exactly how to filter out all PFAS with one filter method.?

Yes, I was in a meeting yesterday, where a chemist informed us about the new Drinking Water Ordinance, which is new now, because it is new that limit values are defined, and he reported that the EU is currently already making efforts to ban these substances as a group. For the first time, the industry has been called upon to do so, and the use of these substances has only been permitted for absolutely necessary products. But the current situation is that all companies say "my product is absolutely necessary", so no progress has been made yet.
So this is an EU-wide issue and will continue to occupy us, and the best thing would probably be to at least significantly restrict the use of products in which PFASs are used.

If you now say that the short-chain PFASs get through the activated carbon, but ion exchange is not much better and that reverse osmosis produces a wastewater stream, which filter method do you consider to be the most forward-looking according to the current state of the art?

We are currently doing a doctoral thesis on the combination of activated carbon and ion exchange. Such hybrid processes are being used for the first time. As far as ion exchangers are concerned, none have yet been approved in Germany for PFAS removal in drinking water, but there are whole books of ion exchange materials. I think there is still potential to test and investigate these materials, but this will take some time because they still need approval.
But I think ion exchange could be a possibility. In addition, there is a lot of research going on in the field of destruction or regeneration. That is to say, in the case of activated carbon through reactivation, it was assumed that the PFASs are completely burnt, at the latest in the afterburning process. As far as I know, there are also attempts to free the PFAS from the regeneration solution in ion exchangers, which entails high costs and may not be feasible in the case of high water quantities.
I was on a pilot project myself this week in a large waterworks that have to deal with PFAS contamination and I can only say that the current status is that often only activated carbon works. This is the only thing that can be tested there, as there is no connection to the sewage system and no reverse osmosis is possible. I am not at all optimistic that it will be possible to regulate this at a reasonable cost, because the concentration is so high. But we are looking into that now. And if that doesn't work, we have to manage the wells accordingly or do without the highly contaminated wells and possibly get replacement water. 5

Okay, so the water in this area is already above the limit values?

Not yet, but above the new limit values are all currently still managing to get below the currently valid values through their mixture. But the future values in the Drinking Water Ordinance cannot be reached. A new treatment plant would have to be built in order to comply with these values.

How would you describe the general problem if you take the future values as a reference? How many plants in Germany would be affected under this scenario and would have to be retrofitted?

This is not yet known. There was a research project on this in our company by colleagues who looked at the database of our company (exclusively drinking water treatment plants) and looked at how many waterworks exceed these values. And it is the case that the value prescribed by the European food authority is exceeded in 8% of the data available to us. That means either if they already use activated carbon, the running times have to be shortened or new activated carbon filters have to be installed. However, there are still many water supply companies that have not measured at all at present, because it is simply not yet obligatory or successful. At the moment, however, it is certain that some will have to shorten their filter running times accordingly and in the future some will also have to build new ones.

How do you see the status of PFAS monitoring in relation to the issue of PFAS sensors? Is the treated water tested regularly or consistently?

At the moment I don't think it is done, so where there are known cases of damage it is done, but I think with many water suppliers it is not done because it is not part of the legislation at the moment.

There is also no legislation that says that PFAS levels in drinking water have to be measured?

Not at the moment, but if it is in the drinking water ordinance next year, then they will have to do it, not only in Germany but EU-wide, because this directive has to be implemented EU-wide. The deadline for implementation of this directive is 2026, by which time it must be done, and I think that no one can be obliged to measure, but we advise our customers to measure all parameters in advance so that they know what to expect. Because in 2026 it has to be fulfilled.

We have seen that a lot has happened in recent years, especially around the issue of PFAS. Do you think that the prohibitions around the group of PFAS will continue to increase after 2026?

I can't tell, I can't assess that either because I'm not on the committees.I am not on the committees. I'm from the treatment technology side, where we have to go more in the direction of analytics. From the water side, however, that's what we want, because we don't want to have to go to a lot of trouble to remove them from the water later on.

How do drinking water purifiers behave with regard to PFAS? Are they active in the fight against PFAS?

In Germany, this cannot be swept under the carpet, as they are obliged to comply with the limit values. The public health department takes care of this by sending them values and limit value transgressions have to be reported directly. They have these obligations from the authorities via the health authorities, which they have to comply with. They have to submit examinations and test results. So what some people are perhaps consciously doing, and I don't want to take anyone's side, is that they are not yet measuring in order to know about it now. However, this is still being delayed until it becomes compulsory.

Maybe I can just add something about the costs, because nothing is up to date any more because the costs of activated carbon have been rising extremely lately. The price of gas is also decisive in reactivation. The water suppliers no longer even look at the costs, but have the problem of getting any activated carbon at all on the market, which is due to the current political situation. Unless ion exchange has also become more expensive, these two processes are now coming further together. Previously, activated carbon was much cheaper than ion exchange. However,

I don't know exactly how this will develop over the next few years, but it has to be taken into account at the moment.

So in the future we might also have to switch to coal alternatives?

Unfortunately, that's not possible. It depends on the molecule, and the alternative activated carbon does not absorb them so well. Especially in drinking water treatment, activated carbon based on hard coal has always been used. There may still be American activated carbon on the market, but it has always been very expensive compared to Chinese. Currently, activated carbon producers are looking for new raw materials, peat is no longer allowed, but possibly wood or plant waste. This could be the way to stop being dependent on foreign activated carbon producers. Otherwise, there are synthetic substances from the arms industry, which are used in gas masks, for example, but they are also extremely expensive.

2.13 Timo Broeker

Name: Timo Broeker
Date: 07.12.2022
Description: Timo Broeker (46) is an engineer for biotechnology and bioprocess engineering with a Master of Science (M.Sc.) degree from the Ostwestfalen-Lippe University of Applied Sciences.
As a transfer manager at TH OWL, Mr. Broeker is responsible for translating ideas from research into application. He has 10 years of professional experience in applied research, managing several large research projects. Mr. Broeker has published numerous papers and given presentations on bioenergy and biorefinery concepts as well as hydrogen applications. In 2018, he won €2.1 million in start-up funding with a working group on functional peptides in the prestigious "Gründungsoffensive Biotechnologie GO-BIO" competition of the German Federal Ministry of Education and Research. Examples of the resulting start-up activities include third place in the business plan competition "Plan B" - Biobased Business Ideas as well as successful pitches and intensive negotiation of a term sheet with the renowned Hightech Gründerfonds, which ultimately did not come to a conclusion. In 2019, he founded Brausekollektiv with friends. For every bottle of "Litfassbrause" hop lemonade sold, a donation is made to the Alliance Against Racism. The project is supported by Bjarne Mädel and Axel Bosse, among others.

In this meeting we discussed the assumptions of the required investments as well as the ongoing process costs of the LTM process. These serve as the basis for the calculations carried out by Timo, which are included in our financial planning.

Amount of water required for Back & Forth Washing:

The total amount of water that fits into the spaces between the activated carbon (pack density) is approximately 1000L of water per cubic metre of activated carbon. With a filter size of 33,5 m^3 the total amount of water is 3350L. However, as water flows through the filter during the back & forth washing process to wash out the activated carbon, the filter is not filled to the brim with water to encourage turbulence during the washing process to wash out the activated carbon more thoroughly. Thus, with an average filling volume of approx. 33.5m^3 activated carbon, we calculate 3000L of water. This means that Aquapurgo produces an average waste stream of 3000L of water per cleaned activated carbon filter.

PFAS load of the activated carbon:

The study by B. Trang shows that 41.4g PFAS were destroyed with the addition of 1L DMSO. However, since this load does not correspond to reality and there are no PFAS load values for the whole of Germany, we will use the example of Raststatt. This showed that about 600g of PFAS were filtered out of the water within one year. We therefore base our calculations on the assumption that we will wash 225g PFAS per customer out of the activated carbon filters. Even though the load value will probably be lower, the 225g serve as a basis for calculating the process costs, on which the addition of DMSO and caustic soda depends.

Basis of calculation:

The example calculation assumes a water quantity to be processed of 9000L water per day witch will be our pilot project. The calculations we made in cooperation with Timo Broeker are to be found in Appendix 4.8 LTM Investment Calculations. For the investments of the final LTM plant we will multiplie the pilot price by a factor of 9,5 amounting to roughly €700k.

2.14 Dr. Andreas Heitmann – IP Laywer

Name: Dr. Andreas Heitmann
Date: 20.11.2022
Description: Dr. Andreas Heitmann advises clients in the entire field of intellectual property law, in particular trademark law, design law and competition law.

Patent Proprietor

In principle, the inventor does not have to be the patent owner. It is conceivable that a company applies for a patent itself or in cooperation with the university. The inventor(s) could then be named in the patent application. Theoretically, one is relatively free in the design of a patent application concerning the patent owner and the inventors. Experience shows that it is difficult to measure the inventors' contributions to the invention. In addition, the patent applicant has to bear considerable costs for the patent application. Therefore, a precise regulation should be created in good time before the patent application to determine the extent to which the inventors will participate in the economic proceeds of the patent (participation in the sale of the patented product or participation in the licence fees received). It would be conceivable to establish a GbR for this purpose. The purpose of the partnership is the exploitation of the patent.

Disclosure of the patent

A patent is only protectable if it is new. Therefore, one may not make the invention publicly available to third parties, as this would be detrimental to novelty. Theoretically, you can disclose the patent when you apply, because you have secured the priority period. This means that it is clear that your invention was new at the time of the patent application. If similar or identical inventions come along after that, then it is no longer new.
It is highly controversial in case law and especially in the literature when one should disclose a patent and whether this makes sense at all. To go into this in detail would be going too far here. In any case, a patent is officially disclosed 1 year after filing. To be on the safe side, one should wait for this year. This applies in particular to the German patent, because it is possible to amend or concretise the patent application at a later date. It therefore makes sense to revise the application in cooperation with the patent office. Only then will the final version of the application be known and publication would make sense.

Costs of a patent application

For a patent application in Germany, at least the costs of the patent office are negligible. The following costs are incurred:

- Costs for filing the patent application EUR 40

- Costs for filing the request for examination, where it is examined whether the patent can be registered at all. The request for examination can be filed 7 years after filing the patent application. Costs EUR 350
- 3 years after registration of the patent, annual fees for the maintenance of the protection are due. These initially amount to EUR 70 and then increase to EUR 2000 up to the 20th year of the term.

It is advisable to have a novelty search carried out by the Office. This would give you a certain overview of what other inventions already exist in the field (determination of the state of the art). Costs EUR 300. The average cost of a patent application is between EUR 2,000 and EUR 10,000. If there are problems in the application procedure or if the application is pushed through the instances, further costs will be incurred. The amount cannot be predicted.

Patent applications abroad

In principle, you can also apply for a patent abroad. Since a patent is a national right, you have to file a patent application with the patent office for each country individually. If, for example, you have a patent application in Germany, you can apply for a patent abroad within one year and take over the priority of the German application.

I cannot say anything about the costs. You would have to check this separately for each country. In any case, the official fees are usually much higher abroad. You also have to entrust the patent application filing to a foreign patent attorney on the spot.

At the same time, it is also possible to apply for a patent abroad using the PTC procedure. The advantage of this procedure is that you do not have to claim the filing priority of the German patent within one year, but can wait another 30 months. Among other things, this procedure makes sense if it is not yet clear whether the German patent will be registered at all.

The disadvantage of the PCT procedure is that considerable costs are incurred. You have to pay an amount of around EUR 4,000 to even file a PCT application. In a further step, one can then decide within 30 months in which country one would like to file a patent application. If it is of interest, I can find out the specific costs here. These vary from country to country. There is the so-called European patent. This patent has to be applied for at the European Patent Office. According to an agreement, 38 countries belong to the European patent. After the patent has been granted, the patent holder can then decide which countries in Europe this patent should cover in detail. The application procedure differs from the German procedure in several respects. In particular, it is much more difficult to "improve" an application during the procedure. If I am interested, I would have to find out the costs of such an application. I have not been able to do this in the short time available.

2.15 Exemplary Interview Questions

#	Question
1	What is your name?
2	What is your profession?
3	What is your position in the company?
4	How long do you already work in this area?
5	Do you think persistent, bioaccumulative chemicals (PFAS) are dangerous?
6	If yes, how serious do you consider this problem to be?
7	When did you first hear about PFAs and in what context?
8	Do you think that PFAS get the attention they deserve?
9	What is the Federal Environment Agency's position on legislative initiatives to produce PFAS alternatives?
10	Do you consider the current treatment and disposal of PFASs to be appropriate?
11	What is the implementation of states and governmental offices suffering from serious PFAS contamination?
12	What do states do with PFAS chemicals after they are filtered out of water?
13	How effective are existing methods (such as oxidation and reduction; bioremediation and ultrasonic treatment) in destroying trace substances (including PFAS chemicals)?
14	Are you familiar with the new approach to the destruction of PFAS? (Low-temperature mineralization of perfluorocarboxylic acids)
15	Do you see the incineration of organic trace substances as forward-looking?
16	Do you think the current regulations are sufficient?
17	Will restrictions and bans on PFAS increase?
18	When can we expect regulatory changes?
19	What is the time frame from the idea to the legal adaptation to the actual implementation of new regulations?
20	How are industry and the federal government working together to counter the PFAS problem?
21	In the case of an industrial ban on PFAS, can previous PFAS contamination be remedied in the short term? If not, how long do you think the problem will last?
22	Does Germany have to take the first step to tackle the global PFAS problem? Does Germany have a budget to deal with PFAS?
23	How do you think the handling of PFAS will develop in the next few years?

