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Renewable Energy in Central and Eastern Europe

Production of Second Generation Biofuels - the Cold Catalytic Conversion Technology

A Master's Thesis submitted for the degree of
"Master of Science"

supervised by

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November, 2013, Munich

Affidavit

I, **Rudolf Jost**, hereby declare

1. that I am the sole author of the present Master Thesis, "Production of Second Generation Biofuels - the Cold Catalytic Conversion Technology", 129 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master Thesis as an examination paper in any form in Austria or abroad.

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Abstract

First generation biofuels appear unsustainable because of the potential stress that their production places food commodities. Second generation biofuels derived from lignocellulosic agriculture and forest residues, from non-food crop feedstock and industrial secondary raw materials. The procedure of second generation of biofuels allows the entire biomass to be used.

The worldwide market demand for liquid fuels such as heavy fuel, light fuel, diesel oil and fuel for heat supplied from renewable resources. The constantly rising demand for energy has led to the excessive use of fossil sources of energy. This has spiked oil costs and most recently caused a parallel rise in food costs.

Regenerative sources of energy come from directly solar energy, i.e. photovoltaic, tidal energy, wind force, geothermal energy and biomass – plant bounded solar power - as well as using secondary raw materials as its input reducing the need for landfills. In highly populated urban centres the growth of municipal waste has become a menacing problem. This study will find an answer for the use of unused resources in production of liquid fuels – so called second generation of biofuels.

The Cold Catalytic Conversion Technology – the depolymerisation of organic substances – is a process in production of hydrocarbon fuels. The main focus of this study is to evaluate the long term availability of the feedstock as well as the technical and financial feasibility of the CCC-Technology. The CCC-system is one of the most efficient economical and ecological technologies for the production of liquid fuels. The study based on cash flow analysis will show, that the investment in the CCC-Technology will guarantee a high income even in the worstcase of rising feedstock costs. The carried out case study highlights exactly this result.

The CCC-process provides proven and sustainable solutions for the conversion of a wide variety of organic feedstock into crude oil or gasoil. Biomass and solid organic municipal waste guarantee a high efficiency of the system. The Master Thesis should give a technical description of the CCC-process as well as the projection, construction and implementation of a CCC-power-plant.

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List of abbreviations and symbols

Abbreviation	Long Text
BImSchG	Bundes Imissions Schutz Gesetz
BioDME	Bio dimethyl ether
BioSNG	Bio synthetic natural gas
BtL	Biomass-to-Liquid
CCC	Cold Catalytic Conversion
CO_2	Carbon-dioxide
CO_2-eq	Carbon-dioxide equivalent
DME	Dimethyl ether
DMF	Dimethyl furan
EU	European Union
FAEE	Fatty acid ethyl ester
FAME	Fatty acid methyl ester
FT	Fischer-Tropsch
GDP	Gross domestic product
GHG	Greenhouse Gas
Gt	Gigatonne
GtL	Gas-to-Liquid
IEA	International Energy Agency
kg	Kilogram
KW	Kilowatt
Mt	Metric Tonne
MW	Megawatt
NNFCC	National Non Food Crops Centre
OECD	Organization of Economic Co-operation and Development
ppm	Parts per million
PPO	Pure Plant Oil
R&D	Research and Development
SORM	Secondary Organic Raw Material
WEA	Winkelkötter Energie Anlagen

1 Introduction

1.1 Motivation

Working over the last 12 years in several projects in renewable energy the author of this study got in contact with engineers working on the implementation of a system of Cold Catalytic Conversion of biomass and secondary raw materials. The principal steps of the process are well known and now there are companies on the market which developed processes for the conversion of biomass waste products and municipal waste to diesel oil.

The low temperature depolymerisation of biomass was invented in Germany in the year 1923. A lot of research in this field was done until 1945 and especially later on in the German Democratic Republic because of an existing lack of fossil oil. Therefore in Germany is concentrated a lot of experience in this field and activities re-started as a consequence of growing oil prices, reducing dependence on oil and environmental problems with municipal waste and plastic.

The present CCC-system allows plant bounded solar energy as well as industrial waste (secondary raw materials) to be converted to marketable liquid energy in the natural cycle. The present system of Cold Catalytic Conversion is comparable to the formation of oil. The catalysts used in the CCC-system are state of the art. By implementation of this large scale production process it is possible to produce the final products of gasoil from biomass and secondary raw materials at competitive prices.

After 3 years of testing the process in a power-plant pilot there is now the first application of a big scale industrial CCC-power-plant in Switzerland and a second one in Herne/Germany.

1.2 Core question and core objective

This study is to review the realistic technical and financial feasibility of production of second generation biofuels (BtL) in a cold catalytic process. The study should concentrate on available resources of residues in agricultural and forestry production as well as in “secondary raw materials” like pre-selected municipal waste (i.e. “yellow sack” for the collection of recyclable packaging material) and industrial feedstock (i.e. shredded fractions of the car recycling industry).

1.3 Structure of the thesis

The production of second generation biofuels by a Cold Catalytic Conversion process is still a new technology.

The first part of the study should give an overview about the potential in general of first and second generation of biofuels out of different feedstock for both systems. Chapter 2 shows the basic principles, an historical overview of first and second generation biofuels. Chapter 3 explains the methodology of this study.

In the second part of the study the process of Cold Catalytic Conversion and the first industrial scaled implementation of a power plant will be explained. In chapter 4 the historical development of the CCC-Technology and the CCC-process are described. Chapter 5 shows the implementation of the first industrial scaled CCC-power-plant. Chapter 6 contents the technical and financial analysis of the master thesis and chapter 7 the conclusion of this work.

2 Basic Principles

The consumption of petroleum has surged during the 20th century, at least partially because of the rise of the automobile industry. Today, fossil fuels such as coal, oil, and natural gas provide more than three quarters of the world's energy. "However at present renewable feedstock attracts attention due to increasing of fossil fuels cost and its graceful irretrievable consumption" [Parmon & Martyanov (2010)].

"An important current focus of research in chemistry, engineering, agriculture and environmental policy is the development of clean technologies that utilize a sustainably produced feedstock to the largest extent possible" [Tilmann, et al. (2009)]. This research is especially important in the transportation fuel sector, which is strongly dependent on petroleum, a non-renewable fossil source of carbon. "However as the worldwide supply of petroleum diminishes, it is becoming increasingly expensive and, accordingly, less attractive as a carbon source. Furthermore, the combustion of fossil fuels or their derivatives for the production of heat and power is associated with a net increase in greenhouse gas levels worldwide" [Huber, et al. (2006), Lynd, et al. (1999)]. "In contrast to the present situation, where the entirety of demand is met by a single source (i.e., petroleum), a more flexible system drawing from multiple energy sources should be an attractive long term solution" [Alonso, et al. (2010)]. In Table 2-1 the main sources of fuels in the present will be shown.

Table 2-1: "Comparison of first, second generation biofuel and petroleum fuel" (Source: Naik, et al. (2010), p. 580)

	Petroleum refinery	**1st generation fuel**	**2nd generation fuel**
Feedstock	Crude petroleum	vegetable oils & corn sugar etc.	Non food, cheap, and abundant plant waste biomass (agricultural & forestry residues, grass, aquatic biomass), SORM, municipal waste
Products	CNG LPG Diesel Petrol Kerosine Jet fuel	FAME or biodiesel corn ethanol sugar alcohol	Hydro treating oil, bio-oil, FT oil, lignocellulosic ethanol, butanol, mixed alcohols
Problems	Depletion/declining of petroleum reserve Environmental pollution Economics and ecological problems	Limited feedstock (food vs. fuel production) Blended partly with conventional fuel	No industrial scaled production, at the moment only pilots
Benefits	Existing infrastructure for the production and distribution	Environmentally friendly, economic & social security	Not competing with food production Advance technology still under development to reduce the cost of conversion Environmentally friendly

The following subchapters should give an overview on basic principles and concepts applied in the subject area of production of second generation biofuels by the Cold Catalytic Conversion.

2.1 Historical overview

"Apart from burning wood as a source of heat, biomass-derived alcohols and oils have been used as liquid energy sources since 6000 BC [Fatih Demirbas 2009]. Alcohols have been used as transportation fuels since the invention of the internal combustion engine in 1897 [Rothman (1983)], while the Diesel engine was initially designed to work with oils [Shay (1993)]. However, the increased availability of inexpensive petroleum almost completely replaced these green alternatives. Presently, given the diminishing worldwide supply of petroleum, the interest in conversion strategies for the production of liquid fuels from biomass is receiving renewed attention, and many options are under consideration. First generation biofuels use conventional technologies to process food crops (e.g., sugar, starch and oils) and consist mainly of alcohols (bioethanol) and oils (biodiesel). These fuels are readily available, because the processes to obtain them are well understood technologies and have been refined over many years of development. The main challenge in research involving first generation biofuels is not in the development of new technologies, but in the optimization of processes to reduce cost, such that green fuels can be competitive with those produced from petroleum" [Alonso, et al. (2010)].

"In the twentieth century major research emphasis was given for the development of petroleum, coal, and natural gas based refinery to exploit the cheaply available fossil feed stock. These feedstock are used in industry to produce multiple products such as fuel, fine chemicals, pharmaceuticals, detergents, synthetic fibre, plastics, pesticides, fertilizers, lubricants, solvent, waxes, coke, asphalt, etc. to meet the growing demand of the population" [Bender (2000), Fatih Demirbas (2006)]. "The fossil resources are not regarded as sustainable and questionable from the economic, ecology and environmental point of views" [Kamm (2006)].

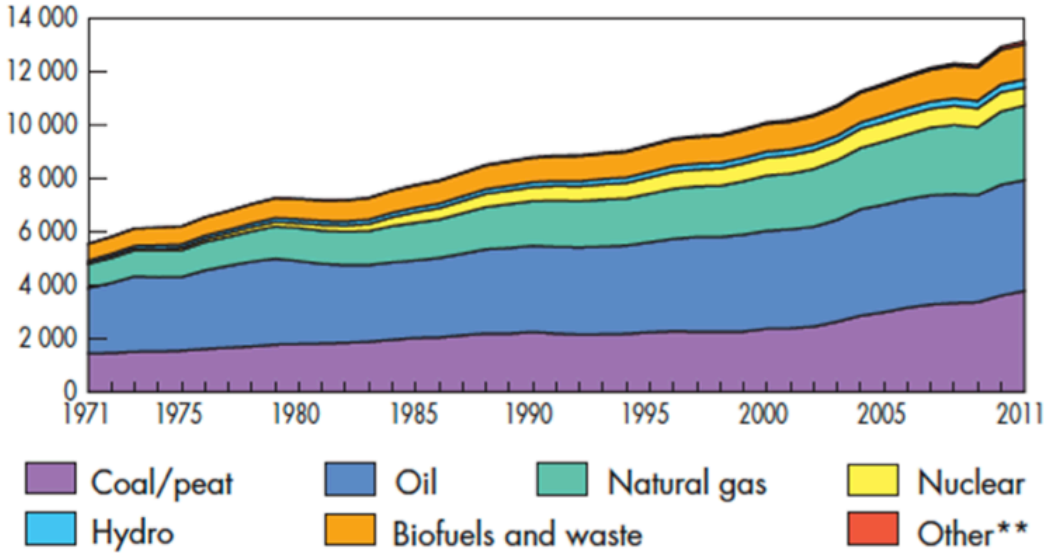


Figure 1: "World total primary energy supply from 1971 to 2011 by fuel [Mt]" (source: IEA statistics (2013))

"The burning of fossil fuels is a big contributor to increasing the level of CO_2 atmosphere which is directly associated with global warming observed in recent decades. The adverse effects of greenhouse gas (GHG) emissions on the environment, together with declining petroleum reserves, have been realized.

Therefore, the quest for sustainable and environmentally benign sources of energy for our industrial economies and consumer societies has become urgent in recent years" [Mabee, et al. (2005)]. Consequently, there is renewed interest in the production and use of fuels from plants or organic waste (Figure 2).

"Global biofuel production has been increasing rapidly over the last decade, but the expanding biofuel industry has recently raised important concerns. In particular, the sustainability of many first generation biofuels – which are produced primarily from food crops such as grains, sugar cane and vegetable oils – has been increasingly questioned over concerns such as reported displacement of food-crops, effects on the environment and climate change."

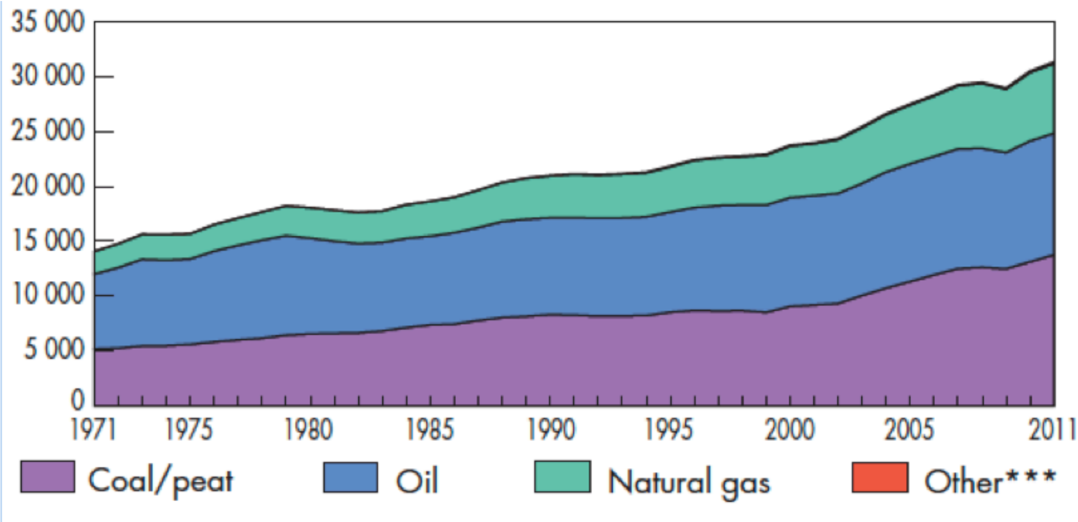


Figure 2: "World CO_2 emissions from 1971 to 2011 by fuel [Mt of CO_2]" (source: IEA statistics (2013))

"In general, there is growing consensus that if significant emission reductions in the transport sector are to be achieved, biofuel technologies must become more efficient in terms of net lifecycle greenhouse gas (GHG) emission reductions while at the same time be socially and environmentally sustainable. It is increasingly understood that most first generation biofuels, with the exception of sugar cane ethanol, will likely have a limited role in the future transport fuel mix.

The increasing criticism of the sustainability of many first generation biofuels has raised attention to the potential of so-called second generation biofuels. Depending on the feedstock choice and the cultivation technique, second generation biofuel production has the potential to provide benefits such as consuming waste residues and making use of abandoned land. In this way, the new fuels could offer considerable potential to promote rural development and improve economic conditions in emerging and developing regions. However, while second generation biofuel crops and production technologies are more efficient, their production could become unsustainable if they compete with food crops for available land. Thus, their sustainability will depend on whether producers comply with criteria like minimum lifecycle GHG reductions, including land use change, and social standards" [IEA report (2010), p.7].

"Currently the transportation sector produces about 25% of global energy-related CO_2 emissions and accounts for roughly 50% of global oil consumption [IEA (2008b)]. Biofuels are seen as one of the most feasible options for reducing carbon emissions in the transport sector, along with improvements in fuel efficiency and electrification of the light vehicle fleet. For heavy-duty vehicles, marine vessels and airplanes in particular, biofuels will play an increasing role to reduce CO_2 emissions since electric vehicles and fuel cells are not feasible for these transport modes.

Over the last decade, global biofuel production increased rapidly; in 2008, about 68 billion litres of bioethanol and 15 billion litres of biodiesel were produced globally (see Figure 1) – almost all of which was first generation biofuel (mainly in the form of ethanol from sugar cane and corn) [IEA (2009b)]. The United States are currently the largest biofuel producer, followed by Brazil and the European Union. While corn-based ethanol is dominating domestic production in the United States, Brazil produces ethanol mainly from sugar cane. In the European Union, biodiesel accounts for the major share of total biofuel production and is mainly derived from oil crops (canola and sunflower) as feedstock.

While the production of first generation biofuels is in an advanced state regarding both, processing and infrastructure, second generation technologies are mainly in a pilot or demonstration stage and are not yet operating commercially. The main obstacle for second-generation biofuels is high initial investment costs as well as higher costs for the end product compared to fossil fuels or many first generation biofuels" [IEA report (2010)].

2.2 Biomass as multiple feedstock

"Biomass derived from trees, agro-forest residues, grasses, plants, aquatic plants and crops are versatile and important renewable feedstock for chemical industry as shown in Figure 3. Through photosynthesis process, plants convert carbon dioxide and water in to primary and secondary metabolite biochemicals. Both of these are industrially important chemicals. Primary metabolites are carbohydrate (simple sugar, cellulose, hemicellulose, starch, etc.) and lignin called lignocellulose present in high volume in biomass. The lignocellulosic biomass can be converted into biofuels” [Naik, et al. (2010)].