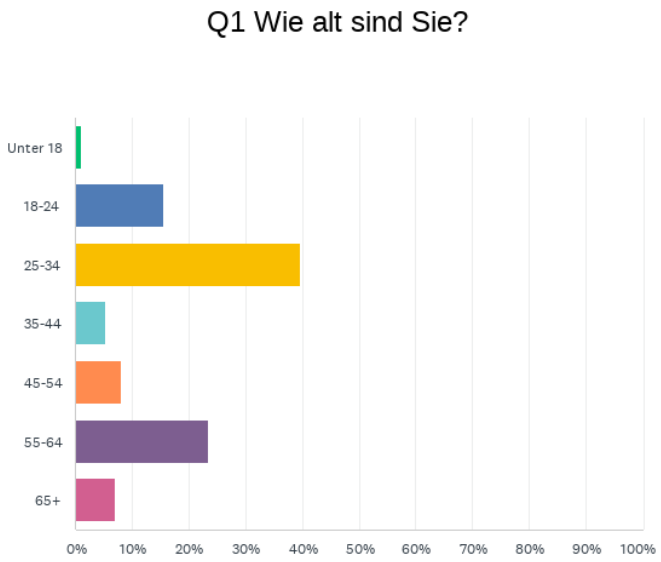
Appendix 3 Survey

Page 1: Demographics

Question 1: “How old are you?”

Answer possibilities:

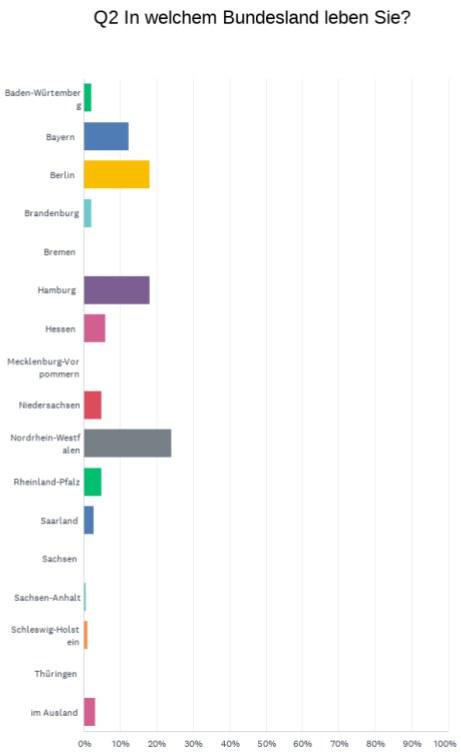
- Under 18
- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65+



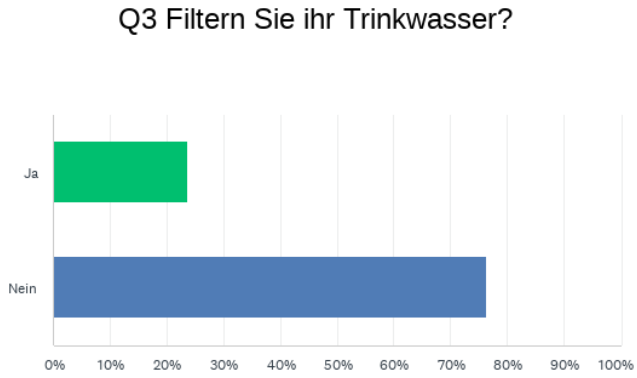
Question 2: “In which state do you live?”

Answer possibilities:

- Bavaria
- Berlin / Brandenburg
- Bremen
- Hamburg
- Lower Saxony
- Saxony
- Saxony-Anhalt
- Mecklenburg-Vorpommern
- North Rhine-Westphalia
- Rhineland-Palatinate
- Saarland
- Schleswig-Holstein
- Turingia



Page 2: General Knowledge about the topic
Question 3: "Do you filter your drinking water?"
Answer possibilities: Yes/No

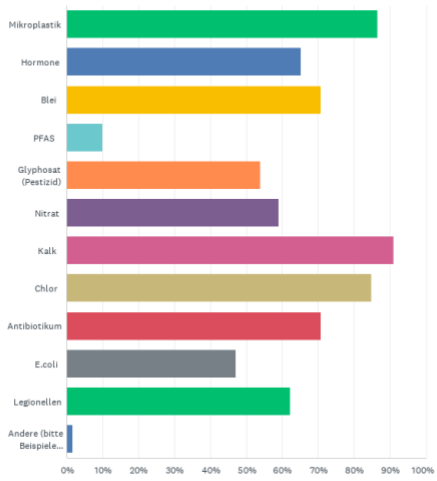


Question 4: "Which of the following pollutants, that exist in drinking water do you know?"
Answer possibilities:

- Microplastic
- Hormones
- Lead
- Glyphosate
- Nitrate
- Calcium
- Chlorine
- Antibiotics
- E-coli
- Legionella

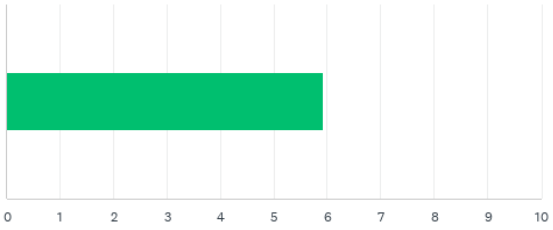
- Other (please specify)

Q4 Welche der folgenden Schadstoffe, die im Trinkwasser vorkommen, kennen Sie?



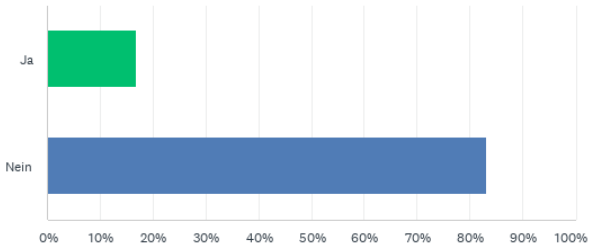
Question 5: " Would you be willing to live using the products shown above to a lesser extent? Please specify your answer on a scale of 1-10. (1 = not at all likely, 10 = very likely)
Answer possibilities: scale 1 to 10

Q5 Könnten Sie damit leben, die oben abgebildeten Produkte im geringeren Maße zu verwenden? Geben Sie ihre Meinung auf einer Skala von 1-10 an.(1 = schwer vorstellbar, 10 = sehr gut vorstellbar)



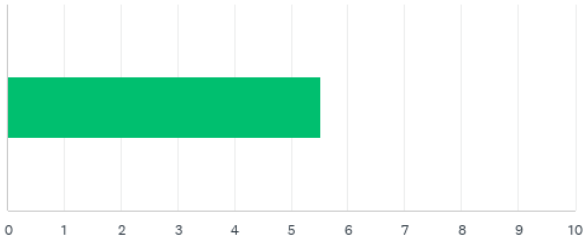
<u>Page 3: Knowledge about PFAS</u>
Question 6: "Have you ever heard of the Term "forever chemicals" or "PFAS"?
Answer possibilities: Yes/no

Q6 Haben Sie den Begriff "forever chemicals" oder "PFAS" schonmal gehört?



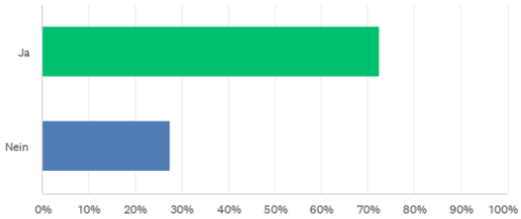
Question 7: “How aware are you that these products that you use, contain pollutants? Please specify your answer on a scale of 1-10. (1 = not at all aware, 10 = very aware)

Q7 Wie bewusst sind Sie sich, dass die Produkte, die Sie benutzen, schädliche Stoffe enthalten?Auf einer Skala von 1-10 (1 = unbewusst, 10 sehr bewusst)



<u>Page 4: Knowledge about PFAS (no prior knowledge)</u>
Question 8: “After getting these information are you concerned regarding your health?”
Answer possibilities: Yes/No

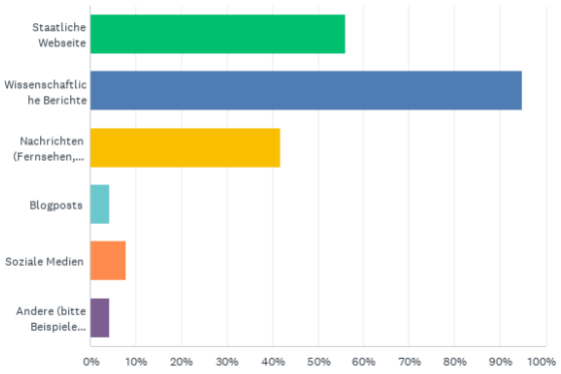
Q8 Nachdem Sie diese Informationen erhalten haben, gibt es Bedenken bezüglich ihrer Gesundheit?



Question 9: “If you would want more information about these chemicals, which source would you trust in most?”
Answer possibilities:

- State Website
- Scientific Reports
- News (TV, Newspaper, etc.)
- Blogposts
- Social Media
- Other (please specify)

Q9 Wenn Sie weitere Informationen zu diesen Chemikalien wollten, welchen Quellen würden Sie vertrauen?

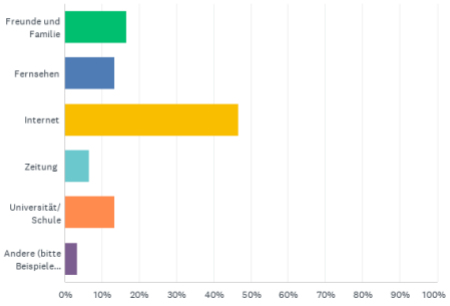


Page 5: Knowledge about PFAS (with prior knowledge)

Question 10:"Where have you heard of these chemicals?"
Answer possibilities:

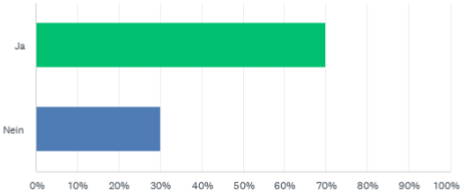
- Internet
- Friends and Family
- TV
- Newspaper
- University / School
- Other (please specify)

Q10 Woher kennen Sie diese Chemikalien?



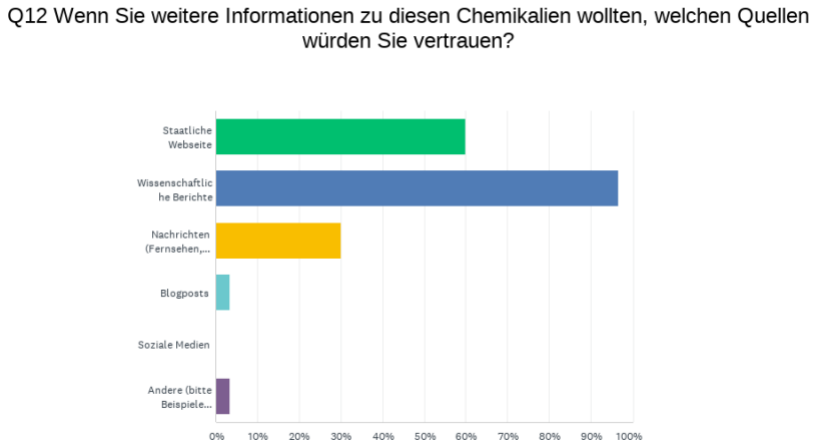
Question 11: "Do you have concerns about your health in regard to these chemicals?"
Answer possibilities: Yes/No

Q11 Haben Sie Bedenken bezüglich ihrer Gesundheit aufgrund dieser Chemikalien?



Question 12: “If you would want more information about these chemicals, which source would you trust in most?”

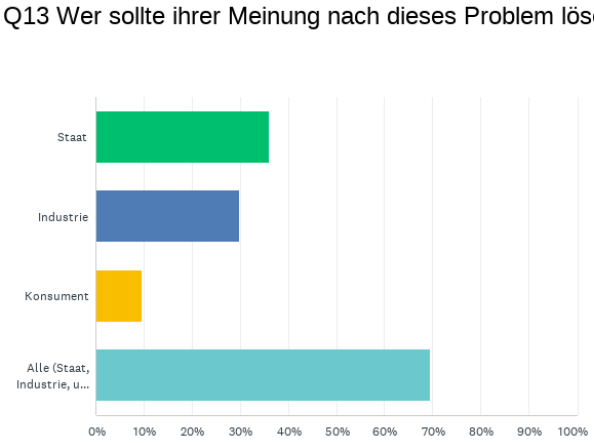
- Internet
- Friends and Family
- TV
- Newspaper
- University / School
- Other (please specify)



Page 6: Solutions for the problem

Question 13: “Who should be responsible for solving this Problem?”
Answer possibilities:

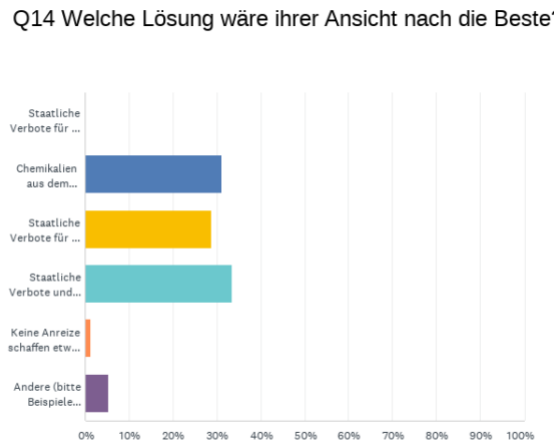
- State
- Industry
- Consumers
- Everyone (Sate, Industry and Consumers cooperate)



Question 14:”Which solution is the best according to your opinion?”
Answer possibilities:

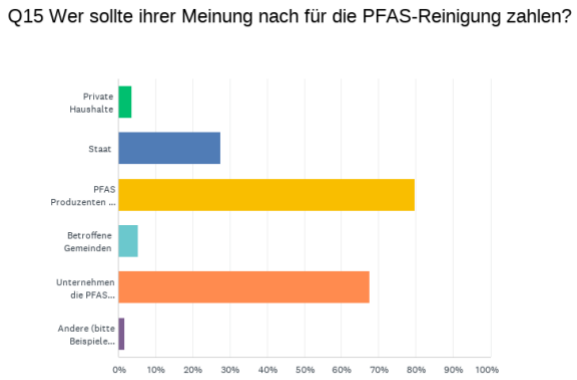
- Filter chemicals out of ground water and destroy them
- State bans and regulations on the industrial use of PFAS
- Bans/Regulations and filtering and destruction of the chemicals

- Create no incentives to change the situation
- Other (please specify)



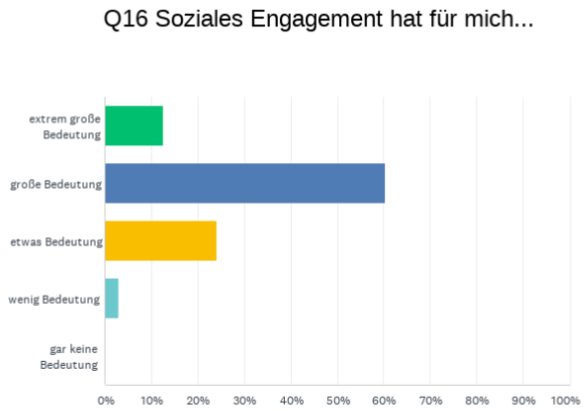
Question 15: “Who should pay for the PFAS-Purification?”
Answer possibilities:

- Private Households
- State
- Industrial Users and Manufactures of PFAS
- Affected Communities
- Companies that make use of PFAS
- Other (please specify)



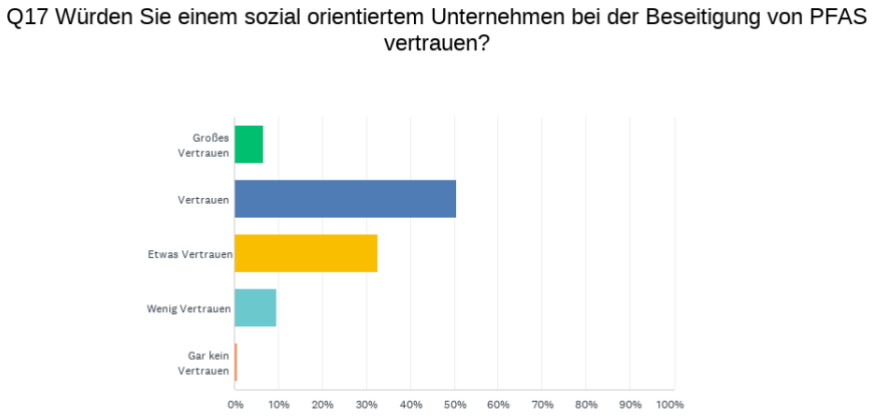
<u>Page 7: Social Entrepreneurship</u>
Question 16:”Social Engagement is for me personally... “
Answer possibilities:

- Extremely important
- Highly important
- A little bit important
- Less important
- Not at all important



Question 17: “How much trust would you give socially-oriented company with the disposal of PFAS?”
Answer possibilities:

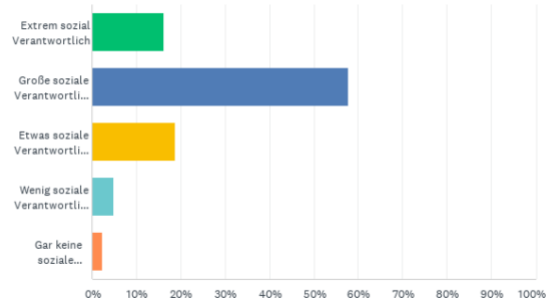
- Great trust
- Trust
- A little trust
- Little to no trust
- No trust



Question 18: “How socially responsible does the idea seem to destroy PFAS as a startup?”
Answer possibilities:

- Extremely large social responsibility
- Large social responsibilty
- A little social responsibility
- No social responsibility

Q18 Wie sozial verantwortlich erscheint die Idee als Startup PFAS zu zerstören?



Final slide:

“Thank you for completing this survey!”

Appendix 4 Group Part

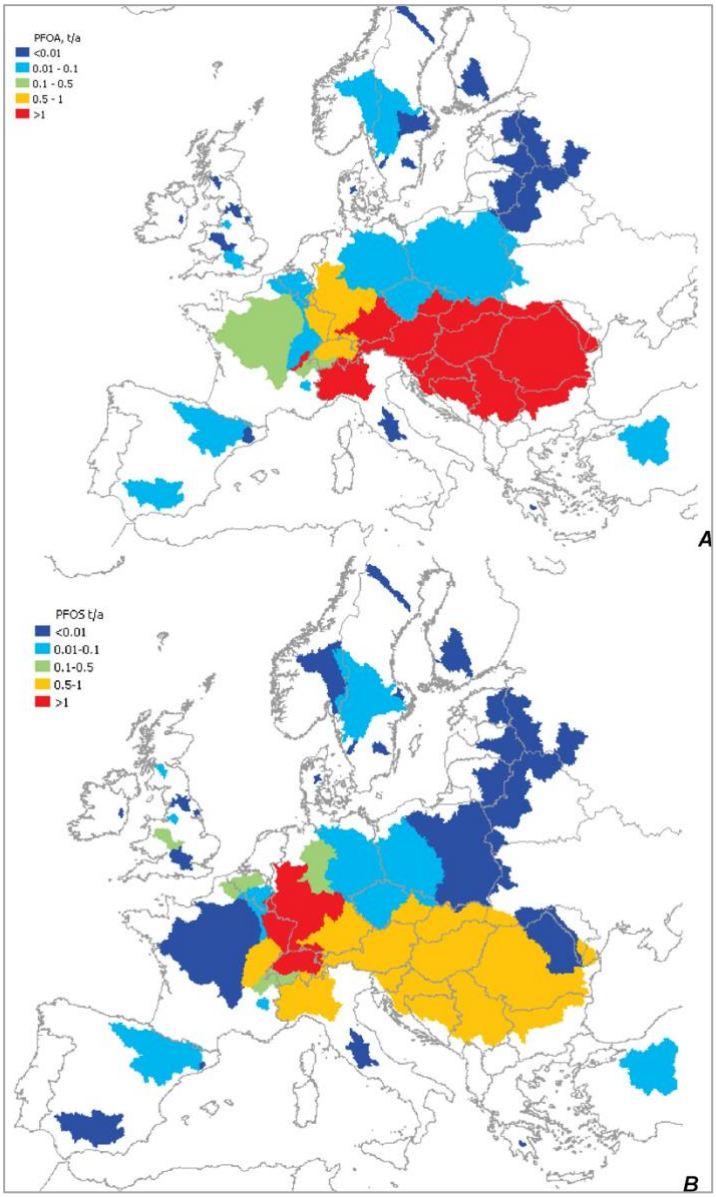
Number	Title
4.1	Cost breakdown for Nordic countries
4.2	Map of European Emissions and Concentrations of PFOS and PFOA
4.3	Value Chain Breakdown
4.4	1st offer from Klärgastechnik Deutschland GmbH
4.5	2nd offer from Klärgastechnik Deutschland GmbH
4.6	Product Description ACF
4.7	Active charcoal offer Unicarb GmbH
4.8	LTM Investment Calculation

4.1 Costs breakdown for Nordic countries

	N people affected (3%)	Screening and monitoring	Health assessment	Upgrade treatment works and maintenance	Soil remediation	Total
Denmark	169,791	EUR 70,000–8.3 million	EUR 280,000–27 million	EUR 7.4 million–274 million	EUR 0–798 million	EUR 8 million–1.1 billion
Finland	164,153	EUR 250,000–22 million	EUR 270,000–26 million	EUR 7.2 million– 265 million	EUR 2.2 million–2.1 billion	EUR 10 million–2.4 billion
Iceland	10,102	EUR 10,000–900,000	EUR 20,000–1.6 million	EUR 400,000–1.6 million	EUR 100,000–86 million	EUR 1 million–105 million
Norway	154,995	EUR 170,000–20 million	EUR 260,000–25 million	EUR 6.8 million– 250 million	EUR 1.6 million – 1.9 billion	EUR 9 million–2.2 billion
Sweden	292,421	EUR 480,000–47 million	EUR 490,000–46 million	EUR 13 million–472 million	EUR 4.3 million – 4.5 billion	EUR 18 million–5.1 billion
Nordic total	*791,462*					*EUR 46 million–11 billion*

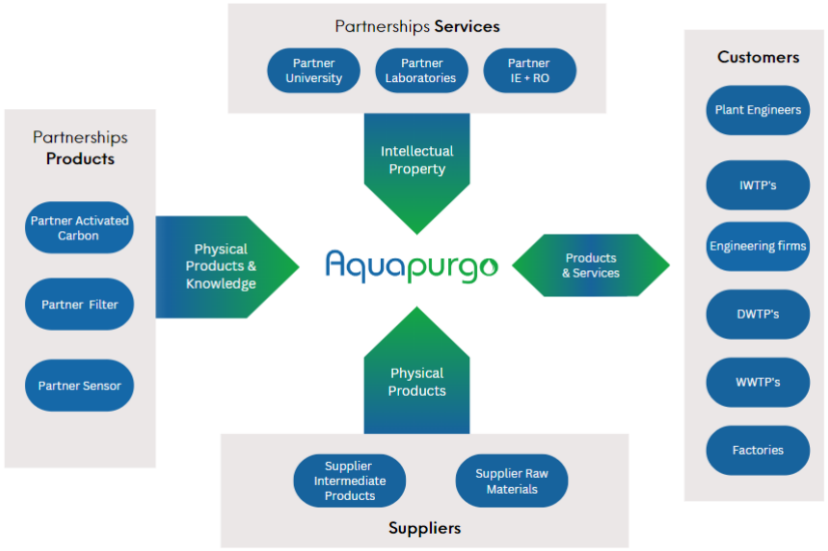
Breakdown of ranges in quantified non-health costs for the Nordic countries
Source: Goldenman et al., 2019

4.2 Map of European Emissions and Concentrations of PFOS and PFOA



Source: Pistocchi, A., & Loos, R. (2009). A Map of European Emissions and Concentrations of PFOS and PFOA. Environmental Science & Technology, 9237–9244

4.3 Value Chain Breakdown



Key Services, Suppliers, Customers and Products
(Source: Own Illustration)

4.4 First offer from Klärgastechnik Deutschland GmbH

Explanation: The following offer from our supplier Klärgastechnik is for an ACF without active charcoal only the filter itself. The price for one filter will be €7.450,00. Among the technical data illustrated in the offer there are also two options illustrated on page two. Option one is the optional isolation of the filter for €850,00 and option two is replacement filter cartridges for €1025,00. Lastly, on page three the terms & conditions are illustrated.

KlärGASTECHNIK Deutschland GmbH

Klärgastechnik Deutschland GmbH • Weststraße 31 • 32657 Lemgo

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Mail: r.sprick@gmx.net

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Fon: +49 (0) 5261 978000
Fax: +49 (0) 5261 978050
info@klaergastechnik.eu
www.klaergastechnik.eu

-29 Frau Böttcher
04.11.2022
Angebotsnummer: 324.I.N.19.10.22

Betrifft: Aktivkohlefilter

Sehr geehrter Herr Sprick,

vielen Dank für Ihr Interesse an unseren Produkten. Gemäß Ihrer Anfrage vom 14.10.2022 möchten wir Ihnen die gewünschten Positionen anbieten.

Pos. 1: Adsorber als Kartuschenfilter (ohne Füllung)

1 Stück Aktivkohlefilter mit Filterkartusche zum einfachen Wechsel der Aktivkohle. Die Filterkartusche kann durch den abnehmbaren Deckel entnommen und eine Ersatzkartusche mit frischer Aktivkohle eingesetzt werden.

Wassermenge ≈	: ca. 5-20 m³/h
Druckverlust	: < 2 mbar
Maximal zulässiger Betriebsdruck	: 100 mbar
Zulässige Temperaturen	: 5 - 35°C
Gasfeuchte, relativ	: < 70%

Lieferumfang:

Anzahl	: 1 Behälter (mit 1 innenliegende Kartusche)
Durchmesser	: DN 500
Höhe gesamt	: ca. 1.350 mm (Gesamthöhe & Rohrachshöhe variabel)
Aktivkohlevolumen	: ca. 0,2 m³
Anschlüsse	: DN 50, als Losflansche mindere Blattstärke PN 10
Material Behälter	: 1.4571 / 1.4301
Inertisierungsanschluss	: 2 x ½"mit DVGW-Kugelhahn
Reservestutzen	: ½"

Manometer	: 1 Stk., NG 63, Messbereich: 0-50 mbar Material: Edelstahl mit Kugelhahn ½"

Der Filter verfügt über einen aufgeflanschten Deckel und Dichtung.

Adsorptionsmittel	: Aktivkohle
Menge	: ca. 100 kg

Kartusche	
Durchmesser	: ca. 495 mm
Höhe	: ca. 1.200 mm
Aktivkohlevolumen	: ca. 0,2 m³

Die Kartusche ist unten und oben mit einem Siebboden aus Edelstahlgewebe verschlossen.
Sie kann über 2 Stück Anschlagpunkte für eine Kette, eine Rundschlinge oder ein Hebeband aus dem Behälter gehoben werden.
Die Abdichtung zum Behälter erfolgt mit Hilfe von zwei installierten Dichtringen.

PREIS, ab Werk **: 7.450,00 € / Einh.**

OPTION 1: Mehrpreis Isolierung für Außenaufstellung

Wärmedämmung	: Mineralwolle ca. 60 mm
Witterungsschutz	: Alublech ca. 1 mm

MEHRPREIS, ab Werk **: 850,00 €**

OPTION 2: Ersatzkartuschen (ohne Füllung)
Ersatzkartusche für den o. g. Aktivkohlefilter zum einfachen Wechseln der Aktivkohle.