“Biomass has received considerable attention as a sustainable feedstock that can replace diminishing fossil fuels for the production of energy, especially for the transportation sector. The overall strategy in the production of hydrocarbon fuels from biomass is to reduce the substantial oxygen content of the parent feedstock to improve energy density and to create C–C bonds between biomass-derived intermediates to increase the molecular weight of the final hydrocarbon product” [Alonso, et al. (2010)].

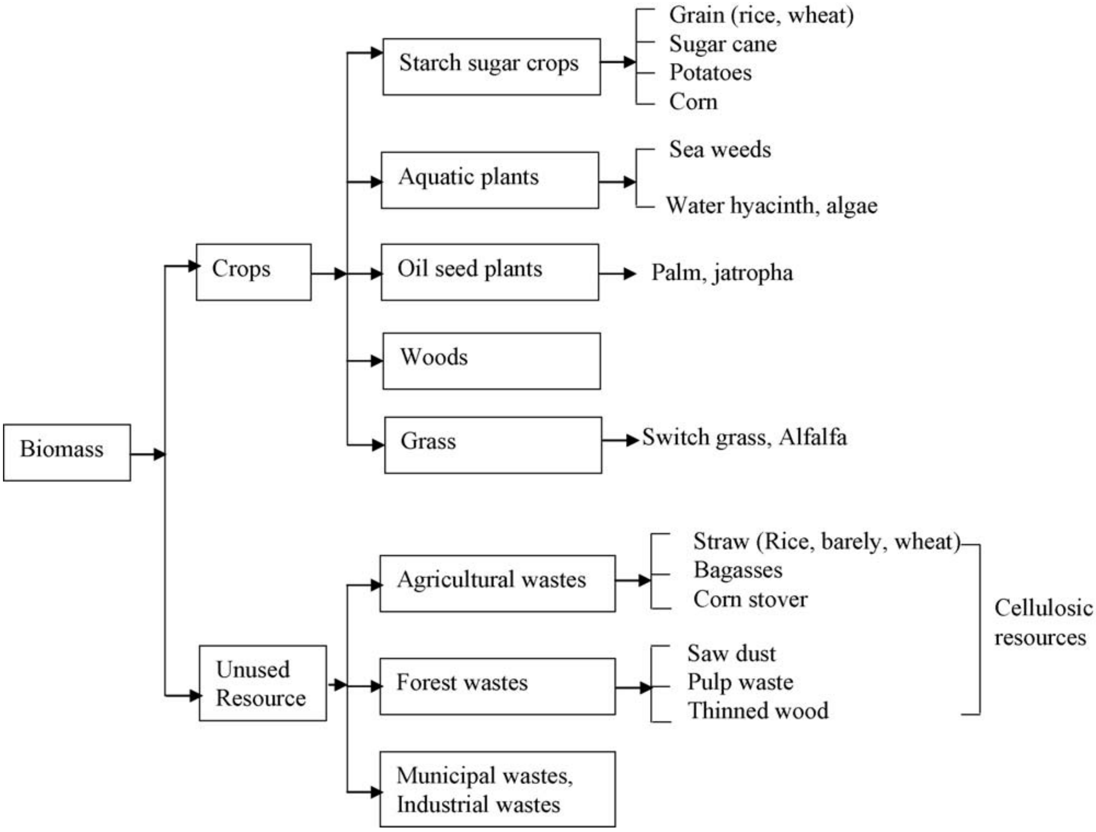


Figure 3: Biomass as renewable feedstock for biorefineries (source: Naik, et al. (2010), p.581)

The world biomass production is many times higher than the global use of the total biomass production. The total world energy use is only one-tenth of the available world biomass (see Figure 4). The endless source of biomass like feedstock for the production of second generation biofuels and implementation of natural circles for the energy production is shown in Figure 5. It describes the potential of plant bounded solar energy for energy use.

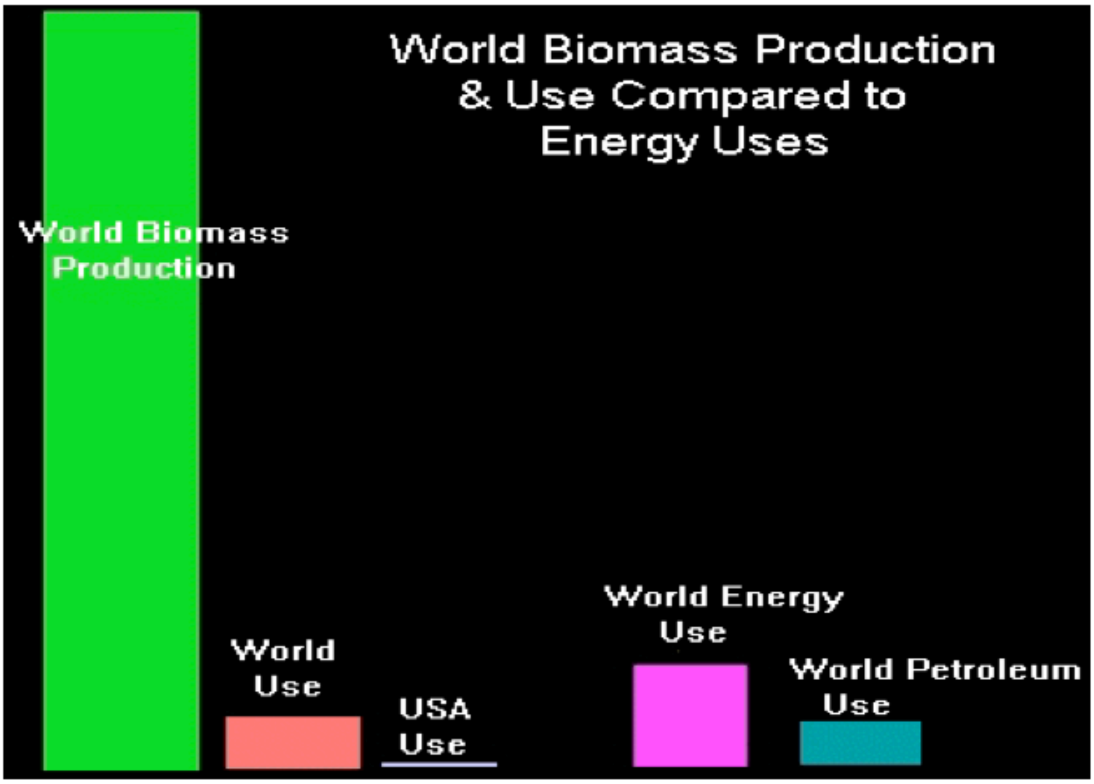


Figure 4: World Biomass Production and Use Compared to Energy Uses (source: U.S. National Renewable Energy Laboratory, 1997)

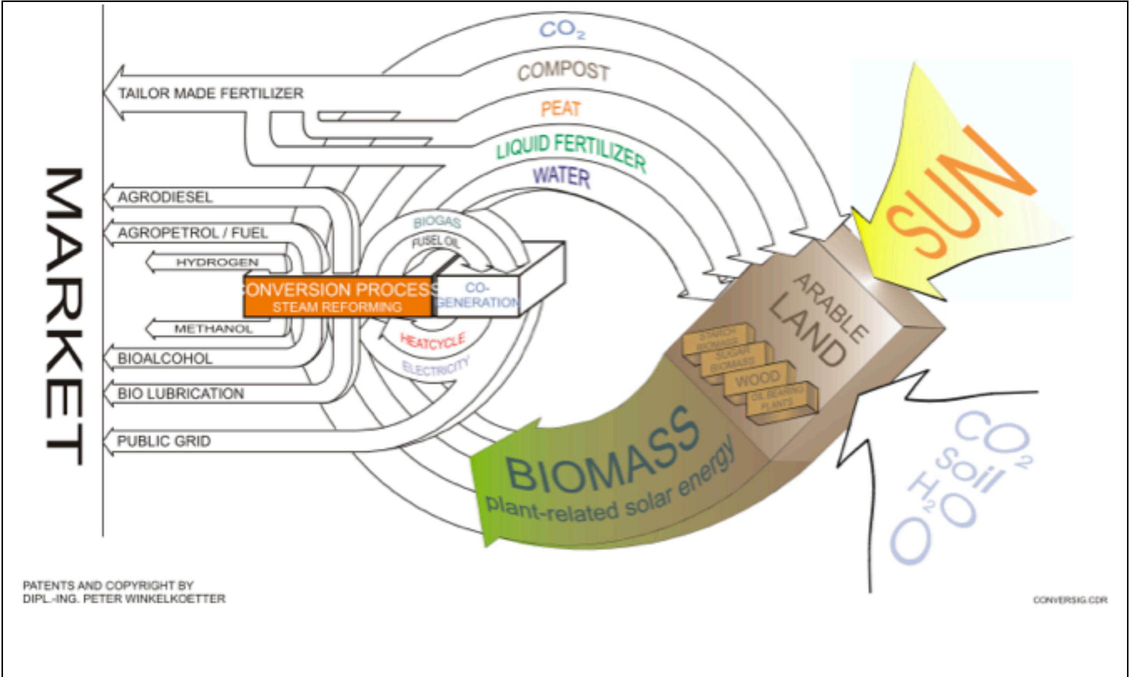


Figure 5: Conversion of solar energy in plants (source: Winkelkötter (2009))

2.3 Overview on first generation of biofuels

First generation biofuels (from seeds, grains and sugars) are:

Petroleum-gasoline substitutes

– Ethanol or butanol by fermentation of starches (corn, wheat, potato) or sugars (sugar beets, sugar cane)

Petroleum diesel substitutes

– Biodiesel by transesterification of plant oils, also called fatty acid methyl ester (FAME) and fatty acid ethyl ester (FAEE)

– From rapeseed (RME), soybeans (SME), sunflowers, coconut, palm, jatropha, recycled cooking oil and animal fats

– Pure plant oils (straight vegetable oil) [UN report (2008)]

First generation biofuels are biofuels, which are on the market in considerable amounts today. “Typical first generation biofuels are sugarcane ethanol, starch-based or ‘corn’ ethanol, biodiesel and Pure Plant Oil (PPO). The feedstock for producing first generation biofuels either consists of sugar, starch and oil bearing crops or animal fats that in most cases can also be used as food and feed or consists of food residues" [IEA report (2010)].

Bioethanol is the most abundantly produced biofuel. "With a production scale of 13.5 billion gallons in 2006, it accounts for more than 94% of total biofuel production [Balat, et al. (2008)], and ethanol production continues to increase, with 17.2 billion gallons produced in 2008" [ENERS (2009)]. "This fast growth is possible because blends of ethanol and gasoline can be used in modern gasoline engines without requiring any modifications [Balat (2005)]. The production of bioethanol, outlined in Figure 6, begins with biomass pre-treatment to produce sugar monomers, such as glucose, that can be converted to ethanol by fermentation using a variety of microorganisms (e.g., yeast, bacteria and mold). The ethanol product is then purified by distillation, where upon it is appropriate for direct use as a fuel or additive. Food crops, such as sugarcane in Brazil and corn in the USA, are the preferred feedstock for bioethanol production, because they are rich in sugars and starches that are easily hydrolysed (as compared to cellulosic feedstock)" [Alonso, et al. (2010)].

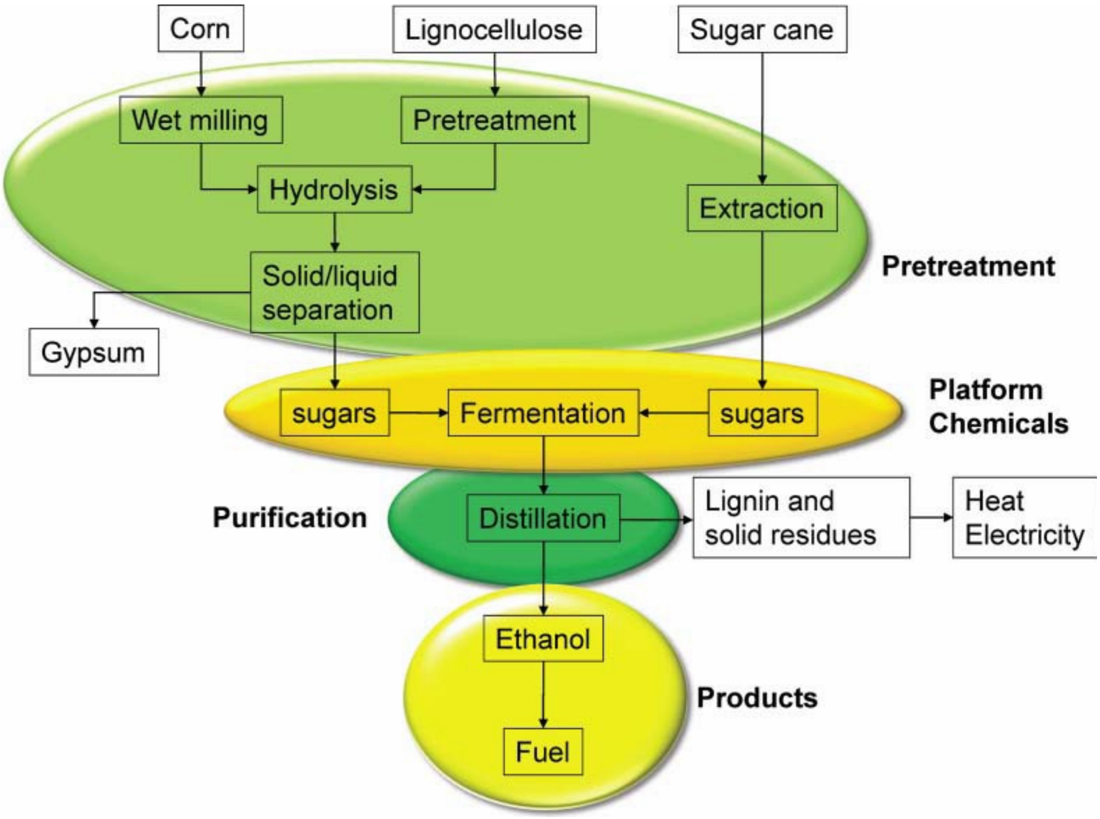


Figure 6: Process schematic: bioethanol production (source: Alonso et al. (2010))

Biodiesel is a renewable diesel fuel that is also known as FAME (fatty acid methyl ester) in the European Community. “Biodiesel has the advantage that it works just as well as normal diesel fuel, but the combustion process expels lower concentrations of toxic emissions. It is made from animal fats, vegetable oils or recycled restaurant greases.

Biodiesel is the second most abundant renewable liquid fuel, with an annual production of 4.3 billion gallons in 2008 [ENERS (2009)]. Biodiesel can be used in current injection engines in a wide range of blends with petrol-diesel or as a pure fuel (without petrol-diesel), and its preparation is outlined schematically in Figure 7. First generation biodiesel [Fukuda, et al. (2001), Ma & Hanna (1999)] is produced by esterification of fatty acids or transesterification of oils (triglycerides) with alcohols (normally methanol and ethanol) using a basic or acidic catalyst. The fatty esters are separated from glycerol by decantation and purified for direct use as fuels. Another alternative to process oil into biofuels is hydro-treating, which can be carried out synergistically in the existing petroleum refinery infrastructure through mixing and co-processing of vegetable oils with petroleum derived feedstock. The main drawback of oil-based processes is the availability of inexpensive feedstock. Normally palm, sunflower, canola, rapeseed and soybean oils are used, but they are expensive and can otherwise be used as food sources” [Alonso et al. (2010)].