Anzahl	: 1
Material	: 1.4571
Durchmesser	: ca. 495 mm
Höhe	: ca. 1.200 mm
Aktivkohlevolumen	: 0,2 m³
Dichtung	: NBR

PREIS, ab Werk **: 1.025,00 € / Stk.**

Bauseitige Leistungen:
- Fundamenterstellung nach Vorgabe
- Blitzschutz

Alle nicht spezifizierten Angaben liegen im Ermessen des Herstellers.
Es gelten unsere beiliegenden allgemeinen Geschäfts- und Montagebedingungen.

Kommerzielle Bedingungen:

Leistungsumfang:	Der Leistungsumfang bezieht sich ausschließlich auf die angebotenen Leistungen. Darüber hinaus gehende Leistungen werden entsprechend unseren allgemeinen Geschäfts- und Montagebedingungen nach Aufwand oder gemäß einer separaten Bestellung abgerechnet.
Lieferzeiten:	z.Zt. ca. 12 Wochen nach Auftragseingang und technischer Freigabe
Lieferterminbindung:	4 Wochen nach Angebotslegung. Zwischenverkauf vorbehalten
Lieferung:	EXW gemäß INCOTERMS 2020
Verpackung:	Beanspruchungsgerecht für Versand / LKW – Transport geeignet
Ansprechpartner:	Bei Rückfragen wenden Sie sich bitte an Frau Böttcher, Tel.: 05261-97800-29 E-Mail: jboettcher@klaergastechnik.eu
Dokumentation:	Technische Dokumentation beinhaltet: - Mechanische und elektrische Datenblätter Standardzukaufteile - Bedienungsanleitung - Einstell- und Prüfprotokolle - Zeichnung - Herstellererklärung 1-fach Papier deutsch
Gewährleistung:	24 Monate nach Lieferung oder Versandbereitschafts-meldung, ausgenommen Verschleißteile
Preise:	ab Werk, zzgl. Transport, Verpackung und MwSt.
Preisbindung:	31.12.2022
Rechnungsstellung:	Bei Lieferung gemäß den gültigen beigefügten Geschäfts- und Montagebedingungen
Zahlungsbedingungen:	100 % bei Lieferung oder Lieferbereitschaftsmeldung und Rechnungsstellung
Zahlungsziel:	90 Tage netto

Wir hoffen, dass Ihnen unser Angebot zusagt und stehen Ihnen für weitere Rückfragen jederzeit gerne zur Verfügung.

Mit freundlichen Grüßen
Klärgastechnik Deutschland GmbH

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info@klaergastechnik.eu

i.A. B. Eng. Julia Böttcher
Assist. Geschäftsführung/ asst. CEO

4.5 Second offer from Klärgastechnik Deutschland GmbH

Explanation: The following(second) offer from our supplier Klärgastechnik is for an ACF without active charcoal only the filter itself. Differentiating from the first offer shown the second offer is for an industrial-scale ACF therefore the large change in price. The price for one filter will be €57.750,00. Among the technical data illustrated in the offer there are also two options illustrated on page two. Option one is the optional isolation of the industrial-scale filter for €12.500,00 and option two is active charcoal filling for one ACF for €2100,00. Lastly, on page three the terms & conditions are illustrated.

Klärgastechnik Deutschland GmbH

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Fax: +49 (0) 5261 9780050
info@klaergastechnik.eu
www.klaergastechnik.eu

-29 Frau Böttcher
18.11.2022
Angebotsnummer: 324.II.N.19.10.22

Betrifft: Aktivkohlefilter

Sehr geehrter Herr Sprick,

vielen Dank für Ihr Interesse an unseren Produkten. Gemäß Ihrer Anfrage vom 14.10.2022 möchten wir Ihnen die gewünschten Positionen anbieten.

Pos. 1: Adsorber als Kartuschenfilter (ohne Füllung)

1 Stück Aktivkohlefilter mit Filterkartusche zum einfachen Wechsel der Aktivkohle. Die Filterkartusche kann durch den abnehmbaren Deckel entnommen und eine Ersatzkartusche mit frischer Aktivkohle eingesetzt werden.

Wassermenge ≈	: ca. 5-20 m³/h
Druckverlust	: < 2 mbar
Maximal zulässiger Betriebsdruck	: 100 mbar
Zulässige Temperaturen	: 5 - 35°C
Gasfeuchte, relativ	: < 70%

Lieferumfang:

Anzahl	: 1 Behälter (mit 1 innenliegende Kartusche)
Durchmesser	: 4,15 m
Höhe gesamt	: 7,15 m (Gesamthöhe & Rohrachshöhe variabel)
Aktivkohlevolumen	: ca. 37 m³
Anschlüsse	: DN 800, als Losflansche mindere Blattstärke PN 10
Material Behälter	: 1.4571 / 1.4301
Inertisierungsanschluss	: 2 x ½"mit DVGW-Kugelhahn
Reservestutzen	: ½"

Manometer	: 1 Stk., NG 63, Messbereich: 0-50 mbar Material: Edelstahl mit Kugelhahn ½"

Der Filter verfügt über einen aufgeflanschten Deckel und Dichtung.

Adsorptionsmittel	: Aktivkohle
Menge	: ca. 1 to

Kartusche	
Durchmesser	: 4,05 m
Höhe	: 7,05 mm
Aktivkohlevolumen	: ca. 37 m³

Die Kartusche ist unten und oben mit einem Siebboden aus Edelstahlgewebe verschlossen.
Sie kann über 2 Stück Anschlagpunkte für eine Kette, eine Rundschlinge oder ein Hebeband aus dem Behälter gehoben werden.
Die Abdichtung zum Behälter erfolgt mit Hilfe von zwei installierten Dichtringen.

PREIS, ab Werk **: 57.750,00 € / Einh.**

OPTION 1: Mehrpreis Isolierung für Außenaufstellung

Wärmedämmung	: Mineralwolle ca. 60 mm
Witterungsschutz	: Alublech ca. 1 mm

MEHRPREIS, ab Werk **: 12.500,00 €**

OPTION 2: Filterkohle

Abgepackt in Kunststofffoliensack	
Anzahl	: 32
Verpackungseinheit (VE)	: Big Bag à 500 kg
ADR	: Kein Gefahrgut
Dichte	: ca. 470 – 530 kg/m³

PREIS, ab Werk **: 2.100,00 € / VE**

Bauseitige Leistungen:
- Fundamenterstellung nach Vorgabe
- Blitzschutz

Alle nicht spezifizierten Angaben liegen im Ermessen des Herstellers.
Es gelten unsere beiliegenden allgemeinen Geschäfts- und Montagebedingungen.

Kommerzielle Bedingungen:

Leistungsumfang:	Der Leistungsumfang bezieht sich ausschließlich auf die angebotenen Leistungen. Darüber hinaus gehende Leistungen werden entsprechend unseren allgemeinen Geschäfts- und Montagebedingungen nach Aufwand oder gemäß einer separaten Bestellung abgerechnet.
Lieferzeiten:	z.Zt. ca. 12 Wochen nach Auftragseingang und technischer Freigabe
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Dokumentation:	Technische Dokumentation beinhaltet: - Mechanische und elektrische Datenblätter Standardzukaufteile - Bedienungsanleitung - Einstell- und Prüfprotokolle - Zeichnung - Herstellererklärung 1-fach Papier deutsch
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Preise:	ab Werk, zzgl. Transport, Verpackung und MwSt.
Preisbindung:	31.12.2022
Rechnungsstellung:	Bei Lieferung gemäß den gültigen beigefügten Geschäfts- und Montagebedingungen
Zahlungsbedingungen:	100 % bei Lieferung oder Lieferbereitschaftsmeldung und Rechnungsstellung
Zahlungsziel:	90 Tage netto

Wir hoffen, dass Ihnen unser Angebot zusagt und stehen Ihnen für weitere Rückfragen jederzeit gerne zur Verfügung.

Mit freundlichen Grüßen
Klärgastechnik Deutschland GmbH

KlärGASTECHNIK Deutschland GmbH

i.A. B. Eng. Julia Böttcher
Assist. Geschäftsführung/ asst. CEO

4.6 Product Description ACF

Explanation: This product description shows both technical and visual pictures of the ACF on page one. The second page informs about quality standards of the product. Those are high quality materials, specific active charcoal, individual design, profitability, service and individual engineering. The document then continues from page three until seven to show possible versions of the ACF with a description as well as visual options.

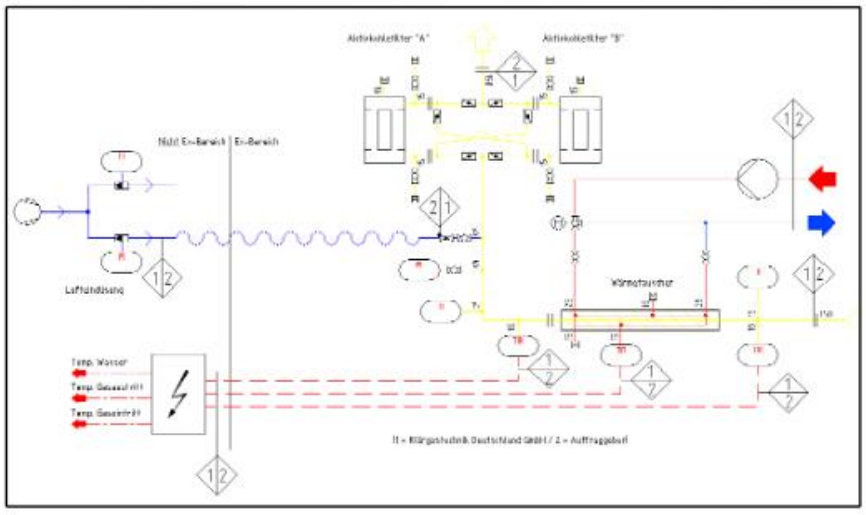
KlärGASTECHNIK Deutschland GmbH

PRODUKTINFORMATION

KGT-Gasreinigungssystem (Aktivkohlefilter)

Doppel-Aktivkohlefilteranlage mit Wärmetauscher und Verrohrung

R+I – Schema der KGT-Gasreinigungsanlage



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Wesentliche Merkmale und Vorteile der KGT-Gasreinigungsanlage (Aktivkohlefilter)

Hochwertige Materialien:

Bei dieser mit Aktivkohle filternden Anlage sind sämtliche gasberührten Teile aus V4A, Werkstoff 1.4571.
Unterstützende Konstruktionen sowie gegebenenfalls die Ummantelung der Isolierung (bei Außenaufstellung) werden ebenfalls aus Edelstahl, Werkstoff 1.4301, gefertigt. Unsere Filter verfügen über einen aufgeflanschten Deckel mit NBR-Dichtung zum einfachen Öffnen des Filters.

Spezifische Aktivkohle:

Wir setzen für die Adsorption von Siloxanen und Schwefelwasserstoff zwei unterschiedliche, spezifische Aktivkohlen ein. Diese wurden in mehrjähriger Forschungsarbeit zusammen mit der Fachhochschule Ostwestfalen-Lippe in der Praxisanwendung erprobt und deren Adsorptionseigenschaften analysiert.

Die Aktivkohlen können auch grundsätzlich in einem Filter übereinander geschichtet werden, sodass nur **ein Filter** für die Adsorption von Siloxanen und Schwefelwasserstoff benötigt wird.

Die jeweilige Aktivkohle benötigt eine relative Feuchte des Gases von < 70%, um Auskondensierungen zuverlässig zu verhindern. Hierfür ist eine Erwärmung des Gases von ca. 5 – 10°C ausreichend, wobei eine exakte Steuerung der Differenz - temperatur nicht notwendig ist. Eine höhere als die genannte Erwärmung sollte verhindert werden, da mit steigender Temperatur die Absorptionskapazität der Aktivkohle abnimmt.

Individuelle Auslegung:

Durch die umfassenden Erkenntnisse aus der Forschungsarbeit können wir die Beladung der Aktivkohlen und damit die Standzeit der Filter sehr genau berechnen bzw. im Vorfeld auslegen.

Da jedoch nicht nur die gewünschten Zielverbindungen (Siloxane und H_2S) auf der Aktivkohle adsorbieren, ist hierfür eine umfassende Gasanalyse notwendig, in welcher auch die für die Standzeit relevanten Störstoffe untersucht werden.

Wirtschaftlichkeit:

Die Aktivkohlen werden im Filter so geschichtet, dass beide Aktivkohlen gleichzeitig beladen sind und die Adsorptionskapazität voll ausgeschöpft wird.
Die Filter können so ausgelegt werden, dass die Aktivkohlen nach einem Jahr Standzeit erschöpft sind. So kann der Wechsel der Aktivkohlen gleichzeitig mit der jährlichen Wartung gemäß DWA durchgeführt werden.

Zusätzliche Anfahrten für den Aktivkohlewechsel entfallen somit.

Ein so genannter Polizeifilter als Sicherheitsfilter ist aufgrund der genauen Standzeitberechnung grundsätzlich nicht notwendig.

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Service:

Wir führen für Sie Gasanalysen für die Auslegung des Aktivkohlefilters und Berechnung der Standzeit durch.

Da die Konzentrationen der Störstoffe im Klärgas natürlichen Schwankungen unterliegen, kann kurz vor Ablauf der errechneten Standzeit diese anhand weiterer Gasanalysen auf Plausibilität geprüft werden. Ggf. kann dann im Bedarfsfall die Menge der beiden Aktivkohlen im Filter beim Wechsel angepasst werden.

Wir wechseln nicht nur die Aktivkohle für Sie, wir führen auch die jährlichen Wartungen gemäß den DWA-Richtlinien durch.

Individuelles Engineering:

Wir passen unsere Anlage Ihren Bedürfnissen an.

Egal ob kleinere Filtereinheiten zur Innenaufstellung, große Anlagen für die Aufstellung im Außenbereich mit Isolierung oder als Kompaktbauweise im Container, wir haben für jeden Fall die passende Lösung für Sie.

Beispielvarianten von KGT-Gasreinigungsanlagen

Variante 1

Es kommt ein Aktivkohlefilter mit aufgeflanschtem Deckel und Bodenablass mit Absperrklappe zum Einsatz.

Der Wechsel erfolgt durch ablassen der gebrauchten Aktivkohle durch den Bodenablass und wieder Auffüllung des Behälter über den aufgeflanschten Deckel.

Dies ist die Kostengünstigste Variante, verursacht jedoch hohe Betriebskosten durch den aufwendigen Wechsel der Aktivkohle.

Beim Wechsel sind erhöhte Maßnahme zum Gesundheitsschutz der Mitarbeiter zu treffen, da eine hohe Staubentwicklung zu erwarten ist. Beim Aktivkohlewechsel in geschlossenen Räumen müssen diese nach dem Wechsel gereinigt werden.

Hier ist ein Aktivkohlefilter dieses Typs in einem Gascontainer mit Kühlung und Druckerhöhung auf einer Biogasanalge zu sehen. Der Kunde hat sich aus Platzgründen für diese variante entschieden.

Durch die Nähe zur Tür und die damit verbundene natürliche Belüftung beim Wechsel der Aktivkohle wir eine starke Verschmutzung des Containers und eine "stehende" Staubwolke vermieden, was das Arbeiten für das ausführende Personal wesentlich angenehmer macht und das Gesundheitsrisiko mindert.

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Variante 2

Es kommt ein Aktivkohlefilter mit Wechselkartuschensystem zum Einsatz. Hierbei werden am Aufstellort des Aktivkohlefilters lediglich die Kartusche mit der Aktivkohle ausgetauscht.

Der Wechsel der Filterkartusche geht schnell und sauber vonstatten, wodurch auch die Stillstandzeit des Filters reduziert wird.

Der eigentliche Aktivkohlewechsel in der Kartusche kann an der frischen Luft erfolgen oder auch im Werk bei KGT, sodass das Betriebspersonal keinen direkten Kontakt zur Aktivkohle haben muss.

Hier ist eine von mehreren Gasreinigungsanlagen des Lippeverbandes als Beispiel zu sehen, bestehend aus einem Aktivkohlefilter mit 0,35 m³ Füllvolumen und Gasvorwärmung.

Bei dieser Variante muss lediglich der Deckel des Filters abgeschraubt werden, sodass die Kartusche mit einem mobilen oder fest installierten Hebezeug gewechselt werden kann.

Bei dem im Bild dargestellten, speziellen Beispiel war der einzig mögliche Aufstellort ein Kellerraum, weshalb der Filter zusätzlich auf 4 Schwerlastrollen aufgestellt ist, um diesen unter eine Deckenluke zu fahren.

Die Kartusche kann entweder vor Ort vom Betriebspersonal mit frischer Aktivkohle befüllt oder in unser Werk geschickt werden, wo wir den Wechsel übernehmen und die Kartusche anschließend zur Kläranlage zurück schicken. Selbstverständlich kann die Kartusche für den Wechsel auch zu jedem anderen Aktivkohleanbieter geschickt werden. Als Wechseleinheit muss lediglich eine weitere Kartusche zum Vorhalten, nicht jedoch ein weiterer Filter angeschafft werden.

<u>Der Kunde genießt mit diesem System die größtmögliche Flexibilität für den Aktivkohlewechsel.</u>

Variante 3

Aktivkohlefilter, welche über den aufgeflanschten Deckel sowohl gefüllt als auch entleert werden.

Aufgrund der Staubentwicklung müssen erhöhte Sicherheitsanforderungen beim Wechsel der Aktivkohle beachtet werden. Zuzüglich zur eigentlichen Arbeitszeit für den Wechsel muss noch die Reinigung des Aufstellortes nach dem Aktivkohlewechsel berücksichtigt werden.

Auf einer Kläranlage des Ruhrverbandes steht als Beispiel diese Gasreinigungsanlage, bestehend aus 2 Aktivkohlefiltern à 0,7 m³ Einfüllvolumen und Gasvorwärmung (nicht im Bild).
Die Aktivkohlefilter werden über den aufgeflanschten Deckel entleert und befüllt. Neben der üblichen PSA für Arbeiten auf Kläranlagen benötigen die Mitarbeiter Schutz-Anzüge, Staubmasken und eine Gebläse zur

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Zwangsbelüftung des Raumes. Alternativ kann der Filter auch abgeflanscht und mit der Palette ins Freie transportiert werden, dies bedarf jedoch einiger Mehrarbeit durch Demontage / Montage des Filters sowie anschließender Dichtheitsprüfung der Verbindungen. Weiterhin ist diese Möglichkeit stark wetterabhängig, was eine Planbarkeit des Aktivkohlewechsels erschwert.

Soll bei einer der Wechsel nicht vor Ort auf der Kläranlage, sondern im Werk des Herstellers oder einer eines Dritten erfolgen, steigen die Investitionskosten, da ein weiterer Filter als Wechselfilter benötigt wird. Weiterhin ist der Anlagenbetreiber eingeschränkt in der Wahl seines Servicepartners, da nicht jeder Aktivkohleanbieter auch in der Lage ist, einen kompletten Aktivkohlefilter nach dem Wechsel einer erneuten Dichtheitsprüfung zu unterzeihen und ein entsprechendes Prüfprotokoll auszustellen.

Weitere Beispielbilder von KGT®-Aktivkohlefiltern

Kläranlage Wolfsburg
2 x 0,7 m³ / Außenaufstellung isoliert
Abscheidung von Siloxanen und H_2S

Kläranlage Magdeburg-Gerwisch
2 x 7 m³ / Außenaufstellung isoliert
Abscheidung von Siloxanen und H_2S

Kläranlage Werne (Lippeverband)
2 x 0,7 m³ als Kartuschensystem / Aufstellung innen
Abscheidung von Siloxanen und H_2S

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4.7 Active charcoal offer Unicarb GmbH

Explanation: The following illustration shows the offer from Unicarb GmbH in the form of a product data sheet. Beginning in the first column with a general description of the product “L-W20C” which is the granulated active charcoal of our choice. Continuing to inform about general applications for the charcoal. The second column informs about the specification of the charcoal, general properties and grain size. Lastly, in the second column are information on packaging of the end product.

UNICARB
Activated Carbon

PRODUKTDATENBLATT

UNICARB® L-W20C

Wasserdampfaktivierte Aktivkohle auf Basis Steinkohle

Beschreibung

UNICARB® L-W20C ist eine granulierte durch Wasserdampf aktivierte Aktivkohle auf Steinkohlebasis. Die bei der Produktion eingesetzten bituminösen Kohlen bringen ein Produkt hervor, dass in diversen Anwendungen eingesetzt werden kann.

Allgemeine Anwendungen

- Aufbereitung von Wasser und Abwasser
- Kondensatentölung
- Peroxidzersetzung
- Prozesswasseraufbereitung
- Schwimmbadwasseraufbereitung (Chlor, Ozon)
- Trinkwasserausbereitung
- Aminwäschen (CO_2 Entfernung)
- Adsorption von organischen Verbindungen
- Getränkeherstellung
- Aufbereitung von Waschlösungen und organischen Flüssigkeiten
- Entchlorung
- Glyzerinherstellung

Bei Fragen wenden Sie sich an unser Expertenteam.

REACH COMPLIANCE

ISO 9001 BUREAU VERITAS Certification

Spezifikation

Jodzahl	min.	900	mg/g
Wassergehalt	max.	5	%
Aschegehalt	max.	15	%

Typische Eigenschaften

Abriebhärte	min.	90	%
BET-Oberfläche		950	m^2/g
Rütteldichte		500	kg/m^3

Körnung

8x16	mesh	1,19-2,38	mm
8x30	mesh	0,56-2,38	mm
12x30	mesh	0,56-1,17	mm
12x40	mesh	0,40-1,17	mm
20x50	mesh	0,30-0,84	mm

Standardverpackung

25kg-Säcke

500kg Big Bags

Schüttgut-Silo LKW

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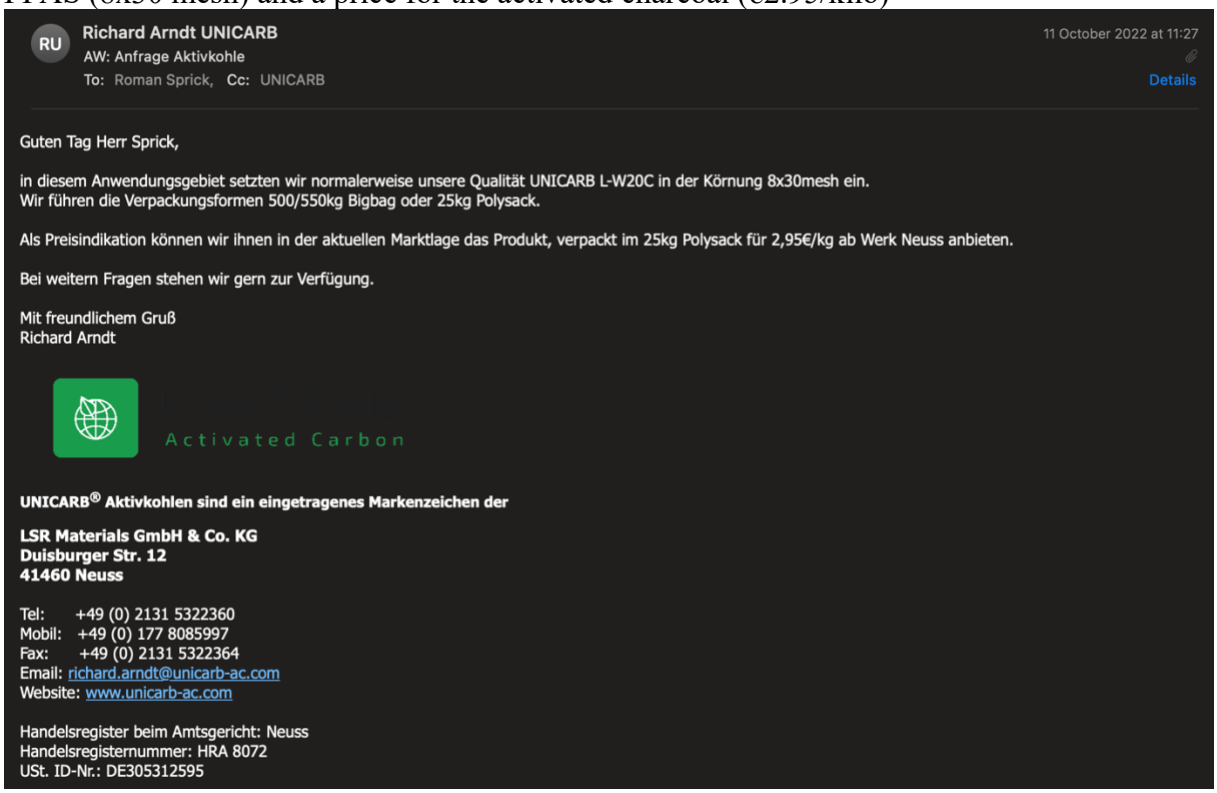
Mail: info@lsr-materials.com
Web: www.unicarb-ac.com /www.lsr-materials.com

LSR
loan supply of raw materials

Explanation: This email is an answer to the question which specific grain size to use for PFAS (8x30 mesh) and a price for the activated charcoal (€2.95/kilo)



RU **Richard Arndt UNICARB** — 11 October 2022 at 11:27
AW: Anfrage Aktivkohle
To: Roman Sprick, Cc: UNICARB — Details

Guten Tag Herr Sprick,

in diesem Anwendungsgebiet setzten wir normalerweise unsere Qualität UNICARB L-W20C in der Körnung 8x30mesh ein.
Wir führen die Verpackungsformen 500/550kg Bigbag oder 25kg Polysack.

Als Preisindikation können wir ihnen in der aktuellen Marktlage das Produkt, verpackt im 25kg Polysack für 2,95€/kg ab Werk Neuss anbieten.

Bei weitern Fragen stehen wir gern zur Verfügung.