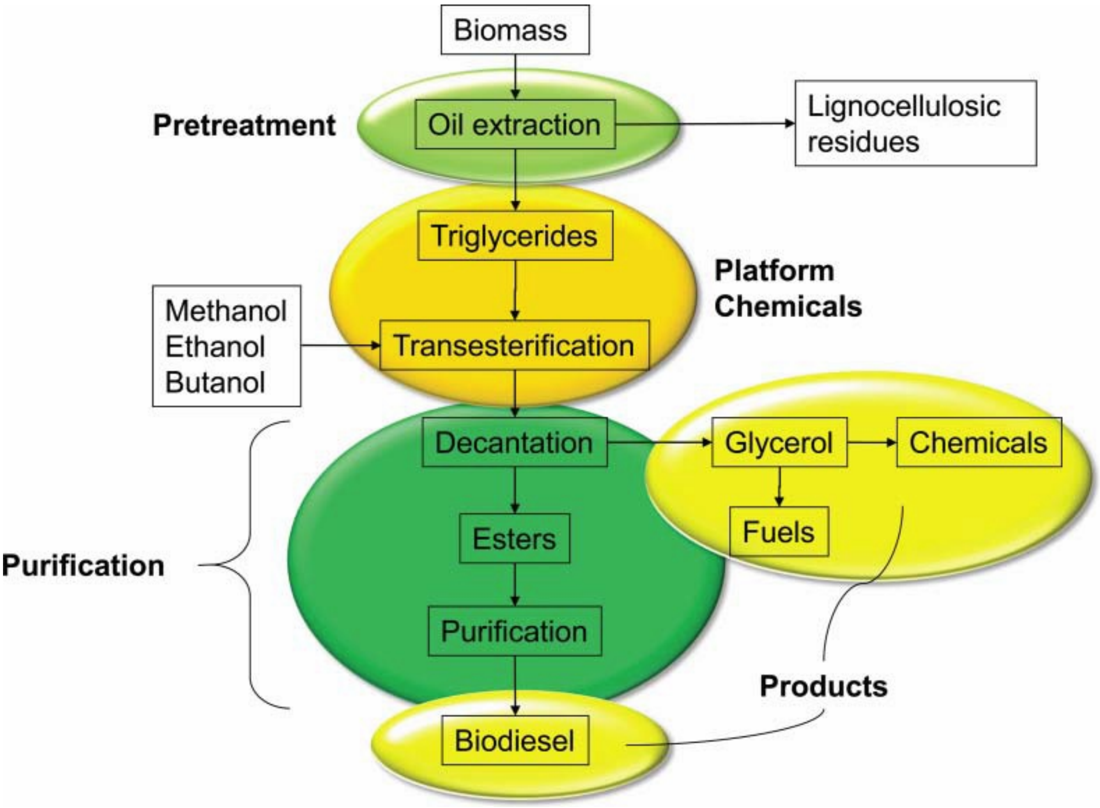


Figure 7: Process schematic: biodiesel production (source: Alonso et al. (2010))

2.4 Second generation biofuels: potential and perspectives

Second generation biofuels (from lignocellulosic biomass, such as crop residues, woody crops or energy grasses) are:

Biochemically produced petroleum-gasoline substitutes

– Ethanol or butanol by enzymatic hydrolysis

Thermo-chemically produced petroleum gasoline substitutes

– Methanol

– Fischer-Tropsch gasoline

– Mixed alcohols

Thermo-chemically produced petroleum-diesel substitutes

– Fischer-Tropsch diesel

– Dimethyl ether (also a propane substitute)

– Green diesel [UN report 2008]

The World Energy Outlook 2009 (IEA (2009a)) 450 Scenario projects biofuels to provide 9% (11.7 EJ) of the total transport fuel demand (126 EJ) in 2030. In the Blue Map Scenario of Energy Technology Perspectives 2008 (IEA (2008b)) that extends analysis until 2050, biofuels provide 26% (29 EJ) of total transportation fuel (112 EJ) in 2050, with second-generation biofuels accounting for roughly 90% of all biofuel. "More than half of the second-generation biofuel production in the Blue Map Scenario is projected to occur in non-OECD countries, with China and India counting for 19% of the total production" [IEA report (2010), p. 8].

The annual "World Energy Outlook" report presents a scenario of rising energy demand by one-third in the period to 2035. Energy-related carbon-dioxide emissions are projected to rise by 20% to 2035, leaving the world on track for a long-term average temperature increase of 3.6°C, far above the internationally agreed 2°C climate target [IEA report (2013)].

In the transport sector, a shift towards low-carbon fuels is required as improving the efficiency of road vehicles alone will not lead to the steep reductions required after 2020. While natural gas and biofuels are promising alternatives to fossil oil, their potential to reduce emissions relative to fossil oil is limited, either due to their carbon content (natural gas) or questions with regard to their sustainability and conflicts with other uses for the feedstock (biofuels) [IEA report (2013a)].

The entire study is focused at a new technology for the production of CO_2 neutral liquid fuels in an industrial way without subsidies from the government.

"Second generation biofuels are those biofuels produced from cellulose, hemicellulose or lignin. Second generation biofuel can either be blended with petroleum-based fuels combusted in existing internal combustion engines, and distributed through existing infrastructure or is dedicated for the use in slightly adapted vehicles with internal combustion engines (e.g. vehicles for DME). Examples of second generation biofuels are cellulosic ethanol and Fischer-Tropsch fuels" [IAE report (2010), p. 22].

"In the production of biofuels it seems to be a drawback of using only the easily processed sugar and triglyceride fractions of a plant because these fractions are only a small part of the biomass. Accordingly, the net energy yield that can be achieved using only these fractions is poor, and only specific crops can be used. To improve energy yield of fuels from biomass, lignocellulosic feedstock must be utilized despite their complexity. Additionally, it is preferable to utilize nonedible biomass as a feedstock for the production of fuels and chemicals, such that the production of transportation fuels does not interfere with either the food supply or disrupt land use unduly [Bartle & Abadi (2010)]. Accordingly, the following section will be devoted to an overview of various processing options currently available for lignocellulosic feedstock" [Alonso et al. (2010)].

2.4.1 Overview on second generation of biofuels

"Second generation biofuels, also known as advanced biofuels, are fuels that can be manufactured from various types of biomass. Biomass is a wide-ranging term meaning any source of organic carbon that is renewed rapidly as part of the carbon cycle. Biomass is derived from plant materials but can also include animal materials.

First generation biofuels are made from the sugars and vegetable oils found in arable crops, which can be easily extracted using conventional technology. In comparison, second generation biofuels are made from lignocellulosic biomass or woody crops, agricultural residues or waste, which makes it harder to extract the required fuel.

Second generation biofuel technologies have been developed because first generation biofuels manufacture has important limitations" [Evans (2008)]. "First generation biofuel processes are useful but limited in most cases: there is a threshold above which they cannot produce enough biofuel without threatening food supplies and biodiversity. Many first generation biofuels are dependent of subsidies and are not cost competitive with existing fossil fuels such as oil, and some of them produce only limited greenhouse gas emissions savings. When taking into account emissions from production and transport, life cycle assessment from first generation biofuels frequently approach those of traditional fossil fuels" [DEPD (2010)]. "Second generation biofuels can help solve these problems and can supply a larger proportion of our fuel supply sustainably, affordably, and with greater environmental benefits.

First generation bioethanol is produced by fermenting plant-derived sugars to ethanol, using a similar process to that used in beer and wine-making (see Ethanol fermentation). This requires the use of 'food' crops, such as sugar cane, corn, wheat, and sugar beet. These crops are required for food, so, if too much biofuel is made from them, food prices could rise and shortages might be experienced in some countries. Corn, wheat, and sugar beet also require high agricultural inputs in the form of fertilizers, which limit the greenhouse gas reductions that can be achieved. Biodiesel produced by transesterification from rapeseed oil, palm oil, or other plant oils is also considered a first generation biofuel.

The goal of second generation biofuel processes is to extend the amount of biofuel that can be produced sustainably by using biomass consisting of the residual non-food parts of current crops, such as stems, leaves and husks that are left behind once the food crop has been extracted, as well as other crops that are not used for food purposes (non food crops), such as switch grass, grass, jatropha, whole crop maize, miscanthus and cereals that bear little grain, and also industry waste such as woodchips, skins and pulp from fruit pressing, etc." [Inderwildi & King (2009)].

"The problem that second generation biofuel processes are addressing is to extract useful feedstock from this woody or fibrous biomass, where the useful sugars are locked in by lignin, hemicellulose and cellulose. All plants contain lignin, hemicellulose and cellulose. These are complex carbohydrates (molecules based on sugar). Lignocellulosic ethanol is made by freeing the sugar molecules from cellulose using enzymes, steam heating, or other pre-treatments. These sugars can then be fermented to produce ethanol in the same way as first generation bioethanol production. The by-product of this process is lignin. Lignin can be burned as a carbon neutral fuel to produce heat and power for the processing plant and possibly for surrounding homes and businesses."

2.4.2 Second generation technology

The following subsections describe the main second generation routes currently under development (see Wikipedia (2013)):

2.4.2.1 Thermochemical routes

According to Wikipedia (2013) the following thermochemical routes can be distinguished:

"Carbon-based materials can be heated at high temperatures in the absence (pyrolysis) or presence of oxygen, air and/or steam (gasification). These thermochemical processes both yield a combustible gas and a solid char. The gas can be fermented or chemically synthesized into a range of fuels, including ethanol, synthetic diesel or jet fuel" [NNFCC (2011)].

- **Gasification**

Gasification technologies are well established for conventional feedstock such as coal and crude oil. “Second generation gasification technologies include gasification of forest and agricultural residues, waste wood, energy crops and black liquor [NNFCC (2009)]. Output is normally syngas for further synthesis to e.g. Fischer-Tropsch products, biomethanol, BioDME or biomethane (synthetic natural gas). Syngas can also be used in heat production and for generation of mechanical and electrical power via gas motors or gas turbines.”

- **Pyrolysis**

“Pyrolysis is a well established technique for decomposition of organic material at elevated temperatures in the absence of oxygen. In second generation biofuels applications forest and agricultural residues, wood waste and energy crops can be used as feedstock to produce e.g. bio-oil for fuel oil applications.”

- **Torrefaction**

Torrefaction is a form of pyrolysis at temperatures typically ranging between 200-320°C. Feedstock and output are the same as for pyrolysis.

2.4.2.2 Biochemical routes

According to Wikipedia (2013) the following biochemical routes can be distinguished:

“Chemical and biological processes that are currently used in other applications are being adapted for second generation biofuels. Biochemical processes typically employ pre-treatment to accelerate the hydrolysis process, which separates out the lignin, hemicellulose and cellulose. Once these ingredients are separated, the cellulose fractions can be fermented into alcohols” [NNFCC (2011a)].

“Feedstock is energy crops, agricultural and forest residues, food industry and municipal biowaste and other biomass containing sugars. Products include alcohols (such as ethanol and butanol) and other hydrocarbons for transportation use.”

2.4.3 Types of biofuel

Based on the information given by Wikipedia (2013) “the following second generation biofuels are under development, although it must be noted that most or all of these biofuels are synthesized from intermediary products such as syngas using methods that are identical in processes involving conventional feedstock, first generation and second generation biofuels. The distinguishing feature is the technology involved in producing the intermediary product, rather than the ultimate off-take.

A process producing liquid fuels from gas (normally syngas) is called a Gas-to-Liquid (GtL) process [Inderwildi & King (2009)]. When biomass is the source of the gas production the process is also referred to as Biomass-to-Liquids (BtL)."

2.4.3.1 From syngas using catalysis

According to Wikipedia (2013) the following liquid fuels can be processed from syngas using catalysis:

- "Biomethanol can be used in methanol motors or blended with petrol up to 10-20% without any infrastructure changes.
- BioDME can be produced from biomethanol using catalytic dehydration or it can be produced directly from syngas using direct DME synthesis. DME can be used in the compression ignition engine.
- Biohydrogen can be used in fuel cells to produce electricity.
- Mixed alcohols (i.e., mixture of mostly ethanol, propanol, and butanol, with some pentanol, hexanol, heptanol, and octanol). Mixed alcohols are produced from syngas with catalysts similar to those used for methanol [see Lu, et al (2012)]. Most R&D in this area is concentrated in producing mostly ethanol. However, some fuels are marketed as mixed alcohols (see Ecalene and E4 Envirolene). Mixed alcohols are superior to pure methanol or ethanol, in that the higher alcohols have higher energy content. Also, when blending, the higher alcohols increase compatibility of gasoline and ethanol, which increases water tolerance and decreases evaporative emissions. In addition, higher alcohols have also lower heat of vaporization than ethanol, which is important for cold starts. (For another method for producing mixed alcohols from biomass see bioconversion of biomass to mixed alcohol fuels)."
- Biomethane (or BioSNG) via the Sabatier reaction

2.4.3.2 From syngas using Fischer-Tropsch

According to Wikipedia (2013) the following liquid fuels can be processed from syngas using Fischer-Tropsch process:

“The Fischer-Tropsch (FT) process is a Gas-to-Liquid (GtL) process [Inderwildi & King (2009)]. When biomass is the source of the gas production the process is also referred to as Biomass-to-Liquids (BtL) [Kavalov & Peteves (2005), Inderwildi, et al. (2008)]. A disadvantage of this process is the high energy investment for the FT synthesis and consequently, the process is not yet economic.

FT diesel can be mixed with fossil diesel at any percentage without need for infrastructure change and moreover, synthetic kerosene can be produced” [Inderwildi & King (2009)].

2.4.3.3 Biocatalysis

According to Wikipedia (2013) the following liquid fuels can be processed by biocatalysis:

- “Biohydrogen might be accomplished with some organisms that produce hydrogen directly under certain conditions. Biohydrogen can be used in fuel cells to produce electricity.
- Butanol and isobutanol via recombinant pathways expressed in hosts such as E. coli and yeast, butanol and isobutanol may be significant products of fermentation using glucose as a carbon and energy source [Evans (2008), DEPD (2010)].
- DMF (2,5-Dimethylfuran). Recent advances in producing DMF from fructose and glucose using catalytic Biomass-to-Liquid process have increased its attractiveness.”

2.4.3.4 Other processes

According to Wikipedia (2013) the following liquid fuels can be processed by other processes:

- “HTU (Hydro Thermal Upgrading) diesel is produced from wet biomass. It can be mixed with fossil diesel in any percentage without need for infrastructure.

- Wood diesel. A new biofuel was developed by the University of Georgia from woodchips. The oil is extracted and then added to unmodified diesel engines. Either new plants are used or planted to replace the old plants. The charcoal by-product is put back into the soil as a fertilizer. According to the director Tom Adams since carbon is put back into the soil, this biofuel can actually be carbon negative not just carbon neutral. Carbon negative decreases carbon dioxide in the air reversing the greenhouse effect not just reducing it."

2.4.4 Feedstock for second generation biofuels

"Based on the information given by Wikipedia (2013) second generation biofuel feedstock include cereal and sugar crops, specifically grown energy crops, agricultural and municipal wastes, cultivated and waste oils, and algae" [NNFFC (2010)].

2.4.4.1 Energy crops / green waste

"Plants are made from lignin, hemicellulose and cellulose; second generation technology uses one, two or all of these components. Common lignocellulosic energy crops include wheat straw, miscanthus, short rotation coppice poplar and willow. However, each offers different opportunities and no one crop can be considered 'best' or 'worst' " [NNFFC (2011b)].

"The potential feedstock for second generation biofuels production considered in this study are biomass from crops residues, other non-food energy crops, wood/forestry residues, and jatropha and algae.

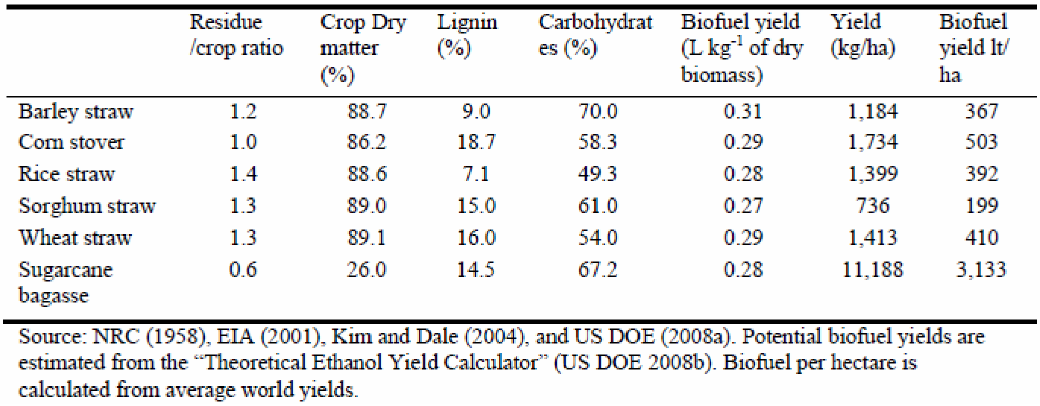
Following the information given by Carriquiry, et al. (2010) the major components of lignocellulosic feedstock are cellulose and hemicellulose (over 67% of dry mass), which can be converted to sugars through a series of thermochemical and biological processes and eventually fermented to bioethanol. In general, lignocellulosic feedstock is divided into three categories:

1. agricultural residues (e.g., crop residues, sugarcane bagasse),
2. forest residues, and
3. herbaceous and woody energy crops.

Current availability and potential energy contribution of each feedstock are discussed next.

Agricultural residues differ in their chemical composition, which leads to different biofuel yields per unit of feedstock. Table 2-2 shows the composition of select agricultural residue feedstock, fraction of crop residues produced, and potential ethanol yield.

Table 2-2: Composition and yields of different feedstock (data source: Carriquiry, et al. (2010))



	Residue /crop ratio	Crop Dry matter (%)	Lignin (%)	Carbohydrates (%)	Biofuel yield (L kg^{-1} of dry biomass)	Yield (kg/ha)	Biofuel yield lt/ ha
Barley straw	1.2	88.7	9.0	70.0	0.31	1,184	367
Corn stover	1.0	86.2	18.7	58.3	0.29	1,734	503
Rice straw	1.4	88.6	7.1	49.3	0.28	1,399	392
Sorghum straw	1.3	89.0	15.0	61.0	0.27	736	199
Wheat straw	1.3	89.1	16.0	54.0	0.29	1,413	410
Sugarcane bagasse	0.6	26.0	14.5	67.2	0.28	11,188	3,133

Source: NRC (1958), EIA (2001), Kim and Dale (2004), and US DOE (2008a). Potential biofuel yields are estimated from the "Theoretical Ethanol Yield Calculator" (US DOE 2008b). Biofuel per hectare is calculated from average world yields.

Green waste such as forest residues or garden or park waste may be used to produce biofuel via different routes. Examples include Biogas captured from biodegradable green waste, and gasification or hydrolysis to syngas for further processing to biofuels via catalytic processes" [Wikipedia (2013)].