Mit freundlichem Gruß
Richard Arndt

Activated Carbon

UNICARB® Aktivkohlen sind ein eingetragenes Markenzeichen der

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Handelsregister beim Amtsgericht: Neuss
Handelsregisternummer: HRA 8072
USt. ID-Nr.: DE305312595

4.8 LTM Investment Calculation

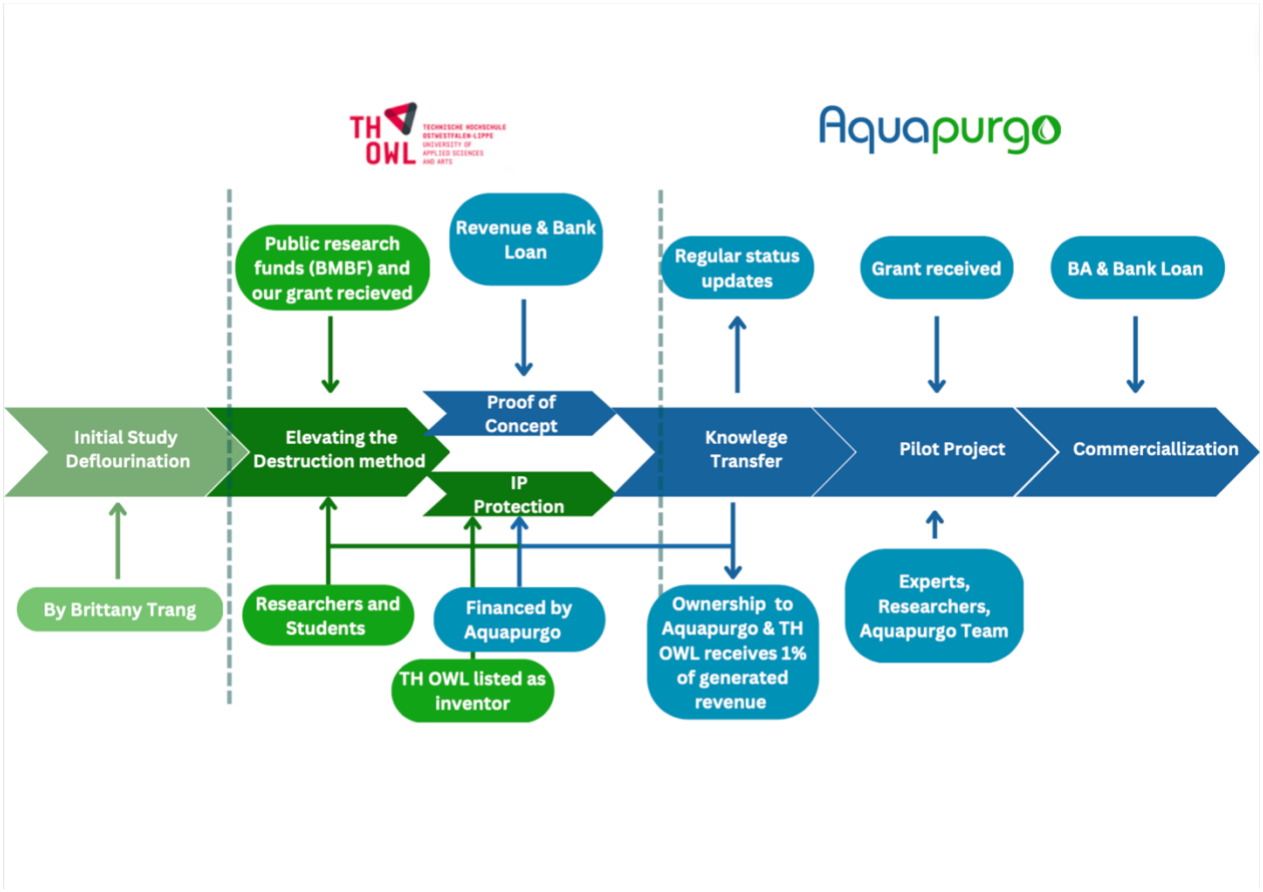
	CAPEX for LTM-Machine			
1	Pressure Tanks, VA, isolated	(inhouse) 9000l	27,500.00 €	
		6500 l	17,850.00 €	
2	Steam Generator		9,900.00 €	
3	Pump		2,000.00 €	
4	Storage Tanks 2x		2,000.00 €	
5	Cross-Flow Heat Exchanger		1,000 €	
6	Cooling Unit & Control Tech		2,000 €	
7	Filtration		3,000.00 €	
Subtotal	**Subtotal**		65,250.00 €	
8	Installation & Overhead Costs	(15% of Subtotal)	9,787.50 €	
Total			**75,037.50 €**	

	OPEX (9000l volume)	Leistung kW	Operating time (h)	Energy (kWh)	Costs	
1	Pump Process	2	2	4	1.60 €	
2	Heating (+ Heat Recovery)	250	3	750	150.00 €	
3	Cooling	20	1	20	4.00 €	
4	Filtration				30.00 €	
5	Solvents / Chemicals				219.51 €	
	Total				**405.11 €**	**per 9000l waste stream**

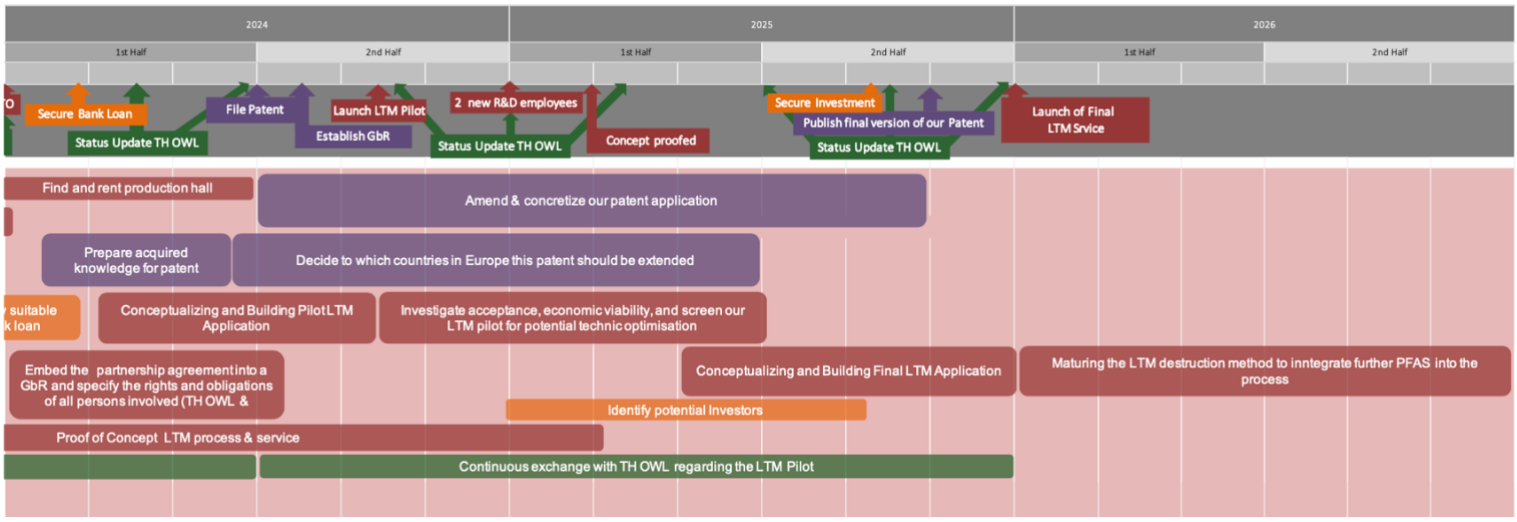
Appendix 9 Finance

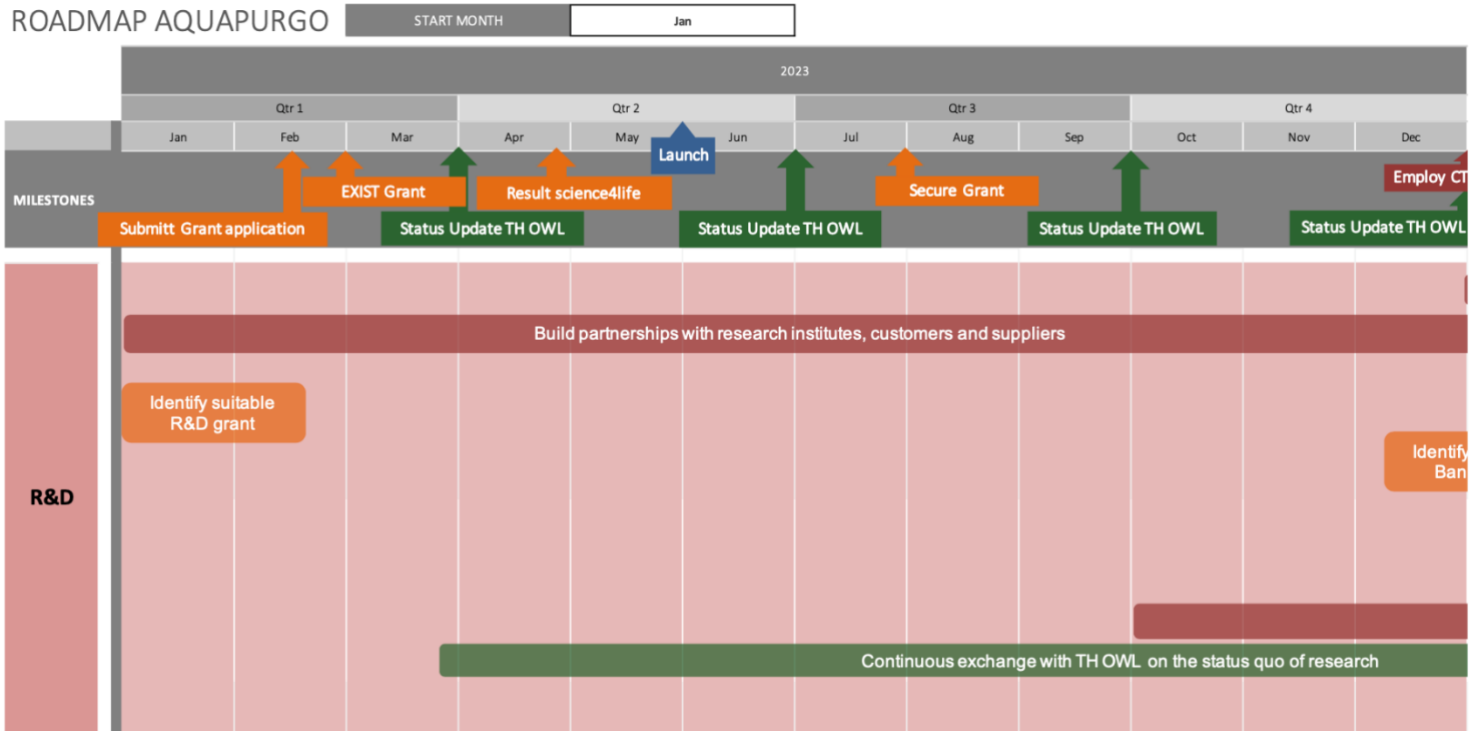
Number	Title
9.1	Knowledge Transfer
9.2	Milestone Road Map
9.3	Funding Methods
9.4	Customer Lifetime Value
9.5	Staff Related Costs
9.6	Employment Overview
9.7	Detailed P&L
9.8	Customer Development
9.9	GoGS in comparison to customer over time
9.10	Graphic Staff Recruitments
9.11	Pessimistic Scenario
9.12	Optimistic Scenario

9.1 Knowledge Transfer



9.2 Milestone Road Map





9.3 Funding Methods

Funding Scenarios

Examples from several industry players

Who	Source	Investors	Amount raised
Aquagga	Grant& BA	AFWERX, Federal Aviation Administration, U.S. Department of Defense, U.S. Environmental Protection Agency	$2.4M
OXbyEL Technologies, Inc.	Grant	National Sciennce Founndation	$255K
Puraffinity	Grant, VC & BA	EASME, UK Innovation & Science Seed Fund, SynbiCITE, Horizon 2020, Innovative UK, Acequia Capital, Kindred Capital	$7.4M
2wiTech Solutions	Grant	National Sciennce Founndation	$481K

https://www.crunchbase.com

9.4 Customer Lifetime Value

Customer Lifetime Value					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Reveue Filter System					
Price Filter System	394.788,90 €				
Gross Margin Filter System	2,5%				
Profit from Filter System	**9.869,72 €**				
Revenue DWA Maintenance					
Price of DWA Maintenance	5.000,00 €	5.000,00 €	5.000,00 €	5.000,00 €	5.000,00 €
Retentio Rate	100%	50%	50%	50%	50%
Comulative Retetion Rate	100%	50%	25%	13%	6%
Gross Margin DWA Maintenance	90%	90%	90%	90%	90%
Profit from DWA Maintenance	**4.500,00 €**	**2.250,00 €**	**1.125,00 €**	**562,50 €**	**281,25 €**
Revenue PFAS remediation service					
Price of PFAS Remediation Service	11.340,00 €	11.340,00 €	11.340,00 €	11.340,00 €	11.340,00 €
Retention Rate	100%	70%	70%	70%	70%
Comulative Retetion Rate	100%	70%	49%	34%	24%
Gross Margin PFAS Remediation Service	90%	90%	90%	90%	90%
Profit from PFAS Remediation Service	**10.206,00 €**	**7.144,20 €**	**5.000,94 €**	**3.500,66 €**	**2.450,46 €**
CP1 Sum of Profits **(CLV 1)**	9.869,72 €				
CP2 Profits	14.369,72 €	2.250,00 €	1.125,00 €	562,50 €	281,25 €
CP2 Sum of Profits **(CLV 2)**	**18.588,47 €**				
CP3 Profits (starting 2026)	24.575,72 €	9.394,20 €	6.125,94 €	4.063,16 €	2.731,71 €
CP3 Sum of Profits **(CLV 3)**	**46.890,73 €**				
CP4 Profits (starting 2026)	10.206,00 €	7.144,20 €	5.000,94 €	3.500,66 €	2.450,46 €
CP4 Sum of Profits **(CLV 4)**	**28.302,26 €**				
CP5 Profits (starting 2026)	14.706,00 €	9.394,20 €	6.125,94 €	4.063,16 €	2.731,71 €
CP5 Sum of Profits **(CLV 5)**	**37.021,01 €**				

9.5 Staff Related Costs

Staff related Costs		2023	2024	2025	2026	2027
Other (office supplies, subscriptions, phones,...)						
G&A staff	G&A	1.466,67 €	2.378,89 €	2.160,00 €	2.160,00 €	2.160,00 €
R&D staff	R&D	- €	758,89 €	1.298,89 €	1.838,89 €	1.620,00 €
Marketing staff	S&M	782,89 €	1.886,89 €	1.668,00 €	1.668,00 €	1.668,00 €
Sales staff	S&M	572,89 €	1.634,89 €	3.269,78 €	5.612,67 €	5.882,89 €
Production	CoGS	1.562,16 €	5.561,00 €	10.998,70 €	13.286,55 €	13.004,43 €
Total other costs		**4.384,61 €**	**12.220,56 €**	**19.395,37 €**	**24.566,11 €**	**24.335,32 €**
Onboarding (computer, desk, light,...)						
G&A staff	G&A	1.211,70 €	403,90 €	- €	- €	- €
R&D staff	R&D	- €	403,90 €	403,90 €	403,90 €	- €
Marketing staff	S&M	1.623,90 €	1.623,90 €	- €	- €	- €
Sales staff	S&M	403,90 €	403,90 €	807,80 €	1.211,70 €	403,90 €
Production	CoGS	653,70 €	903,50 €	1.403,10 €	749,40 €	124,90 €
Total onboarding costs		**3.893,20 €**	**3.739,10 €**	**2.614,80 €**	**2.365,00 €**	**528,80 €**
Total staff related		**8.277,81 €**	**15.959,66 €**	**22.010,17 €**	**26.931,11 €**	**24.864,12 €**