2.4.4.2 Municipal solid waste

"Municipal solid waste comprises a very large range of materials, and total waste arisings are increasing. In the UK, recycling initiatives decrease the proportion of waste going straight for disposal, and the level of recycling is increasing each year. However, there remain significant opportunities to convert this waste to fuel via gasification or pyrolysis" [NNFFC (2009b)].

The following text is taken from Hoornweg, et al. (2013):

"Solid waste — the stuff we send down our chutes, discard at work and put on the curb every week — is a striking by-product of civilization. The average person in the United States throws away their body weight in rubbish every month. When waste management works well, we give it little thought: out of sight and, usually, quickly out of mind. Discarded materials are collected, some are recycled or composted, and most are landfilled or incinerated. But the global view is troubling.

In the past century, as the world's population has grown and become more urban and affluent, waste production has risen tenfold. By 2025 it will double again. Rubbish is being generated faster than other environmental pollutants, including greenhouse gases. Plastic clogs the world's oceans and rivers, causing flooding in developing-world cities. Solid-waste management is one of the greatest costs to municipal budgets.

The waste problem is acute in emerging cities. Landfills such as Laogang in Shanghai, China; Sudokwon in Seoul; the now-full Jardim Gramacho in Rio de Janeiro, Brazil; and Bordo Poniente in Mexico City vie for the title of the world's largest. Each typically receives more than 10,000 tonnes of waste per day. Rapidly developing cities such as Shenzhen in China are adding to the world's 2,000-plus inventory of waste incinerators. With the largest able to process more than 5,000 tonnes per day, concerns over ash disposal, air pollution and costs are rising too.

As city dwellers become richer, the amount of waste they produce reaches a limit. Wealthy societies tend to curb their waste. So as living standards around the world rise and urban populations stabilize, global solid-waste generation will peak.

Just when is difficult to predict. But by extending current socio-economic trends to 2100, we project that 'peak waste' will not occur this century. Unless we reduce population growth and material consumption rates, the planet will have to bear an increasing waste burden.

Solid waste is mostly an urban phenomenon. In rural communities there are fewer packaged products, less food waste and less manufacturing. A city resident generates twice as much waste as their rural counterpart of the same affluence. If we account for the fact that urban citizens are usually richer, they generate four times as much.

As urbanization increases, global solid-waste generation is accelerating. In 1900, the world had 220 million urban residents (13% of the population). They produced fewer than 300,000 tonnes of rubbish (such as broken household items, ash, food waste and packaging) per day. By 2000, the 2.9 billion people living in cities (49% of the world's population) were creating more than 3 million tonnes of solid waste per day. By 2025 it will be twice that — enough to fill a line of rubbish trucks 5,000 kilometres long every day.

Together, the member countries of the Organisation for Economic Co-operation and Development (OECD) are the largest waste generators, producing around 1.75

million tonnes per day. This volume is expected to increase until 2050, owing to urban population growth, and then to slowly decline, as advances in material science and technology make products smaller, lighter and more resource efficient.

Some countries generate more waste than others. Japan issues about one-third less rubbish per person than the United States, despite having roughly the same gross domestic product (GDP) per capita. This is because of higher-density living, higher prices for a larger share of imports and cultural norms. Waste quantities worldwide can also vary seasonally, by up to 30%, as horticultural and food wastes fluctuate. For example, household waste volumes double in the week after Christmas in Canada.

Waste reduction and dematerialization efforts in OECD countries are countered by trends in East Asia, particularly in China. China's solid-waste generation is expected to increase from 520,550 tonnes per day in 2005 to 1.4 million tonnes per day in 2025. East Asia is now the world's fastest growing region for waste, a distinction that is likely to shift to south Asia (mainly India) in 2025, and then to sub-Saharan Africa around 2050.

As a country becomes richer, the composition of its waste changes. With more money comes more packaging, imports, electronic waste and broken toys and appliances. The wealth of a country can readily be measured, for example, by how many mobile phones it discards. Solid waste can thus be used as a proxy for the environmental impact of urbanization. Most of a material's impact is through production and use. Less than 5% stems from waste management, which includes emissions from collection trucks, landfills and incinerators.

The rate at which solid-waste generation will rise depends on expected urban population and living standards growth and human responses. In 2012 the World Bank report “What a Waste” estimated, that global solid-waste generation would rise from more than 3.5 million tonnes per day in 2010 to more than 6 million tonnes per day in 2025. These values are relatively robust, because urban populations and per capita GDP can be well forecast for several decades.

Extending those projections to 2100 for a range of published population and GDP scenarios shows that global 'peak waste' will not happen this century if current trends continue (see 'When will waste peak?'). Although OECD countries will peak by 2050 and Asia–Pacific countries by 2075, waste will continue to rise in the fast-growing cities of sub-Saharan Africa. The urbanization trajectory of Africa will be the main determinant of the date and intensity of global peak waste.

Using 'business-as-usual' projections, we predict that, by 2100, solid-waste generation rates will exceed 11 million tonnes per day — more than three times today's rate. With lower populations, denser, more resource-efficient cities and less consumption (along with higher affluence), the peak could come forward to 2075 and reduce in intensity by more than 25%. This would save around 2.6 million tonnes per day.

How can today's situation be improved? Much can be done locally to reduce waste. Some countries and cities are leading the way. San Francisco in California has a goal of 'zero waste' (100% waste diversion by reduction and recycling) by 2020; already more than 55% of its waste is recycled or reused. The Japanese city of Kawasaki has improved its industrial processes to divert 565,000 tonnes of potential waste per year — more than all the municipal waste the city now handles. The exchange and reuse of materials connects steel, cement, chemical and paper firms into an industrial ecosystem.

North America and Europe have tried disposal fees, and found that as fees increase, waste generation decreases. Another tactic is to steer people to buy less with their increased wealth, and to spend more on experiential activities that require fewer resources.

But greater attention to consumption and improvement in waste management is needed in rapidly urbanizing regions in developing countries, especially in Africa. Through increased education, equality and targeted economic development, as in the sustainability scenario we evaluated (SSP1), the global population could stabilize below 8 billion by 2075, and urban populations shortly thereafter. Such a path reflects a move towards a society with greater urban density and less overall material consumption. Also needed is a widespread application of 'industrial ecology' — designing industrial and urban systems to conserve materials. This begins with studies of the urban metabolism — material and energy flows in cities.

Reducing food and horticultural waste is important — these waste components are expected to remain large. Construction and demolition also contribute a large fraction by mass to the waste stream; therefore, building strategies that maximize the use of existing materials in new construction would yield significant results.

The planet is already straining from the impacts of today's waste, and we are on a path to more than triple quantities. Through a move towards stable or declining populations, denser and better-managed cities consuming fewer resources, and greater equity and use of technology, we can bring peak waste forward and down. The environmental, economic and social benefits would be enormous."

2.4.4.3 Black liquor

"Black liquor, the spent cooking liquor from the kraft process that contains concentrated lignin and hemicellulose, may be gasified with very high conversion efficiency and greenhouse gas reduction potential [WTW (2007)] to produce syngas for further synthesis to e.g. biomethanol or BioDME."

2.4.5 Greenhouse gas emissions

"Producing second generation biofuels offers greater greenhouse gas emissions savings than those obtained by first generation biofuels" [Wikipedia (2013)].

"Lignocellulosic biofuels can reduce greenhouse gas emissions by around 90% when compared with fossil petroleum, in contrast first generation biofuels offer savings of 20-70%."

"The energy sector is by far the largest source of greenhouse-gas emissions, accounting for more than two-thirds of the total in 2010 (around 90% of energy-related greenhouse-gas emissions are CO_2 and around 9% are methane [CH_4], which is generally treated, in this analysis, in terms of its CO_2 equivalent effect). The energy sector is the second-largest source of CH_4 emissions after agriculture and we have estimated total energy-related CH_4 emissions to be 3.1 Gigatonnes (Gt) of carbon-dioxide equivalent (CO_2-eq) in 2010 (around 40% of total CH_4 emissions). Accordingly, energy has a crucial role to play in tackling climate change. Yet global energy consumption continues to increase, led by fossil fuels, which account for over 80% of global energy consumed, a share that has been increasing gradually since the mid-1990s" [IEA report (2013a)].

New technologies have to be developed and implemented in the energy market, which extract CO_2 from the atmosphere by using biomass as principle feedstock.

2.4.6 Commercial development

"Based on information given by [Wikipedia (2013)] an operating lignocellulosic ethanol production plant is located in Canada, run by Iogen Corporation. The demonstration-scale plant produces around 700,000 litres of bioethanol each year. A commercial plant is under construction. Many further lignocellulosic ethanol plants have been proposed in North America and around the world.

The Swedish specialty cellulose mill Domsjö Fabriker in Örnsköldsvik, Sweden develops a biorefinery using Chemrec's black liquor gasification technology. When commissioned in 2015 the biorefinery will produce 140,000 tons of biomethanol or 100,000 tons of BioDME per year, replacing 2% of Sweden's imports of diesel fuel for transportation purposes.

In the UK, companies like INEOS Bio and British Airways are developing advanced biofuel refineries, which are due to be built by 2013 and 2014 respectively. Under favourable economic conditions and strong improvements in policy support, NNFCC projections suggest advanced biofuels could meet up to 4.3 per cent of the UK's transport fuel by 2020 and save 3.2 million tonnes of CO_2 each year, equivalent to taking nearly a million cars off the road.

Second generation biofuels are not yet produced commercially, but a considerable number of pilot and demonstration plants have been announced or set up in recent years, with research activities taking place mainly in North America, Europe and a few emerging countries (e.g. Brazil, China, India and Thailand). Current IEA projections see a rapid increase in biofuel demand, in particular for second generation biofuels, in an energy sector that aims on stabilising atmospheric CO_2 concentration at 450 parts per million (ppm)."

3 Methodology

This study is based on research and experience of engineers developing technologies for the production of first and second generation biofuels. The long-term contact with investors and suppliers of feedstock materials for the processes gave an impression on the acceptance of the CCC-Technology in the market.

3.1 Investigation of the CCC-Technology via literature research

The direct contact with WEA engineers over thirteen years was an important pool of information about the CCC-Technology and the implementation of the process - shown in this study in different own documents.

In order to get an overview on different technologies in production of first and second generation of biofuels and the technology internet research, scientific papers and journals have been used for background information.

3.2 Description of the first industrial scale CCC-application

A pilot CCC-power-plant, running over three years near Munich/Germany was the first big (almost industrial) scaled plant to get an impression of the technical feasibility of the CCC-Technology and the product as well.

The technical realization of an industrial scaled CCC-power-plant is based on the results of the pilot. The main components, the process parameters and the input materials for the implementation of an industrial scaled CCC-power-plant are defined.

Therefore two groups of investors are interested to enter in one CCC-project each – first in Switzerland, second in Herne/Germany. Working on the necessary permits for the application of the plant it could be realistic to enter the production process of a marketable product in Q II 2014.

3.3 Methodology of financial analysis

In this study the financial feasibility is created in a cash flow analysis. Up to now a CCC-power-plant was not implemented. This means for the financial feasibility that lots of input will be based on estimations and outlook into the future. The cash flows are presented in three scenarios over a project period of 20 years:

- The basecase will show the investors economical situation for running the CCC-power-plant in Herne.

- The bestcase scenario is created under the condition that input materials are subsidized by the supplier of shredded light fractions from the car recycling industry.

- The third case – worstcase scenario – handles with a higher input price for shredded materials of the yellow sack then in the basecase scenario. This could be a situation in the next future if a number of CCC-power-plants will be installed and running in the long-term production of second generation biofuels.

4 The Cold Catalytic Conversion Technology

In the next sub-chapters an overview of the current status of the Cold Catalytic Conversion Technology will be given.

4.1 Historical development of the technology

4.1.1 History

The basis of CCC-Technology, anaerobic carbon enrichment, goes back to the time of 400,000,000 years ago. The nature process, the reaction of biomass in tight oil caverns, which are outlined with Aluminiumsilicat, is understood with higher temperature in the CCC-process. Anaerobic carbon enrichment dates back to the former technology of making charcoal. But even more recent process such as dry distillation and pyrolysis gasification were also used as long ago as the 19th century, enabling, among other things, city gas and fuel to be produced for a long time from coal.

These reductive fuel preparation and refining processes have already been used over the past 200 years: carbonisation of lignite coal, wood or turf; production of char tar and char oil to produce liquid hydrocarbons; and using mid- and high-temperature carbonisation with this gas production method for various industrial processes.

But only nowadays, the potential of these depolymerisation technologies is slowly being acknowledged and the new CCC-Technology can also implement them at industrial level. When adequate process technologies are applied optimum process flows and significantly improved environmental protection are combined with considerably higher efficiency in electricity production.

4.1.2 Variants of systems for de-polymerization and regulatory prospects

In Table 4-1 an overview on the realized variants of systems based on de-polymerization is given. They represent the known exemplary systems put into operation for test purposes within the last 10 to 15 years. The input materials in all variants have been selected as they do not generate any costs for feedstock. They include neither gate fees nor subsidies for input materials. It represents a cost-neutral financial aspect regarding the production costs per litre. High production costs mainly depend on high energy, the provision of high process temperatures and pressures during process execution; high maintenance costs or costs for to deposit polluted residues out of the process.

In the special case of CCC-Technology the production costs per unit product oil are a result of the cold catalytic process carried out in a rotating milling-drum. The process runs with low temperature, without pressure and almost without polluted residues that has to be deposited. In comparison to the other two catalytic technologies (KDV and Clyvia) the CCC-Technology has the advantage of lower maintenance costs due to the effective realisation of the process engineering.

Table 4-1: List of exemplary systems and utilized input materials for depolymerisation of biomass and secondary raw materials (data source: Winkelkötter (2010))

Basic of this list is an amount of 300.000 Mt/a input Material

Manufacturer	**System**	**Input material Mt/a**	**Output material**	**Process Temp.**	**Pressure bar**	**Mechanical realisation**	**Comments *)**	**Status of development**	**Process efficiency**
FZK Lurgi	BTL Bio to liquid	Biomass	50.000	1200	80	degassing, gas to liquid	expencive approx. 3,00 €/l	demo pilot	17%
Shell Research	HTU	Biomass	appr. 60.000	350	180	degassing, gas to liquid	appr. 3,50 €/l	pilot	20%
HAW Willner	catalytic	Biomass used oil sewer sludge	100.000	370	1	converter stiring	high consumption of atalyst 2,50 €/l	pilot	40%
Uni Tuebingen Prof. Stadlbauer	NTK catalyst	Biomass syn. Organic sewer sludge	80.000	400	1	converter stiring	high maintainance cost 3,00 €/l complicat process	pilot	30%
Ozmoenergy Envosmart	Ozmoenergy	syn. Organic	180.000	390 - 420	?	converter stiring	complicate process 3,50 €/l	demo pilot	35%
Alphacat	KDV catalytic	Biomass syn. Organic waste oil	170.000	270 - 350	1	centrifugal pumping	high abrassiv method high maintainance 1,20 €/l	small units 500 kg/h	58%
Clyvia	Clyvia Cl 500	waste oil	180.000	380 - 420	0,3	converter	similar to classical Refinery 1,00 €/l	pilot	62%
WEA	CCC technology	Biomass syn. Organic waste oil oil sludge rubber	230.000	350	0,5	roller mill closed cycle	evacuated milling process with catalyst 0,30 €/l	industrial scale production line	78%

Vegetable and fruit oil production plants are working with classical system of old fashioned oil mills: Berlin big amount of electricity, high press-cake production (not longer than 6 days storable). Only the plant seeds are used and a very low input/output efficiancy (net approx 20 %). For using as motorfuel it must be added with 20 % of fossil methanol.

Test results are taken from techn. University
***) excl. gate fee / subsidies for feedstock**

“The Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives and of the Council of 5 April 2006 establishes a legal framework for the treatment of waste within the European Community” [Directive 2008/98/EC (2008)]. It aims the waste hierarchy, waste management as well as regulations of permits and registrations. In case of increasing waste in the European Union the European Parliament had taken regard to prevention and the reduction of waste.

Key terms used in the act are [Directive 2008/98/EC (2008)]:

- “Waste: any substance or object, which the holder discards or intends or is required to discard.
- Waste management: the collection, transport, recovery and disposal of waste, including the supervision of such operations and the after-care of disposal sites, and including actions taken as a dealer or broker.
- Prevention: measures taken before a substance, material or product has become waste.
- Recovery: any operation the principal result of which is waste serving a useful purpose.
- Recycling: any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes.”

In the CCC-process the solution of recovery and recycling will be realized in an economical and ecological way according to the directive (see Table 4-2). “This Directive should also clarify when the incineration of municipal solid waste is energy-efficient and may be considered a recovery operation” [Directive 2008/98/EC (2008)].

Table 4-2: Comparison of the CCC-Plant and the European Standard Incineration Plant (data source: Winkelkötter (2010))

Comparsion of the CCC-power-plant - - - - - - - and the - - - - - - European Standard Incineration Plant

Input material and amount: municipal waste	350.000,00 Mt / a
Ordinary analysis for central european cities:	
watercontent	55,00 %
secondary organic raw material (SORM)	33,00 %
minerals	7,00 %
metall	5,00 %
Energy content of SORM	5,00 MW / Mt

CCC-power-plant processing results				**Incineration plant processing results**			
Investment costs	170.000.000,00 €			Investment costs	380.000.000,00 €		
Gate fee = public costs	0,00 € / Mt			Gate fee = public costs	200,00 € / Mt		
self sufficient	100,00 %			loss for vaporising and slag production	80,00 %		
own consumption (out of SORM)	10,00 %			fossile energy use	20,00 %		
	unit €	amount per year	total price €		unit €	amount per year	total price €
CO2 production:		11.580 Mt		CO2 production:		115.500 Mt	
Electricity:	60,00 / MWh	17.000,00 MWh	1.020.000,00	Electricity:	60,00 / MWh	60.000 MWh	3.600.000,00
Crude oil:	500,00 / Mt	45.000,00 Mt	22.500.000,00	Income out of gatefee:	200,00 / Mt	350.000 Mt	70.000.000,00
Fertilizer:	400,00 / Mt	16.000 Mt	6.400.000,00				
Local transfer heat:	30,00 / MWh	17.000,00 MWh	510.000,00	Local transfer heat:	30,00 / MWh	40.000 MWh	1.200.000,00
Metalls:		24.500,00 Mt		Yearly power input costs: (20 % fossile energy)	60,00 / MWh	70.000 MWh	-4.200.000,00
Minerals:		17.500,00 Mt					
				High poluted hazardous slag:	800,00 / Mt	47.250 Mt	-37.800.000,00
				Poluted water tratment:	10,00 / Mt	209.000 Mt	-2.090.000,00
Yearly maintenance costs: 2%			-4.000.000,00	Yearly maintenance costs: 3,5			-13.300.000,00
Residues landfill costs:			0,00	Residues landfill costs:			-7.125.000,00
Catalysator costs:	2.900,00 / Mt	140,00 Mt	-406.000,00	(Filter dust etc.)			
Amount of employees:		50 Pers.	-2.500.000,00	Amount of employees:		100 Pers.	-5.000.000,00
Note: AGRODIESEL Crude oil with 5 % higher cetanpower and out of 60 % renewable energy origin (Co2 neutral)				Note: Per ton incinerated waste is created: harzardous air 6000 m3, polluted water 700 Ltr., hightoxic poison after exhaust gas cleaning 600 kg			
Total income per year			**23.524.000,00**	**Total income per year**			**5.285.000,00**
Carbon credit + green points not calculated excl. Gate fee							

The comparison of the CCC-Technology and the European standard incineration plant (see Table 4-2) shows the efficiency of the CCC-Technology in municipal waste management. According to the directive mentioned above the CCC-process allows a treatment of municipal waste that is more diverse with respect to the marketable products than the simple incineration of waste. In the CCC-case besides heat and electricity the outcomes are several types of energy carrier like crude oil and fertilizer.

The water content of the feedstock (350,000 Mt/a) is about 55%, which has to be squeezed out for the CCC-process. That means an amount of 180,000 Mt press water with a content of 8% of organic material, which could be converted in a biogas power plant for production of electricity and heat for the preparation (drying) of the feedstock. 8% OTS out of the biogas power-plant are 16,000 Mt organic materials which could be sold like fertilizer for energy crops. In the incineration process the water content of the feedstock is not reduced by pre-treatment. So, the thermal conversion required a relatively high share of energy for vaporisation which makes the incineration less efficient.

The content of minerals (7%) and metals (5%) will be separated in the preparation phase of the feedstock for the CCC-process or in the rotating milling-drum at the end of the conversion process. These materials could be implemented in different existing recycling lines. Residues out of the incineration process have to be deposited and are not available for further utilisation.

33% SORM out of the feedstock means 115,500 Mt/a input for the conversion into gasoil. Mixed municipal waste has at least an efficiency in the CCC-process approximately 45% with a potential of 50,000 Mt of gasoil. 10% are needed for the process-energy additional to the energy out of the biogas produced by using the press water. The marketable potential of crude oil coming out of the CCC-conversion-process is round about 45,000 Mt with a market price of at least 500 €/Mt in accordance to the market price of crude oil class Brent (581 €/Mt 11/2013). In case of incineration the production of gasoil is not an issue and therefore not considered.

4.2 Present state of the technology: the CCC-process

4.2.1 Base process

The base process was researched and developed in 1994- 2004. While the patent application was fairly extensive, it has meanwhile been diversified and developed further. The new steps are specified as narrowly limited processes and secured in special process PCT of their own.

4.2.2 Description of the process: crude oil or gasoil out of organic secondary raw material by catalytic depolymerisation heated in a rotating mixing–milling–system

The invention contains a procedure and a device for the catalytic depolymerisation of hydrocarbons and a separation of mineral substances of waste at temperatures from 280°C to 390°C with mixture of aluminium silicate as catalyst in zeolite-crystalline form, doted with the elements of Natrium, Calcium, Magnesium and marginal other minerals with an energy input mainly in form of a combination into the rotating-milling mixing.

Known is the catalytic depolymerisation with a special catalyst from sodium-doted aluminium silicate from the international patent application No.WO 2007/056982 A2. With this catalyst the residual with hydrocarbons is split to gasoil and gasoline. The energy source for this process of depolymerisation and evaporation is heating with gas or gasoil combustion or heating with electrical energy disconnected by a wall.

Disadvantage of this procedure is the temperatures drop through the wall into the reaction batch to reach the reaction temperature. This over heating, caused by the temperature drop produces coke in crystalline form. The quantity of coke increases, if the temperature rise of the wall rises in relation to the reaction. The higher the temperature drops the higher the coke production.

This reaction coke reacts now with the catalyst to a non-reactive product, which litter the plant and which stops the reaction. This reaction mixture of the catalyst and the reaction coke connects itself with the wall of the plant to hard residue and requires a high cleaning expenditure. The invention describes now a process without this disadvantage by avoiding the production of crystalline coke and therefore the product between the catalyst and the coke. This reduces dramatically the consumption of catalyst.

The economical procedure is also not possible with an intensive heating of the wall and the transportation of heat through the wall into the reaction. The heat is needed together with a mixing of the reaction partners waste and catalyst. Therefore an economical way of this catalytic process can only be the combination of the mixing and the heat transfer in one process. This contents an energy input of 0.2 kWh/kg produced diesel for depolymerisation, evaporation and final heating from 250°C to the reaction temperature of 330°C – 380°C. With the entry of plastics the energy is higher for the melting of the material.

Now a process of the heat entry and in addition adapted catalyst system were found, which these disadvantage to avoid perfectly. The system transported not the heat by the wall, but develops the heat directly in the reaction system by conversion of mechanical energy to thermal energy.

The energy input takes place thereby in a system from an O_2-evacuated screw-feeder and moving of the rotating-cylinder-mill in opposite directions, in a tight system with separation of gasoil steam over a lock into an upper part of the plant. The milling system serves thereby also the complete cleaning of the surfaces for heat exchanging in the cycle.

Also the catalyst is again developed. Only for the plastics, bitumen and waste oils thereby the doping of a full-through-crystallized y-molecule with sodium was determined as optimal. For the biological materials, as fats and biological oils, the doping with calcium became as optimally discovered. For the conversion with wood the doping with magnesium is necessary, in order to produce high-quality diesel. For the material with a higher content of halogens, like oil for electrical transformation and PVC, the additional input with potassium is necessary.

The product of the plant is crude oil or gasoil. This product is needed to 10% for the production of the process energies in the form of heat and electric power. The exhaust gas of the “Turbine-Gen-Set” is used to heat the processing rotating-cylinder-mill and for preheating and drying of the input (see Figure 8: [3]). The “Turbine-Gen-Set” also is used for the combustion of the 1% hexangas, produced in the process.

Figure 8 shows the rotating-cylinder-mill [1]. This shows 4 sections, the central-cylinder is the reactor. In this part works the screw-feeder in opposite direction to the mill, controlled with a control valve. The second section is the lock-separator section at the right side. The upper pump works against the venture nozzle in the condenser, controlled by a second control valve. The third section is the sword-washer with the separation of the residue and recycling the long-chained hydrocarbon steam to the plant again. The fourth section is the condensing or distillation of the oil-steam.

With the screw-feeder [2] is designated, which the material input on the sucking mill-cylinder [1] and the connection to the cycle catalyst-batch [4]. On the opposite side the central-outlet-pipe [5] into the lock [6].

At the reactor outlet [5] and [6] is the product vapour line [7] for processed oil steam to the distilling plant [9] with the condenser [8]. The condenser [8] is a tube water radiator; the water in the cooling circuit is re-cooled.

In the front part of the condenser [8] possibly developing water separates, which is separated over a conductivity sensor with regulated drain valve, so that the product is free of water. The product gasoil is derived in the top of the column. The quality of the gasoil is regulated over the reflux tube over the return flow quantity.

The reflux tube has a connection to the gasoil storage. This storage-heat is used for the preliminary drying and preliminary heating of the internal consumed 10% of the produced gasoil. All containers are provided for the purpose of the phase of the heating up with an electrical external heating-system.

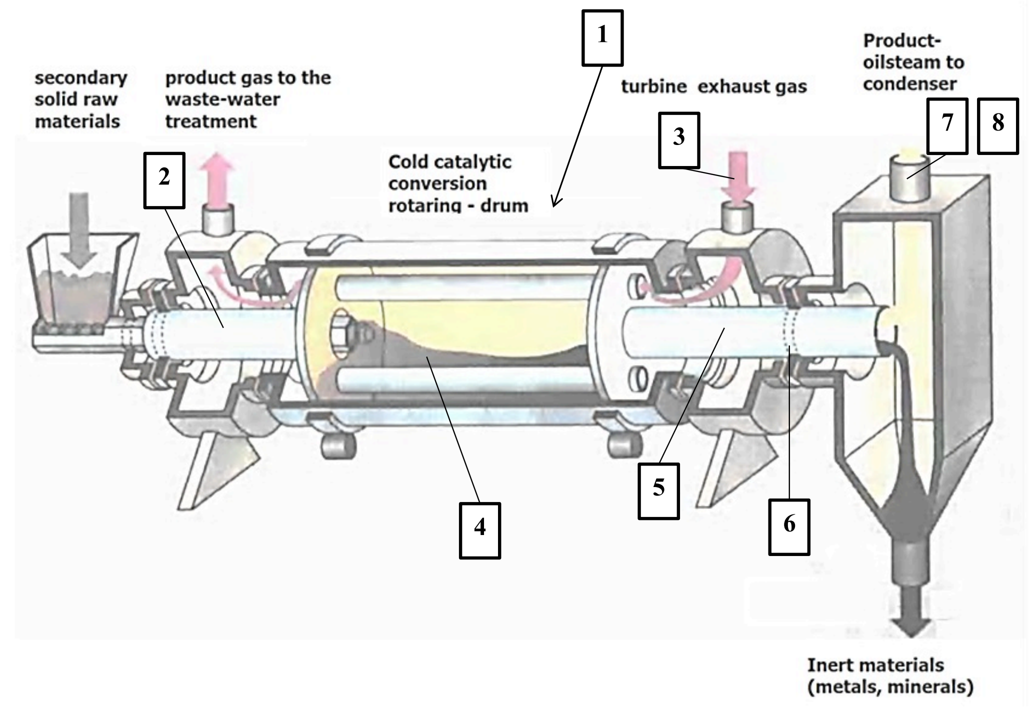


Figure 8: The rotating-cylinder-mill of the Cold Catalytic Conversion system (source: own document)

Cold Catalytic Conversion is a multi-stage cold catalytic depolymerisation process and a “soft” method comparing to incineration. Conversion temperature is well below 400°C. The CCC-process uses no incineration but converts organic waste to very high-grade carbon-steam. This progressive cold-catalytic conversion with integrated oil distillation and residue cleanings carried out in an entirely closed system, minimizing the emissions against zero. Conventional incineration systems convert only a small part of the waste input into electricity and release the majority as hazardous slag and heat, which cannot be easily transported or stored.

CCC-systems have a guaranteed energy efficiency ranging from 45 to 90% depending on the composition of the feedstock. This is possible because the CCC-process is designed as a circulating energy process, which the entire process heat is consumed by treatment of the conversion process.

The closed system and the low conversion temperature of a CCC-plant guarantees nearly zero emissions. Unlike incineration plants, CCC-plants do not overheat inorganic materials present in the feedstock. Instead these materials pass through the system without creating pollutants and can be easily recycled.

5 Implementation of the first industrial scaled CCC-power-plant

In the next chapter an overview of the current status of the implementation of the first industrial scaled CCC-power-plant will be given.

5.1 The CCC-power-plant pilot

In 2009/2010 the CCC-power-plant pilot was installed with a capacity of 500 kg/h shredded fractions of yellow sack as well as shredded light fractions from the car recycling industry. The rotation-mill in Figure 9 (5 m length, 1.5 m diameter) was heated by electrical power with a stabile temperature of 320°C. For a detailed description of the pilot plant realized in the year 2009/2010 please refer to Annex 1: Documentation of pilot project: The patent.

The product oil was tested by SGS (see chapter 6.2 Analysis of the Product). It will be sold to refineries for blending with fossil crude oil and will be distillated for market supply.

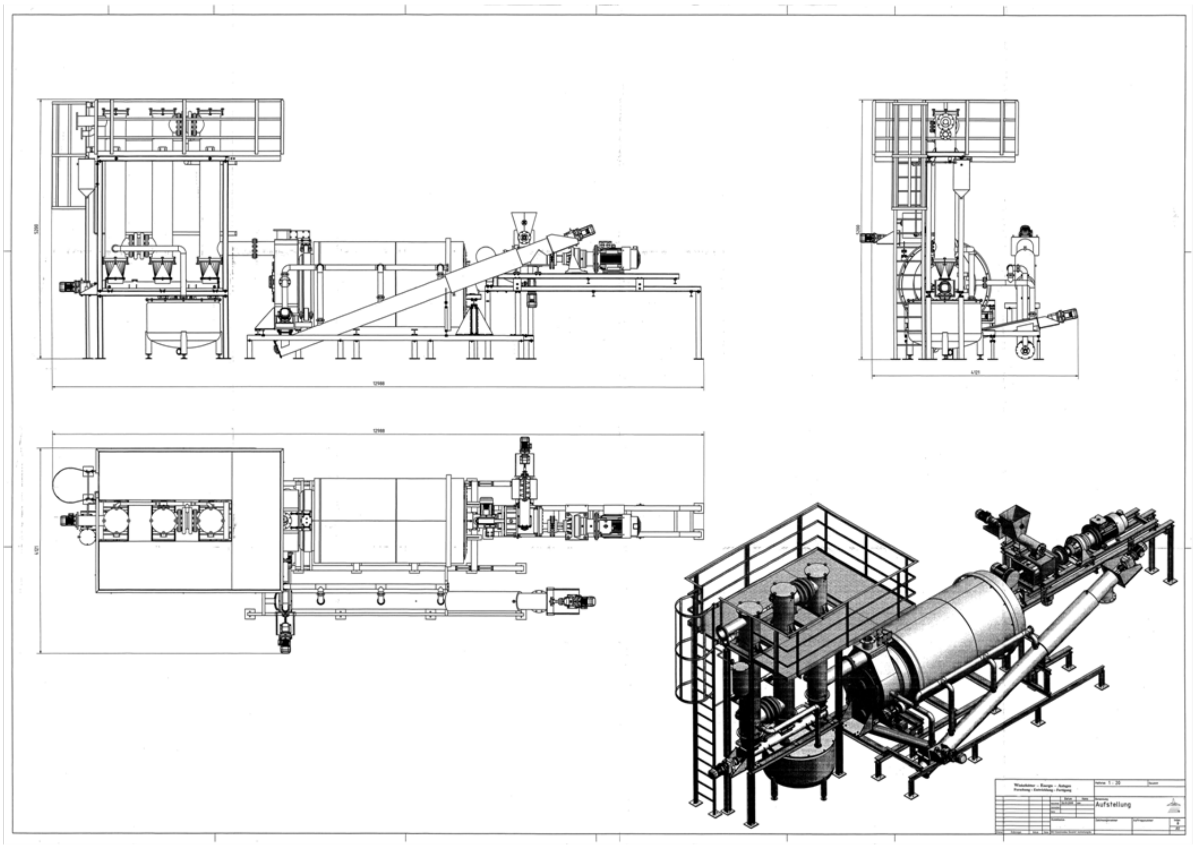


Figure 9: Several views on the main component of the CCC- power-plant pilot (source: Winkelkötter (2009))

5.2 The patent

The specification of the patent describes the conversion process of secondary organic raw materials into oil steam or gasoil and the realization of the process (see Annex 1: Documentation of pilot project: The patent). It gives an overview of the process itself as well as the technical equipment and components for the installation of a CCC-power-plant. The conversion process by catalytic depolymerisation in between 320° – 380°C reacts in an oxygen evacuated rotating-milling-drum. The inner surface of the milling-drum is constructed of high-temperature-, high-acid-, high-abrasion-resistant composed material, i.e. Hastelloy. The process rotating-drum will be heated with the exhaust-gas of a gas turbine, disconnected from the process by a wall.