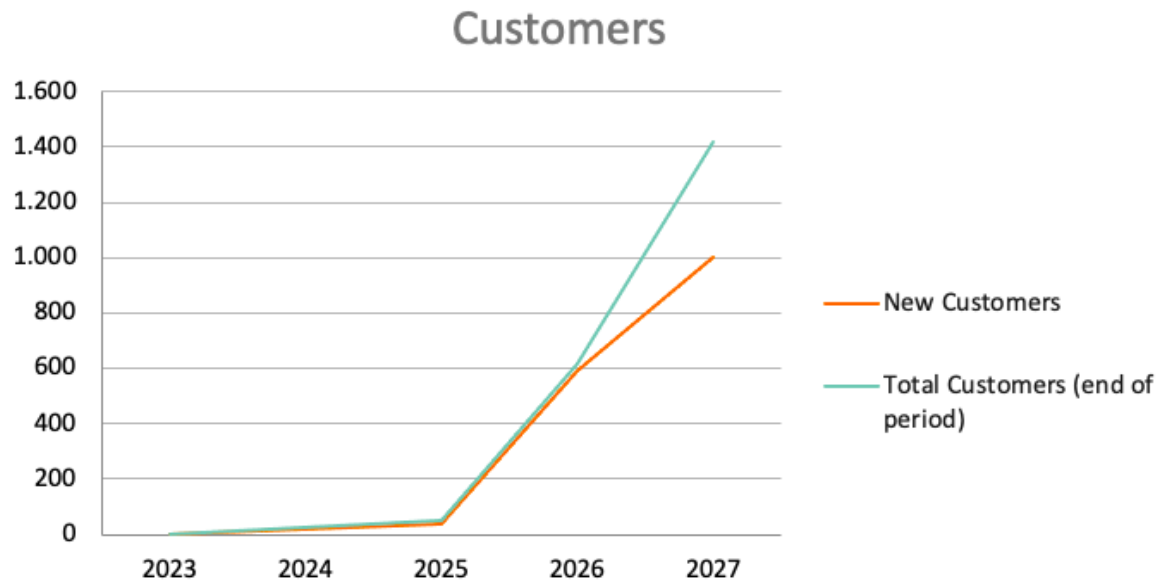
9.6 Employment Overview

Aquapurgo Salaries						
Year		**2023**	**2024**	**2025**	**2026**	**2027**
G&A						
Founder & CEO		12.000,00 €	24.000,00 €	24.000,00 €	24.000,00 €	24.000,00 €
Intern assistant			2.080,00 €	6.240,00 €	6.240,00 €	6.240,00 €
Founder & COO		12.000,00 €	24.000,00 €	24.000,00 €	24.000,00 €	24.000,00 €
Founder & CFO		12.000,00 €	24.000,00 €	24.000,00 €	24.000,00 €	24.000,00 €
Total G&A Salaries	G&A	**36.000,00 €**	**74.080,00 €**	**78.240,00 €**	**78.240,00 €**	**78.240,00 €**
G&A Headcount		3	4	4	4	4
R&D						
CTO			50.000,00 €	50.000,00 €	50.000,00 €	50.000,00 €
Scientist				21.600,00 €	43.200,00 €	43.200,00 €
PhD Candidate					43.200,00 €	43.200,00 €
Total R&D Salaries	R&D	**0,00 €**	**50.000,00 €**	**71.600,00 €**	**136.400,00 €**	**136.400,00 €**
R&D Headcount		0	1	2	3	3
Marketing & Brand						
Founder & Head of Marketing		12.000,00 €	24.000,00 €	24.000,00 €	24.000,00 €	24.000,00 €
Praktikant intern			6.240,00 €	6.240,00 €	6.240,00 €	6.240,00 €
Total Marketing & Brand Salaries	S&M	**12.000,00 €**	**30.240,00 €**	**30.240,00 €**	**30.240,00 €**	**30.240,00 €**
Marketing Headcount		1	2	2	2	2
Sales						
Founder & Head of Sales		12.000,00 €	24.000,00 €	24.000,00 €	24.000,00 €	24.000,00 €
Sales rep			35.040,00 €	35.040,00 €	35.040,00 €	35.040,00 €
Sales rep				17.520,00 €	35.040,00 €	35.040,00 €
Sales rep				17.520,00 €	35.040,00 €	35.040,00 €
Sales rep					35.040,00 €	35.040,00 €
Sales rep					35.040,00 €	35.040,00 €
Sales rep					35.040,00 €	35.040,00 €
Sales rep						35.040,00 €
Total Sales Salaries	S&M	**12.000,00 €**	**59.040,00 €**	**94.080,00 €**	**234.240,00 €**	**269.280,00 €**
Sales Headcount		1	2	4	7	8
Production						
Engineer M.A.		24.050,00 €	48.100,00 €	48.100,00 €	48.100,00 €	48.100,00 €
Engineer M.A.				48.100,00 €	48.100,00 €	48.100,00 €
Engineer BA			41.000,00 €	41.000,00 €	41.000,00 €	41.000,00 €
Plant Worker				6.000,00 €	24.000,00 €	24.000,00 €
Plant Worker				6.000,00 €	24.000,00 €	24.000,00 €
Plant Worker					24.000,00 €	24.000,00 €
Plant Worker					12.000,00 €	24.000,00 €
Plant Worker					4.000,00 €	24.000,00 €
Plant Worker						24.000,00 €
Mechanic		18.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €
Mechanic		18.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €
Mechanic			36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €
Mechanic			36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €
Mechanic			36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €
Mechanic			36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €
Mechanic				36.000,00 €	36.000,00 €	36.000,00 €
Mechanic				36.000,00 €	36.000,00 €	36.000,00 €
Mechanic				36.000,00 €	36.000,00 €	36.000,00 €
Mechanic				36.000,00 €	36.000,00 €	36.000,00 €
Mechanic				36.000,00 €	36.000,00 €	36.000,00 €
Mechanic				36.000,00 €	36.000,00 €	36.000,00 €
Mechanic					36.000,00 €	36.000,00 €
Mechanic					36.000,00 €	36.000,00 €
Mechanic					36.000,00 €	36.000,00 €
Total Production Salaries	CoGS	**60.050,00 €**	**305.100,00 €**	**581.200,00 €**	**765.200,00 €**	**821.200,00 €**
Production Headcount		3	8	17	23	24
Total Wages		**120.050,00 €**	**518.460,00 €**	**855.360,00 €**	**1.244.320,00 €**	**1.335.360,00 €**
Total Headcount		8	17	29	39	41

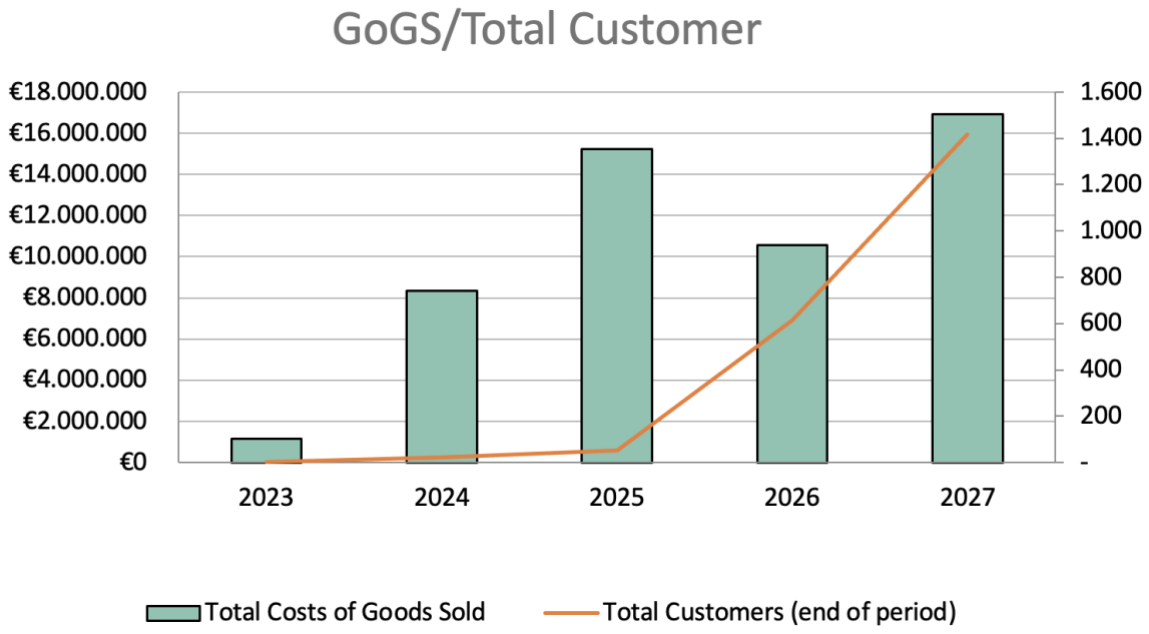
9.7 Detailed P&L

P&L Aquapurgo					
Year	**2023**	**2024**	**2025**	**2026**	**2027**
Revenue					
Revenue ACF	1.184.366,70 €	8.685.355,80 €	15.791.556,00 €	€9.788.159,72	€16.590.101,22
Revenue DWA Maintenance	6.000,00 €	€47.000,00	€103.500,00	€304.565,00	€580.782,50
LTM Service (starting 2026)	n.a.	n.a.	n.a.	€6.142.639,86	€14.711.101,90
Number of new customers	3	22	40	590	1.000
Total Revenue	**1.190.366,70 €**	**8.732.355,80 €**	**15.895.056,00 €**	**16.235.364,58 €**	**31.881.985,62 €**
growth in %		634%	82%	2%	96%
Costs of Goods Sold					
Purchases from suppliers	1.076.697,00 €	7.895.778,00 €	14.355.960,00 €	8.898.327,02 €	15.081.910,20 €
LTM Process costs	n.a.	n.a.	n.a.	275.973,17 €	413.959,75 €
Production rent	0,00 €	39.480,00 €	78.960,00 €	78.960,00 €	78.960,00 €
Labor	60.050,00 €	305.100,00 €	581.200,00 €	765.200,00 €	821.200,00 €
Overhead	19.113,86 €	102.252,50 €	201.977,80 €	534.382,95 €	532.576,33 €
Total Costs of Goods Sold	**1.155.860,86 €**	**8.342.610,50 €**	**15.218.097,80 €**	**10.552.843,13 €**	**16.928.606,28 €**
Gross Profit	**34.505,84 €**	**389.745,30 €**	**676.958,20 €**	**5.682.521,45 €**	**14.953.379,34 €**
growth in %		1130%	174%	839%	263%
LTM Investments					
R&D processes	250.000,00 €	250.000,00 €	250.000,00 €		
IP protection		10.690,00 €	50.000,00 €	61.426,40 €	147.181,02 €
Pilot		75.037,50 €			
LTM Plant			712.856,25 €		
LTM Trucks			255.000,00 €		
R&D Personnell	0,00 €	50.000,00 €	71.600,00 €	136.400,00 €	136.400,00 €
Total LTM Development Costs	**250.000,00 €**	**385.727,50 €**	**1.339.456,25 €**	**197.826,40 €**	**283.581,02 €**
Operating Expenses					
Rent	7.200 €	30.600 €	52.200 €	70.200 €	73.800 €
Utilities	720 €	1.440 €	1.440 €	1.440 €	1.440 €
Server Infrastructure	40 €	40 €	40 €	40 €	40 €
Marketing	6.000 €	30.000 €	45.000 €	45.000 €	45.000 €
Insurance	8.764 €	37.848 €	62.441 €	90.835 €	97.481 €
Legal expenses	4.000 €	4.000 €	4.000 €	4.000 €	4.000 €
Onboarding	3.240 €	2.836 €	1.212 €	1.616 €	404 €
Staff related	2.822 €	6.660 €	8.397 €	11.280 €	11.331 €
Total Operating Expenses	32.786 €	113.423 €	174.730 €	224.411 €	233.496 €
Personnel					
G&A	36.000 €	74.080 €	78.240 €	78.240 €	78.240 €
S&M	24.000 €	89.280 €	124.320 €	264.480 €	299.520 €
Total salaries	60.000 €	163.360 €	202.560 €	342.720 €	377.760 €
Total SG&A	**92.786 €**	**276.783 €**	**377.290 €**	**567.131 €**	**611.256 €**
EBITDA	**- 308.280 €**	**- 272.765 €**	**- 1.039.788 €**	**4.917.565 €**	**14.058.542 €**
Depreciation				168.071 €	168.071 €
EBIT	**- 308.280 €**	**- 272.765 €**	**- 1.039.788 €**	**4.749.493 €**	**13.890.471 €**
Interests Loan 8%		12.000 €	12.000 €	12.000 €	12.000 €
EBT	**- 308.280 €**	**- 284.765 €**	**- 1.051.788 €**	**4.737.493 €**	**13.878.471 €**
German Corporation tax: 15,825%	- €	- €	- €	749.708 €	2.196.268 €
German Trade Tax: 14,525%	- €	- €	- €	688.121 €	2.015.848 €
Net Income	**- 308.280 €**	**- 284.765 €**	**- 1.051.788 €**	**3.299.664 €**	**9.666.355 €**
Accumulated Net Income	- 308.280 €	- 593.045 €	- 1.644.832 €	1.654.832 €	11.321.187 €
Operating Cashflow	**- 308.280 €**	**- 284.765 €**	**- 1.051.788 €**	**3.467.735 €**	**9.834.426 €**