5.3 The first industrial scaled CCC-power-plant

One of the first industrial scaled installations of a CCC-power-plant will be in Herne/Germany (see Figure 10). The power plant is outlined for a capacity of 120,000 Mt/a of input material. 60,000 Mt of shredded fractions of yellow sack collections is in the moment the present available feedstock for this power plant. The size of the two rotating milling-drums is outlined for double of feedstock material. In the next future shredded rubber of used tires will be tested in the plant for converting into gasoil.

Near by the location in Herne are several recycling companies who are able to support the power plant with additional feedstock material in the future for a higher efficiency of the plant. In this study only the actual situation with the defined input material will be calculated. The advantage of this plant site is the easy access via railway and waterway transport.

Figure 10: Plant site of first industrial scaled CCC-power-plant in Herne/Germany, Hafenstrasse 2 (source: Google Maps (2013))

As shown in Table 5-1 most of the components for the installation of a CCC-power-plant are state of the art.

Table 5-1: List of modules for the 5 Mt/h Cold Catalytic Conversion plant HERNE 2013 (data source: Winkelkötter (2013))

Quantity	**Module**	**Remark**
1	Raw material reception mill/grinder with approx. 70 kW electric engine	
2	Reactor drums 20,000 mm length, 2,200 mm diameter, Heat–exch.-cylinder coated wall inside cylinder with 8 mm DIN 1.4571 pressed steel plate plain wall process temperature 250° – 500°C	See Figure 11

Quantity	Module	Remark
3	Reception silos twin walled with perforated tubes for CO_2 ventilation for air evacuation	
1	De-metallisation station with electric magnetic roller packages	
4	Spiral conveyors 300 mm diameter	
2	Twin screw press with 60 kW electric engine	
1	Milling station with a fast running millwheel	
1	Silencer drum to recover the catalyst powder out of the oil steam	
6	Condenser towers and optional 1 distillation column	
1	Collection pool under the distillation/condenser plant	
	Frameworks for the whole installation CCC-plant	
3	Product oil tanks capacity approx. 1,500 m^3 each	
2	Power stations diesel fuelled-gas turbine-set (approx.: 1.5 MW) and heat recovery unit	
	Containerised control centre	
	Basic foundation works	
1	Fork lifter approx. capacity 2.5 tons	
	Several piping, mounting and electrical works	
4	Weeks test running incl. 4 engineers	

One of the main components of the CCC-power-plant is the rotating milling-drum (see Figure 11). Each drum is mounted on two heavy bearings - which require appropriate dimensioned foundations out of concrete. They also serve as basis for the electric drive motor.

Figure 11: The picture above shows two of the conversion-drums. The drums are about 22 meters long, and 3 meters in diameter (source: own document)

The construction and installation of the conversion-drum with screw feeder on the left and central-outlet-pipe on the right is shown in Figure 12. The total construction of the milling-drum is about 22 meters long and 3 meters in diameter. The drum itself is about 12 meters long, double walled for indirect heating the process with exhaust gas out of the gas turbine. Part of the rotating drum is the screw feeder shown on the left in Figure 12 as well as the central-outlet-pipe on the right.

In the upper part of the outlet-pipe the oil steam flows to the condenser for to become liquid gasoil. On the bottom side of the outlet-pipe the overflow of used catalyst containing metals and minerals are washed out of the milling-drum and separated for recycling; the used catalyst will be purified and reused in the process.

The milling-drum is installed with an incline of 5° from the screw feeder (left side) to the outlet-pipe with the sword-washer on the right hand side. Rotating two times a minute, catalyst, metal and mineral residues move slowly from the feeder to the outlet-pipe.

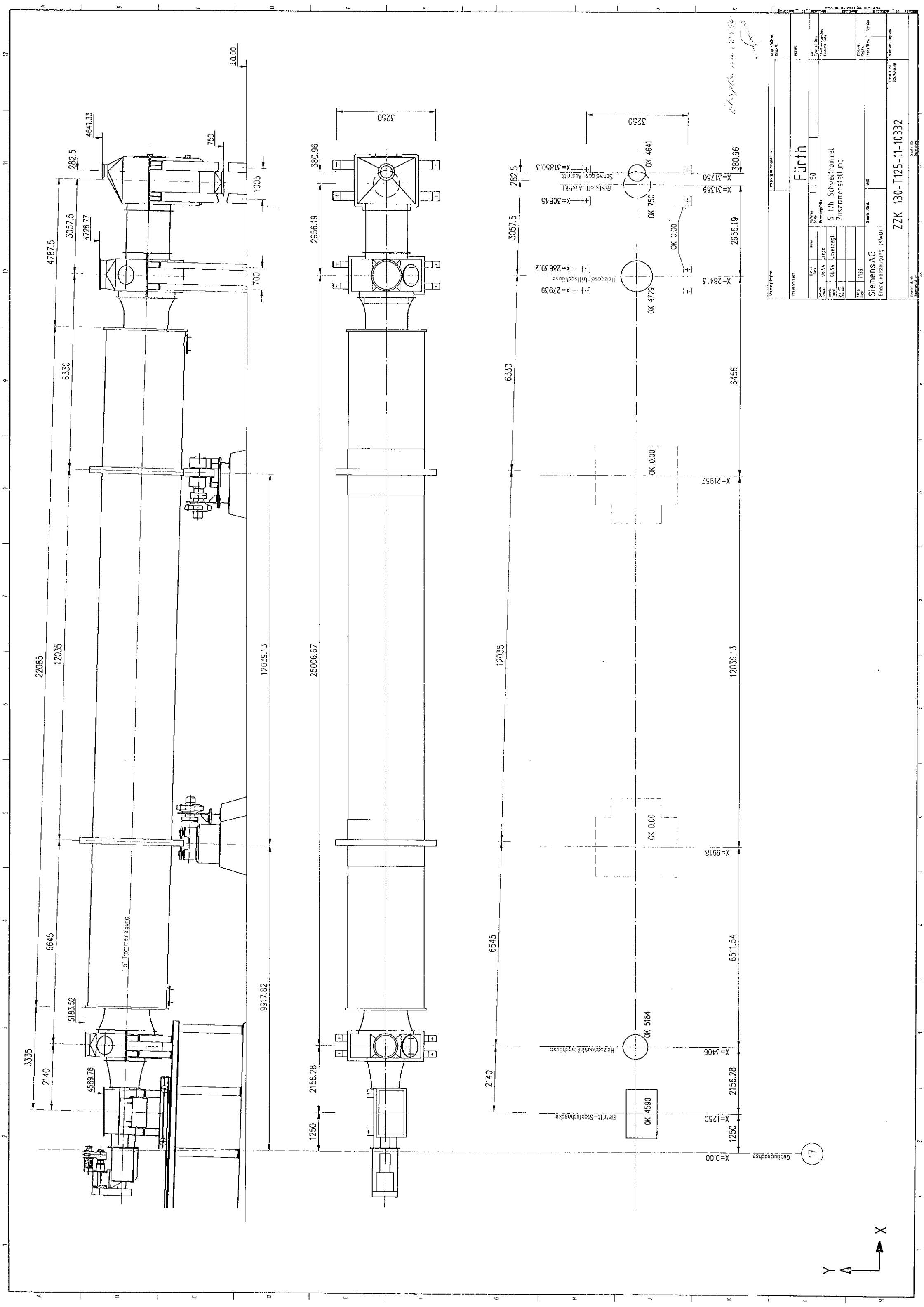


Figure 12: Construction scheme of the conversion-drums implemented in the first industrial scaled CCC-power-plant in Herne/Germany (source: Winkelkötter (2013))

6 Analysis and Assessment

6.1 Analysis of the possible input materials

The CCC-power-plant is able to convert any kind of organic materials into a kind of high classified crude oil. The efficiency of the power content of the organic raw material depends on the content of carbons, hydro carbons and convertible proteins. The complete biomass harvested in plantations or the free nature areas is a raw material, which was grown by solar energy. The content of carbon in this kind of input material is not that high then modern cultural waste. The energy content of bio feedstock is nearly 50% lower than plastic and rubber waste out of the recycling industries. In Table 6-1 an overview on useable input materials for Cold Catalytic Conversion plants, system WEA is given.

Table 6-1: Declaration of useable input materials for Cold Catalytic Conversion plants, system WEA (data source: Winkelkötter (2013))

Usable input materials	[kW/kg]
Standard plastic (PE, PB, PP,PU)	9.0
Rubber (car tires shredded granulate)	8.2
Synthetic textiles	8.4
Hard wood	4.7
Soft wood, straw, grass	4.1
Fluid oil press cake	7.6
Oil sludge with 50 % sand content	4.5

6.2 Analysis of the Product

The Cold Catalytic Conversion process makes a gasoil that can be used like fossil crude oil. The product is a liquid fuel that can be blended in the common refineries with fossil fuels or used 100% pure compared with refinery diesel fuel and can be used in conventional diesel engines.

In Annex 2: Analysis of the product and in Annex 2a: Analysis of the product two analysis reports of SGS Laboratory, Speyer and ASG Analytik-Service, Neusäss are shown. SGS analysed the product produced in the power-plant pilot in 2011 made out of shredded fractions of the yellow sack by conversion with a process temperature of 320°C and condensed at the end of the process. Contents like heavy metals and sulphur will be separated in the refinery process. The gasoil proved by ASG in 2007 was a sample out of a small laboratory scaled plant. The feedstock was shredded plastic material from yellow sack collection. In that analysis the cetane (Cetanzahl) of 55.2 needs attention because it is about 10% higher than the cetane number in the standard diesel (cetane number: 45 -51).

6.3 Financial assessment via cash flow analysis

6.3.1 Financial aspects

The financial feasibility is based on several forecasts of the CCC-Technology as well as the first industrial scaled project. The result of the financial analysis is the indicator for the investor to take over a technology in renewable energy that will be profitable and bankable in the future.

6.3.2 Three scenarios/financial aspects

The cash flow analysis will be described in three different scenarios:

- basecase
- bestcase
- worstcase

The CCC-power-plant will be constructed and set up production of crude oil within 16 months; life time of the plant is calculated on 20 years.

6.3.3 Parameters basecase

The basecase scenario will show the actual situation in establishing a CCC-power-plant. Most of the indicators are forecasts or based on information and data from the investors in Herne/Germany.

6.3.3.1 Total investment costs

The total investment costs are defined on an offer of WEA engineers/Germany who is also the holder of the patent. These total investment costs are including all components for the power plant. The investment of the CCC-power-plant is calculated without subsidies of the government or any other sponsoring.

6.3.3.2 Operating costs

The operating costs are based on assumptions according to information from the investors and WEA engineers.

- Property lease is calculated on the aspects of the investor.
- Property maintenance
- Repairs are continuously services, spare parts, maintenance services over 20 years. The value is based on the information of WEA engineers.
- Personal includes all costs for running the plant 24/7 over 8200 working hours/year. 5 working people, 2 technicians per shift.
- Management fees
- Insurance is based on the information of WEA engineers.
- Annual report
- Input material is calculated on the investor's information. Yellow sack input materials are calculated on 30 €/Mt.

6.3.3.3 Depreciation

The depreciation is calculated based on life time of the power plant linear over 20 years. According to the costs of repairs of the total equipment the technical status of the CCC-power-plant will be on time over lifetime.

6.3.3.4 Inflation

According to ECB the inflation is calculated based on 2%.

6.3.3.5 Equity/debt proportion/interest payment

The proportion in the investment equity/debt financing is calculated in the basecase with 10% equity by the investor, 90% debt loan with 5.75% interest rate fix over 15 years.

6.3.3.6 Revenues

The revenues are calculated based on the price for crude oil Brent/Mt (581 € - 14%).

6.3.4 Parameters bestcase

A high efficient feedstock for the CCC-process are shredded light fractions form the car recycling industry, subsidized with 80 €/Mt. Over the first 4 years in the bestcase scenario the subsidies are calculated like additional payment, decreasing 25% per year.

6.3.5 Parameters worstcase

The worstcase scenario is based on a market price for input materials of 110 €/Mt.

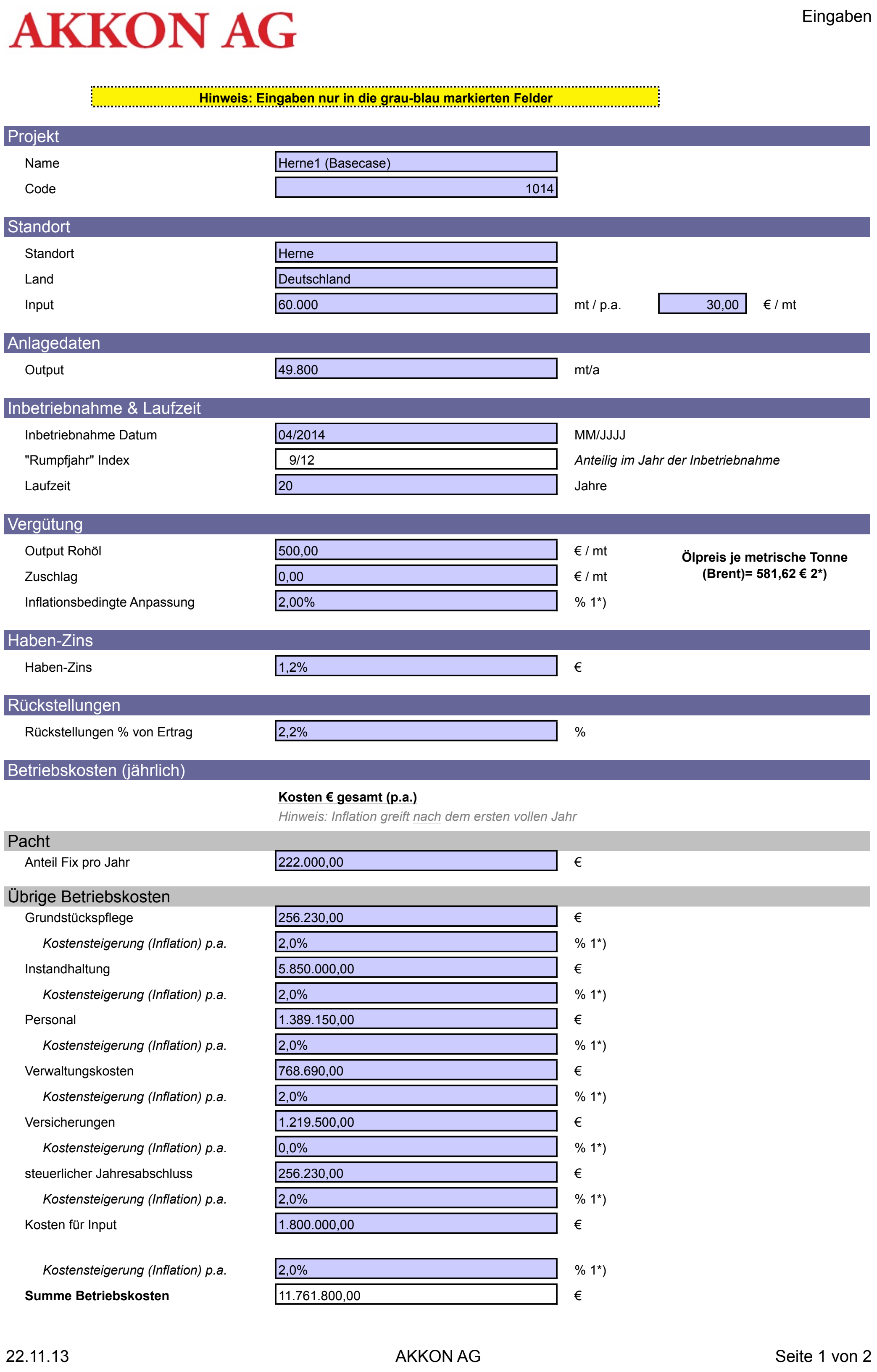
6.3.6 Basecase scenario

The basecase scenario is the most realistic financial guess from today's point of view. Feedstock is calculated on market price, operating costs are calculated on a high level, repairs are calculated over 12% of the total investment costs per year and guarantees a 24 hours/7 days a week (8200 hours/a) production of the plant including spare parts. CCC-power-plants are generally constructed in two lines with one conversion-drum and one gas turbine each, sufficient for a bypass operation during maintenance time of one of the turbines.

The estimated revenues are based on the available input of 60,000 Mt/a. With an efficiency of 83% of the CCC-process a production of 49.800 Mt of crude oil is estimated, 10% of the product is used for own consumption for energy supply, 44,820 Mt are marketable crude oil sold for 500 €/Mt to the refinery.

After payback of the equity in year 1 the cash flow is stable over the life time of the project. Increasing the revenues and costs by 2% over 20 years the cash flow is also increasing over 20 years. In year 15, after payback of the debt financing, the cash flow is rather high over the last 5 years.

Table 6-2: Basecase scenario: Project cost data (data source: AKKON AG (2013))



AKKON AG

Eingaben

Hinweis: Eingaben nur in die grau-blau markierten Felder

Projekt

Name	Herne1 (Basecase)			
Code	1014			

Standort

Standort	Herne			
Land	Deutschland			
Input	60.000	mt / p.a.	30,00	€ / mt

Anlagedaten

Output	49.800	mt/a

Inbetriebnahme & Laufzeit

Inbetriebnahme Datum	04/2014	MM/JJJJ
"Rumpfjahr" Index	9/12	*Anteilig im Jahr der Inbetriebnahme*
Laufzeit	20	Jahre

Vergütung

Output Rohöl	500,00	€ / mt	**Ölpreis je metrische Tonne (Brent)= 581,62 € 2*)**
Zuschlag	0,00	€ / mt	
Inflationsbedingte Anpassung	2,00%	% 1*)	

Haben-Zins

Haben-Zins	1,2%	€

Rückstellungen

Rückstellungen % von Ertrag	2,2%	%

Betriebskosten (jährlich)

Kosten € gesamt (p.a.)
Hinweis: Inflation greift nach dem ersten vollen Jahr

Pacht

Anteil Fix pro Jahr	222.000,00	€

Übrige Betriebskosten

Grundstückspflege	256.230,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Instandhaltung	5.850.000,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Personal	1.389.150,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Verwaltungskosten	768.690,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Versicherungen	1.219.500,00	€
Kostensteigerung (Inflation) p.a.	0,0%	% 1*)
steuerlicher Jahresabschluss	256.230,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Kosten für Input	1.800.000,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Summe Betriebskosten	11.761.800,00	€

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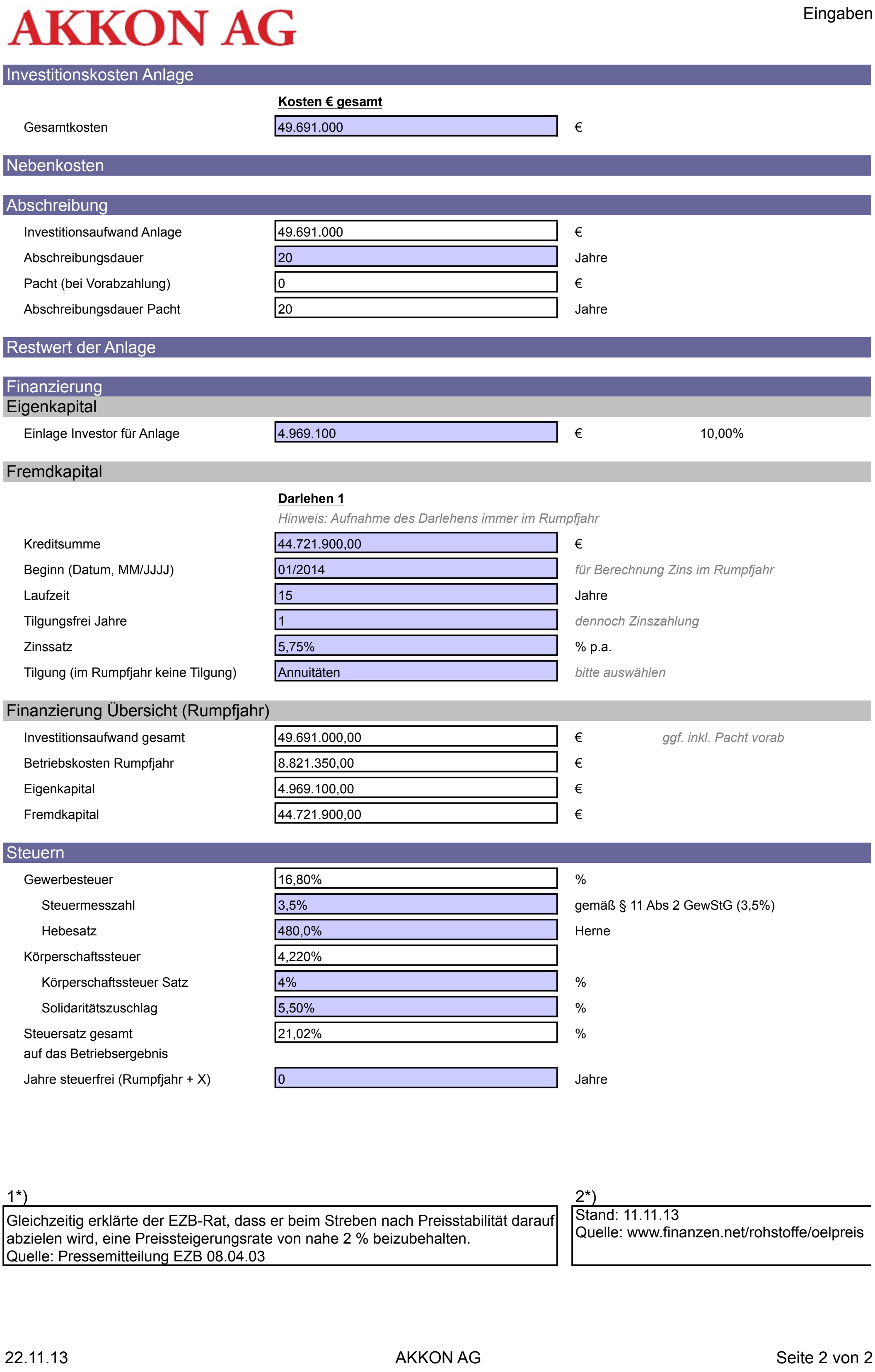
Table 6-3: Basecase scenario: Project input data (data source: AKKON AG (2013))



AKKON AG

Eingaben

Investitionskosten Anlage

	Kosten € gesamt	
Gesamtkosten	49.691.000	€

Nebenkosten

Abschreibung

Investitionsaufwand Anlage	49.691.000	€
Abschreibungsdauer	20	Jahre
Pacht (bei Vorabzahlung)	0	€
Abschreibungsdauer Pacht	20	Jahre

Restwert der Anlage

Finanzierung

Eigenkapital

Einlage Investor für Anlage	4.969.100	€	10,00%

Fremdkapital

Darlehen 1

Hinweis: Aufnahme des Darlehens immer im Rumpfjahr

Kreditsumme	44.721.900,00	€
Beginn (Datum, MM/JJJJ)	01/2014	*für Berechnung Zins im Rumpfjahr*
Laufzeit	15	Jahre
Tilgungsfrei Jahre	1	*dennoch Zinszahlung*
Zinssatz	5,75%	% p.a.
Tilgung (im Rumpfjahr keine Tilgung)	Annuitäten	*bitte auswählen*

Finanzierung Übersicht (Rumpfjahr)

Investitionsaufwand gesamt	49.691.000,00	€	*ggf. inkl. Pacht vorab*
Betriebskosten Rumpfjahr	8.821.350,00	€	
Eigenkapital	4.969.100,00	€	
Fremdkapital	44.721.900,00	€	

Steuern

Gewerbesteuer	16,80%	%
Steuermesszahl	3,5%	gemäß § 11 Abs 2 GewStG (3,5%)
Hebesatz	480,0%	Herne
Körperschaftssteuer	4,220%	
Körperschaftssteuer Satz	4%	%
Solidaritätszuschlag	5,50%	%
Steuersatz gesamt auf das Betriebsergebnis	21,02%	%
Jahre steuerfrei (Rumpfjahr + X)	0	Jahre

1*)
Gleichzeitig erklärte der EZB-Rat, dass er beim Streben nach Preisstabilität darauf abzielen wird, eine Preissteigerungsrate von nahe 2 % beizubehalten.
Quelle: Pressemitteilung EZB 08.04.03

2*)
Stand: 11.11.13
Quelle: www.finanzen.net/rohstoffe/oelpreis

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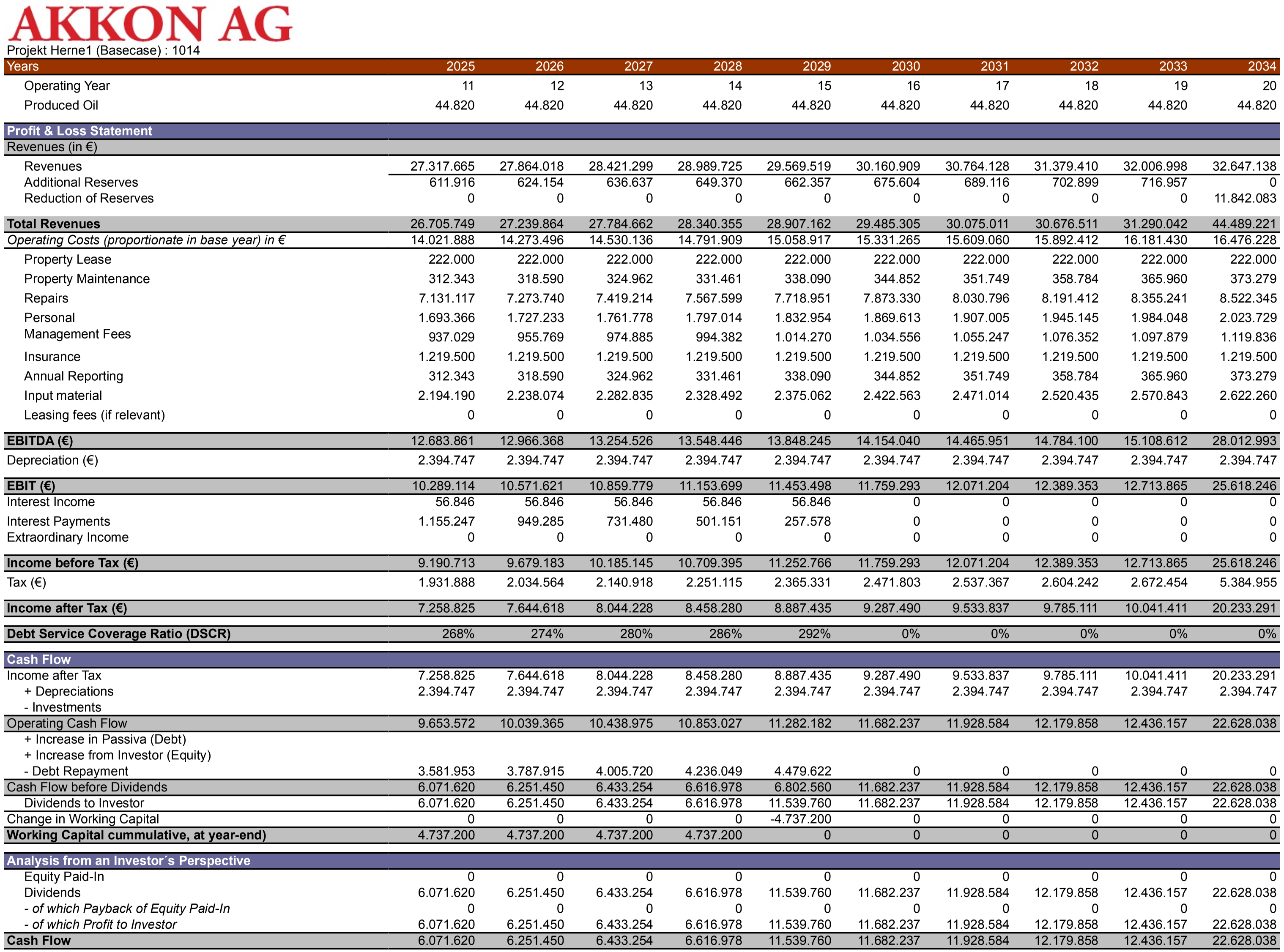
Table 6-4: Basecase scenario: Profit and loss statement of year 1 to 10 (data source: AKKON AG (2013))

AKKON AG

Projekt Herne1 (Basecase) : 1014	**Basecase**	Laufzeit 2014 bis 2034 (20 Jahre)										
Years	SUMME	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Operating Year			1	2	3	4	5	6	7	8	9	10
Produced Oil	930.015	33.615	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820
Profit & Loss Statement												
Revenues (in €)												
Revenues	561.311.557	16.807.500	22.410.000	22.858.200	23.315.364	23.781.671	24.257.305	24.742.451	25.237.300	25.742.046	26.256.887	26.782.024
Additional Reserves	11.842.083	376.488	501.984	512.024	522.264	532.709	543.364	554.231	565.316	576.622	588.154	599.917
Reduction of Reserves	11.842.083	0	0	0	0	0	0	0	0	0	0	0
Total Revenues	561.311.557	16.431.012	21.908.016	22.346.176	22.793.100	23.248.962	23.713.941	24.188.220	24.671.984	25.165.424	25.668.732	26.182.107
Operating Costs (proportionate in base year) in €	288.407.496	8.821.350	11.761.800	11.968.206	12.178.740	12.393.485	12.612.525	12.835.945	13.063.834	13.296.281	13.533.376	13.775.214
Property Lease	4.606.500	166.500	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000
Property Maintenance	6.417.888	192.173	256.230	261.355	266.582	271.913	277.352	282.899	288.557	294.328	300.214	306.219
Repairs	146.527.113	4.387.500	5.850.000	5.967.000	6.086.340	6.208.067	6.332.228	6.458.873	6.588.050	6.719.811	6.854.207	6.991.292
Personal	34.794.554	1.041.863	1.389.150	1.416.933	1.445.272	1.474.177	1.503.661	1.533.734	1.564.409	1.595.697	1.627.611	1.660.163
Management Fees	19.253.663	576.518	768.690	784.064	799.745	815.740	832.055	848.696	865.670	882.983	900.643	918.656
Insurance	25.304.625	914.625	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500
Annual Reporting	6.417.888	192.173	256.230	261.355	266.582	271.913	277.352	282.899	288.557	294.328	300.214	306.219
Input material	45.085.266	1.350.000	1.800.000	1.836.000	1.872.720	1.910.174	1.948.378	1.987.345	2.027.092	2.067.634	2.108.987	2.151.167
Leasing fees (if relevant)	0	0	0	0	0	0	0	0	0	0	0	0
EBITDA (€)	272.904.062	7.609.662	10.146.216	10.377.970	10.614.360	10.855.477	11.101.416	11.352.275	11.608.150	11.869.143	12.135.356	12.406.893
Depreciation (€)	49.691.000	1.796.060	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747
EBIT (€)	223.213.062	5.813.602	7.751.469	7.983.223	8.219.613	8.460.730	8.706.669	8.957.528	9.213.403	9.474.396	9.740.609	10.012.146
Interest Income			30.858	56.846	56.846	56.846	56.846	56.846	56.846	56.846	56.846	56.846
Interest Payments	26.527.628	2.357.217	2.571.509	2.571.509	2.446.982	2.315.294	2.176.035	2.028.768	1.873.033	1.708.343	1.534.184	1.350.011
Extraordinary Income	0	0	0	0	0	0	0	0	0	0	0	0
Income before Tax (€)	197.512.141	3.456.385	5.210.818	5.468.560	5.829.477	6.202.282	6.587.481	6.985.606	7.397.217	7.822.899	8.263.271	8.718.982
Tax (€)	41.517.052	726.532	1.095.314	1.149.491	1.225.356	1.303.720	1.384.688	1.468.374	1.554.895	1.644.373	1.736.940	1.832.730
Income after Tax (€)	155.995.089	2.729.853	4.115.504	4.319.069	4.604.121	4.898.562	5.202.792	5.517.232	5.842.322	6.178.526	6.526.332	6.886.252
Debt Service Coverage Ratio (DSCR)		323%	395%	219%	224%	229%	234%	240%	245%	251%	256%	262%
Cash Flow												
Income after Tax	155.995.089	2.729.853	4.115.504	4.319.069	4.604.121	4.898.562	5.202.792	5.517.232	5.842.322	6.178.526	6.526.332	6.886.252
+ Depreciations	49.691.000	1.796.060	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747
- Investments	49.691.000	49.691.000										
Operating Cash Flow		-45.165.087	6.510.251	6.713.816	6.998.868	7.293.309	7.597.539	7.911.979	8.237.069	8.573.273	8.921.079	9.280.999
+ Increase in Passiva (Debt)	44.721.900	44.721.900										
+ Increase from Investor (Equity)	4.969.100	4.969.100										
- Debt Repayment	44.721.900	0	0	2.165.691	2.290.218	2.421.906	2.561.165	2.708.432	2.864.167	3.028.857	3.203.016	3.387.189
Cash Flow before Dividends	160.964.189	4.525.913	6.510.251	4.548.125	4.708.650	4.871.404	5.036.374	5.203.547	5.372.902	5.544.416	5.718.063	5.893.810
Dividends to Investor	160.964.189	1.954.404	4.344.560	4.548.125	4.708.650	4.871.404	5.036.374	5.203.547	5.372.902	5.544.416	5.718.063	5.893.810
Change in Working Capital	0	2.571.509	2.165.691	0	0	0	0	0	0	0	0	0
Working Capital cummulative, at year-end)		2.571.509	4.737.200	4.737.200	4.737.200	4.737.200	4.737.200	4.737.200	4.737.200	4.737.200	4.737.200	4.737.200
Analysis from an Investor´s Perspective												
Equity Paid-In		4.969.100	624.540	0	0	0	0	0	0	0	0	0
Dividends	160.964.189	1.954.404	4.344.560	4.548.125	4.708.650	4.871.404	5.036.374	5.203.547	5.372.902	5.544.416	5.718.063	5.893.810
- of which Payback of Equity Paid-In	4.969.100		4.344.560	624.540	0	0	0	0	0	0	0	0
- of which Profit to Investor	155.995.089	1.954.404	0	3.923.585	4.708.650	4.871.404	5.036.374	5.203.547	5.372.902	5.544.416	5.718.063	5.893.810
Cash Flow	155.995.089	-3.014.696	4.344.560	4.548.125	4.708.650	4.871.404	5.036.374	5.203.547	5.372.902	5.544.416	5.718.063	5.893.810