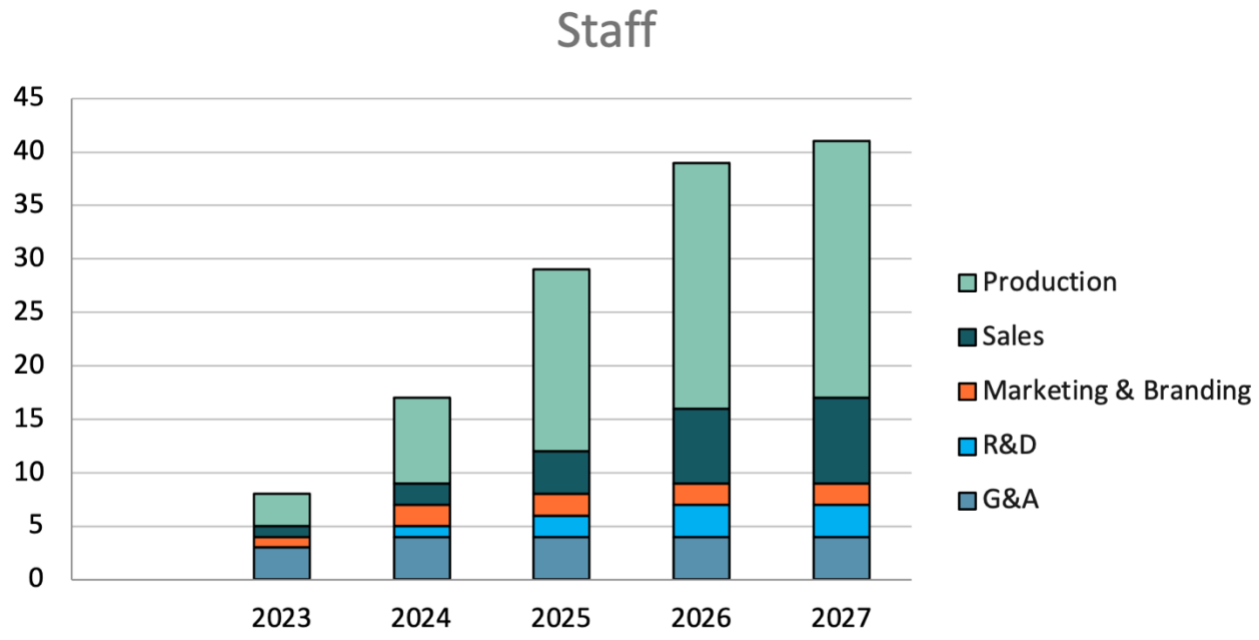
9.8 Customer Development



9.9 GoGS in comparison to customer over time



9.10 Graphic Staff Recruitments



9.11 Pessimistic Scenario

P&L Aquapurgo

Year	2023	2024	2025	2026	2027
Revenue					
Revenue ACF	1.130.531,85 €	8.290.566,90 €	15.073.758,00 €	€9.343.243,37	€15.836.005,71
Revenue DWA Maintenance	6.000,00 €	€46.850,00	€103.425,00	€291.886,75	€580.763,75
LTM Service (starting 2026)	n.a.	n.a.	n.a.	€5.835.507,87	€14.496.109,51
Number of new customers	3	21	38	561	950
Total Revenue	**1.136.531,85 €**	**8.337.416,90 €**	**15.177.183,00 €**	**15.470.637,99 €**	**30.912.878,97 €**
growth in %		634%	82%	2%	100%
Costs of Goods Sold					
Purchases from suppliers	1.076.697,00 €	7.895.778,00 €	14.355.960,00 €	8.898.327,02 €	15.081.910,20 €
LTM Process costs	n.a.	n.a.	n.a.	303.570,48 €	455.355,72 €
Production rent	0,00 €	39.480,00 €	78.960,00 €	78.960,00 €	78.960,00 €
Labor	60.050,00 €	305.100,00 €	581.200,00 €	765.200,00 €	821.200,00 €
Overhead	19.113,86 €	102.252,50 €	201.977,80 €	534.382,95 €	532.576,33 €
Total Costs of Goods Sold	**1.155.860,86 €**	**8.342.610,50 €**	**15.218.097,80 €**	**10.580.440,45 €**	**16.970.002,25 €**
Gross Profit	**-19.329,01 €**	**-5.193,60 €**	**-40.914,80 €**	**4.890.197,53 €**	**13.942.876,71 €**
growth inn %		27%	788%	-11952%	285%
LTM Investments					
R&D processes	250.000,00 €	250.000,00 €	250.000,00 €		
IP protection		10.690,00 €	50.000,00 €	58.355,08 €	145.031,10 €
Pilot		75.037,50 €			
LTM Plant			712.856,25 €		
LTM Trucks			255.000,00 €		
R&D Personnell	0,00 €	50.000,00 €	71.600,00 €	136.400,00 €	136.400,00 €
Total LTM Development Costs	**250.000,00 €**	**385.727,50 €**	**1.339.456,25 €**	**194.755,08 €**	**281.431,10 €**
Operating Expenses					
Rent	7.200 €	30.600 €	52.200 €	70.200 €	73.800 €
Utilities	720 €	1.440 €	1.440 €	1.440 €	1.440 €
Server Infrastructure	40 €	40 €	40 €	40 €	40 €
Marketing	6.000 €	30.000 €	45.000 €	45.000 €	45.000 €
Insurance	8.764 €	37.848 €	62.441 €	90.835 €	97.481 €
Legal expenses	4.000 €	4.000 €	4.000 €	4.000 €	4.000 €
Onboarding	3.240 €	2.836 €	1.212 €	1.616 €	404 €
Staff related	2.822 €	6.660 €	8.397 €	11.280 €	11.331 €
Total Operating Expenses	32.786 €	113.423 €	174.730 €	224.411 €	233.496 €
Personnel					
G&A	36.000 €	74.080 €	78.240 €	78.240 €	78.240 €
S&M	24.000 €	89.280 €	124.320 €	264.480 €	299.520 €
Total salaries	60.000 €	163.360 €	202.560 €	342.720 €	377.760 €
Total SG&A	**92.786 €**	**276.783 €**	**377.290 €**	**567.131 €**	**611.256 €**
EBITDA	**- 362.115 € -**	**667.704 € -**	**1.757.661 €**	**4.128.312 €**	**13.050.190 €**
Depreciation				168.071 €	168.071 €
EBIT	**- 362.115 € -**	**667.704 € -**	**1.757.661 €**	**3.960.241 €**	**12.882.118 €**
Interests Loan					
EBT	**- 362.115 € -**	**667.704 € -**	**1.757.661 €**	**3.960.241 €**	**12.882.118 €**
German tax rate (2022): 15,825%	- €	- €	- €	653.305 €	2.065.192 €
German Trade Tax: 14,525%	- €	- €	- €	575.225 €	1.871.128 €
Net Income	**- 362.115 € -**	**667.704 € -**	**1.757.661 €**	**2.731.710 €**	**8.945.798 €**
Accumulated Net Income	- 362.115 € -	1.029.818 € -	2.787.479 € -	55.769 €	8.890.029 €
Operating Cashflow	**- 362.115 € -**	**667.704 € -**	**1.757.661 €**	**2.899.782 €**	**9.113.869 €**

9.12 Optimistic Scenario

P&L Aquapurgo

Year	2023	2024	2025	2026	2027
Revenue					
Revenue ACF	1.238.201,55 €	9.080.144,70 €	16.509.354,00 €	€10.233.076,07	€17.344.196,73
Revenue DWA Maintenance	6.000,00 €	€47.150,00	€103.575,00	€317.243,25	€580.801,25
LTM Service (starting 2026)	n.a.	n.a.	n.a.	€6.449.771,85	€14.926.094,30
Number of new customers	3	23	42	620	1.050
Total Revenue	**1.244.201,55 €**	**9.127.294,70 €**	**16.612.929,00 €**	**17.000.091,17 €**	**32.851.092,28 €**
growth in %		634%	82%	2%	93%
Costs of Goods Sold					
Purchases from suppliers	1.076.697,00 €	7.895.778,00 €	14.355.960,00 €	8.898.327,02 €	15.081.910,20 €
LTM Process costs	n.a.	n.a.	n.a.	303.570,48 €	455.355,72 €
Production rent	0,00 €	39.480,00 €	78.960,00 €	78.960,00 €	78.960,00 €
Labor	60.050,00 €	305.100,00 €	581.200,00 €	765.200,00 €	821.200,00 €
Overhead	19.113,86 €	102.252,50 €	201.977,80 €	534.382,95 €	532.576,33 €
Total Costs of Goods Sold	**1.155.860,86 €**	**8.342.610,50 €**	**15.218.097,80 €**	**10.580.440,45 €**	**16.970.002,25 €**
Gross Profit	**88.340,69 €**	**784.684,20 €**	**1.394.831,20 €**	**6.419.650,72 €**	**15.881.090,02 €**
growth inn %		888%	178%	460%	247%
LTM Investments					
R&D processes	250.000,00 €	250.000,00 €	250.000,00 €		
IP protection		10.690,00 €	50.000,00 €	64.497,72 €	149.330,94 €
Pilot		75.037,50 €			
LTM Plant			712.856,25 €		
LTM Trucks			255.000,00 €		
R&D Personnell	0,00 €	50.000,00 €	71.600,00 €	136.400,00 €	136.400,00 €
Total LTM Development Costs	**250.000,00 €**	**385.727,50 €**	**1.339.456,25 €**	**200.897,72 €**	**285.730,94 €**
Operating Expenses					
Rent	7.200 €	30.600 €	52.200 €	70.200 €	73.800 €
Utilities	720 €	1.440 €	1.440 €	1.440 €	1.440 €
Server Infrastructure	40 €	40 €	40 €	40 €	40 €
Marketing	6.000 €	30.000 €	45.000 €	45.000 €	45.000 €
Insurance	8.764 €	37.848 €	62.441 €	90.835 €	97.481 €
Legal expenses	4.000 €	4.000 €	4.000 €	4.000 €	4.000 €
Onboarding	3.240 €	2.836 €	1.212 €	1.616 €	404 €
Staff related	2.822 €	6.660 €	8.397 €	11.280 €	11.331 €
Total Operating Expenses	32.786 €	113.423 €	174.730 €	224.411 €	233.496 €
Personnel					
G&A	36.000 €	74.080 €	78.240 €	78.240 €	78.240 €
S&M	24.000 €	89.280 €	124.320 €	264.480 €	299.520 €
Total salaries	60.000 €	163.360 €	202.560 €	342.720 €	377.760 €
Total SG&A	**92.786 €**	**276.783 €**	**377.290 €**	**567.131 €**	**611.256 €**
EBITDA	**- 254.445 €**	**122.174 € -**	**321.915 €**	**5.651.622 €**	**14.984.103 €**
Depreciation	- €	- €	- €	168.071 €	168.071 €
EBIT	**- 254.445 €**	**122.174 € -**	**321.915 €**	**5.483.551 €**	**14.816.032 €**
Interests Loan		12.000 €	12.000 €	12.000 €	12.000 €
EBT	**- 254.445 €**	**110.174 € -**	**333.915 €**	**5.471.551 €**	**14.804.032 €**
German tax rate (2022): 15,825%	- €	19.334 €	- €	894.369 €	2.371.234 €
German Trade Tax: 14,525%	- €	16.003 €	- €	794.743 €	2.150.286 €
Net Income	**- 254.445 €**	**74.837 € -**	**333.915 €**	**3.782.439 €**	**10.282.512 €**
Accumulated Net Income	- 254.445 €	- 179.608 €	- 513.522 €	3.268.917 €	13.551.429 €
Operating Cashflow	**- 254.445 €**	**74.837 € -**	**333.915 €**	**3.950.510 €**	**10.450.583 €**

Appendix 10 Team Page

Meet the Team

Marc-Florian Steffens

Marc has completed a B.A. Business Administration a major in Marketing and then continued to work in a start up as head of marketing, which exposed him to certain other topics inside the startup such as Strategy and HR. Combining his start-up experience with his now area of expertise in Strategy makes Marc a perfect fit to take over Business Model & Operations.

Business Model & Operations

- Business Model: 24 Steps
- 4 V's Operations

Roman Sprick

After finishing his B.A. International Business Administration with a focus on Renewable Energy, Roman was working as a Strategy Consultant for Klärgastechnik Deutschland GmbH. Now at Nova SBE, his focus lies on Entrepreneurship & Innovation and he will take over the Stragey & Implementation part of our business.

Strategy & Implementation

- Competitive Strategy
- Corporate Strategy
- Entry Strategy / Go-to-Market
- Strategy Execution / Roadmap
- Strategy Robustness

Benedikt Erwin Heitmann

Born and raised in Berlin, Benedikt can show considerable Business Administration experience with internships at IAB Communications GmbH and Swapfiets. Currently he is pursuing an Area of Expertise in Entrepreneurship & Innovation and in order to further expand on his skills in that area, he will take over the R&D and Financing part.

R&D & Finance

- Process Diagram & Analytics
- Cooperations
- Financial Analysis
- Funding of Research
- Future Outlook

Robin-Kate Stegner

Having worked for a health-tech startup from Berlin in B2B Branding and Marketing, Robin is our expert when it comes to everything branding related. Her strenghts lie in careful organization of team tasks and creative thinking. Besides taking over the Branding & Social Entrepreneurship part, she will also be responsible for building the website.

Branding & Social Entrepreneurship

- Mission / Vision
- Positioning Map + Statement
- Brand Archetype/ Language
- Brand Identity Prism
- Social Startup
- Website Creation

Till-Hendrik Schubert

With a Bachelor focusing on Marketing and considerable Consulting experience, Till us an excellent candidate to take over the Marketing part of our start-up. Together with Prof. Dr. Claudia Bünte, he published a book on the topic of Artificial Intelligence in Marketing and was also Head of Marketing at the Berlin stock exchange circle.

Marketing

- 7 P's
- Marketing Strategy
- Marketing Funnel
- Marketing Execution
- Awareness Campaign