Table 6-5: Basecase scenario: Profit and loss statement of year 11 to 20 (data source: AKKON AG (2013))



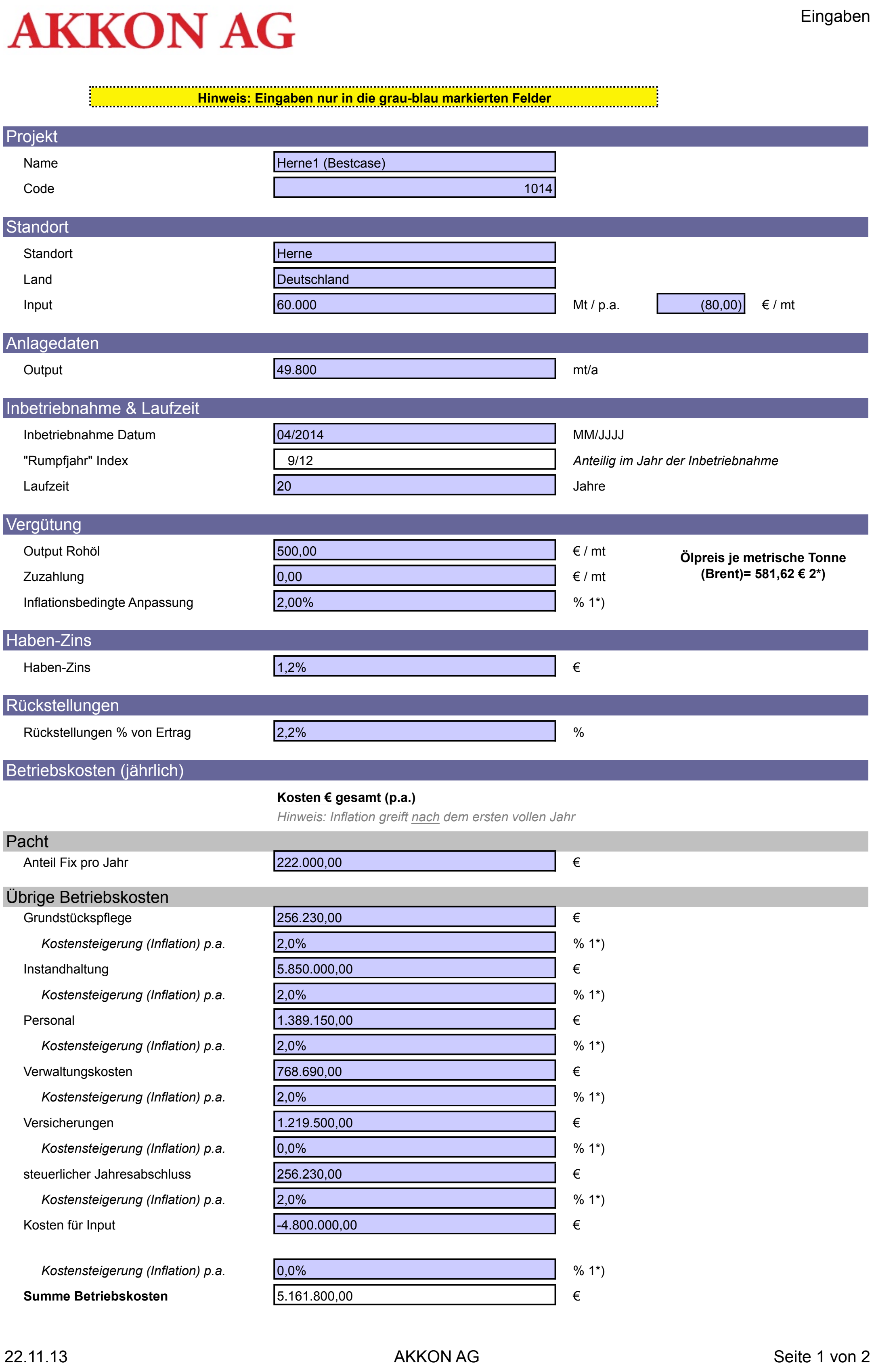
AKKON AG
Projekt Herne1 (Basecase) : 1014

Years	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Operating Year	11	12	13	14	15	16	17	18	19	20
Produced Oil	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820
Profit & Loss Statement										
Revenues (in €)										
Revenues	27.317.665	27.864.018	28.421.299	28.989.725	29.569.519	30.160.909	30.764.128	31.379.410	32.006.998	32.647.138
Additional Reserves	611.916	624.154	636.637	649.370	662.357	675.604	689.116	702.899	716.957	0
Reduction of Reserves	0	0	0	0	0	0	0	0	0	11.842.083
Total Revenues	26.705.749	27.239.864	27.784.662	28.340.355	28.907.162	29.485.305	30.075.011	30.676.511	31.290.042	44.489.221
Operating Costs (proportionate in base year) in €	14.021.888	14.273.496	14.530.136	14.791.909	15.058.917	15.331.265	15.609.060	15.892.412	16.181.430	16.476.228
Property Lease	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000
Property Maintenance	312.343	318.590	324.962	331.461	338.090	344.852	351.749	358.784	365.960	373.279
Repairs	7.131.117	7.273.740	7.419.214	7.567.599	7.718.951	7.873.330	8.030.796	8.191.412	8.355.241	8.522.345
Personal	1.693.366	1.727.233	1.761.778	1.797.014	1.832.954	1.869.613	1.907.005	1.945.145	1.984.048	2.023.729
Management Fees	937.029	955.769	974.885	994.382	1.014.270	1.034.556	1.055.247	1.076.352	1.097.879	1.119.836
Insurance	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500
Annual Reporting	312.343	318.590	324.962	331.461	338.090	344.852	351.749	358.784	365.960	373.279
Input material	2.194.190	2.238.074	2.282.835	2.328.492	2.375.062	2.422.563	2.471.014	2.520.435	2.570.843	2.622.260
Leasing fees (if relevant)	0	0	0	0	0	0	0	0	0	0
EBITDA (€)	12.683.861	12.966.368	13.254.526	13.548.446	13.848.245	14.154.040	14.465.951	14.784.100	15.108.612	28.012.993
Depreciation (€)	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747
EBIT (€)	10.289.114	10.571.621	10.859.779	11.153.699	11.453.498	11.759.293	12.071.204	12.389.353	12.713.865	25.618.246
Interest Income	56.846	56.846	56.846	56.846	56.846	0	0	0	0	0
Interest Payments	1.155.247	949.285	731.480	501.151	257.578	0	0	0	0	0
Extraordinary Income	0	0	0	0	0	0	0	0	0	0
Income before Tax (€)	9.190.713	9.679.183	10.185.145	10.709.395	11.252.766	11.759.293	12.071.204	12.389.353	12.713.865	25.618.246
Tax (€)	1.931.888	2.034.564	2.140.918	2.251.115	2.365.331	2.471.803	2.537.367	2.604.242	2.672.454	5.384.955
Income after Tax (€)	7.258.825	7.644.618	8.044.228	8.458.280	8.887.435	9.287.490	9.533.837	9.785.111	10.041.411	20.233.291
Debt Service Coverage Ratio (DSCR)	268%	274%	280%	286%	292%	0%	0%	0%	0%	0%
Cash Flow										
Income after Tax	7.258.825	7.644.618	8.044.228	8.458.280	8.887.435	9.287.490	9.533.837	9.785.111	10.041.411	20.233.291
+ Depreciations	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747
- Investments										
Operating Cash Flow	9.653.572	10.039.365	10.438.975	10.853.027	11.282.182	11.682.237	11.928.584	12.179.858	12.436.157	22.628.038
+ Increase in Passiva (Debt)										
+ Increase from Investor (Equity)										
- Debt Repayment	3.581.953	3.787.915	4.005.720	4.236.049	4.479.622	0	0	0	0	0
Cash Flow before Dividends	6.071.620	6.251.450	6.433.254	6.616.978	6.802.560	11.682.237	11.928.584	12.179.858	12.436.157	22.628.038
Dividends to Investor	6.071.620	6.251.450	6.433.254	6.616.978	11.539.760	11.682.237	11.928.584	12.179.858	12.436.157	22.628.038
Change in Working Capital	0	0	0	0	-4.737.200	0	0	0	0	0
Working Capital cummulative, at year-end)	4.737.200	4.737.200	4.737.200	4.737.200	0	0	0	0	0	0
Analysis from an Investor´s Perspective										
Equity Paid-In	0	0	0	0	0	0	0	0	0	0
Dividends	6.071.620	6.251.450	6.433.254	6.616.978	11.539.760	11.682.237	11.928.584	12.179.858	12.436.157	22.628.038
- of which Payback of Equity Paid-In	0	0	0	0	0	0	0	0	0	0
- of which Profit to Investor	6.071.620	6.251.450	6.433.254	6.616.978	11.539.760	11.682.237	11.928.584	12.179.858	12.436.157	22.628.038
Cash Flow	6.071.620	6.251.450	6.433.254	6.616.978	11.539.760	11.682.237	11.928.584	12.179.858	12.436.157	22.628.038

6.3.7 Bestcase scenario

In the bestcase scenario all parameters are equal to the basecase, except the feedstock depends on the subsidies for shredded fractions of the car recycling industry. This additional payment is calculated of 80 €/Mt over 4 years, decreasing 25% per year. By installation of more CCC-power-plants it might be possible, that the additional payment for these feedstock materials will be nearly zero over the next 5 years. The bestcase scenario is almost similar to the basecase over the life time but much higher in the total result. The additional payment for the feedstock is that low, it is marginal in that overview of the bestcase scenario.

Table 6-6: Bestcase scenario: Project input data (data source: AKKON AG (2013))



AKKON AG

Eingaben

Hinweis: Eingaben nur in die grau-blau markierten Felder

Projekt

Name	Herne1 (Bestcase)	
Code	1014	

Standort

Standort	Herne			
Land	Deutschland			
Input	60.000	Mt / p.a.	(80,00)	€ / mt

Anlagedaten

Output	49.800	mt/a

Inbetriebnahme & Laufzeit

Inbetriebnahme Datum	04/2014	MM/JJJJ
"Rumpfjahr" Index	9/12	*Anteilig im Jahr der Inbetriebnahme*
Laufzeit	20	Jahre

Vergütung

Output Rohöl	500,00	€ / mt
Zuzahlung	0,00	€ / mt
Inflationsbedingte Anpassung	2,00%	% 1*)

Ölpreis je metrische Tonne (Brent)= 581,62 € 2*)

Haben-Zins

Haben-Zins	1,2%	€

Rückstellungen

Rückstellungen % von Ertrag	2,2%	%

Betriebskosten (jährlich)

Kosten € gesamt (p.a.)

Hinweis: Inflation greift nach dem ersten vollen Jahr

Pacht

Anteil Fix pro Jahr	222.000,00	€

Übrige Betriebskosten

Grundstückspflege	256.230,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Instandhaltung	5.850.000,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Personal	1.389.150,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Verwaltungskosten	768.690,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Versicherungen	1.219.500,00	€
Kostensteigerung (Inflation) p.a.	0,0%	% 1*)
steuerlicher Jahresabschluss	256.230,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Kosten für Input	-4.800.000,00	€
Kostensteigerung (Inflation) p.a.	0,0%	% 1*)
Summe Betriebskosten	5.161.800,00	€

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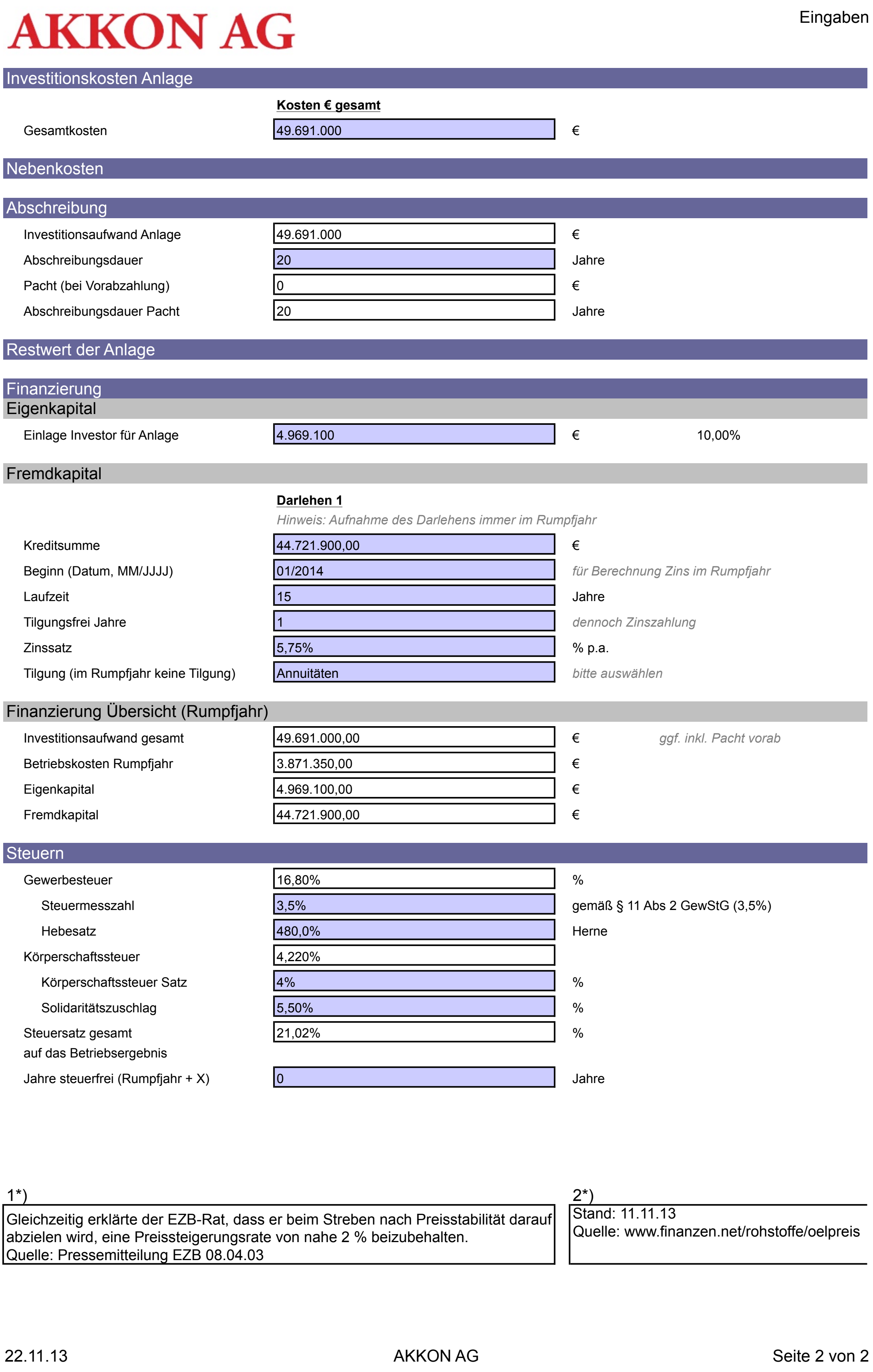
Table 6-7: Bestcase scenario: Project cost data (data source: AKKON AG (2013))



AKKON AG

Eingaben

Investitionskosten Anlage

	Kosten € gesamt	
Gesamtkosten	49.691.000	€

Nebenkosten

Abschreibung

Investitionsaufwand Anlage	49.691.000	€
Abschreibungsdauer	20	Jahre
Pacht (bei Vorabzahlung)	0	€
Abschreibungsdauer Pacht	20	Jahre

Restwert der Anlage

Finanzierung

Eigenkapital

Einlage Investor für Anlage	4.969.100	€	10,00%

Fremdkapital

	Darlehen 1	
	Hinweis: Aufnahme des Darlehens immer im Rumpfjahr	
Kreditsumme	44.721.900,00	€
Beginn (Datum, MM/JJJJ)	01/2014	*für Berechnung Zins im Rumpfjahr*
Laufzeit	15	Jahre
Tilgungsfrei Jahre	1	*dennoch Zinszahlung*
Zinssatz	5,75%	% p.a.
Tilgung (im Rumpfjahr keine Tilgung)	Annuitäten	*bitte auswählen*

Finanzierung Übersicht (Rumpfjahr)

Investitionsaufwand gesamt	49.691.000,00	€	*ggf. inkl. Pacht vorab*
Betriebskosten Rumpfjahr	3.871.350,00	€	
Eigenkapital	4.969.100,00	€	
Fremdkapital	44.721.900,00	€	

Steuern

Gewerbesteuer	16,80%	%
Steuermesszahl	3,5%	gemäß § 11 Abs 2 GewStG (3,5%)
Hebesatz	480,0%	Herne
Körperschaftssteuer	4,220%	
Körperschaftssteuer Satz	4%	%
Solidaritätszuschlag	5,50%	%
Steuersatz gesamt auf das Betriebsergebnis	21,02%	%
Jahre steuerfrei (Rumpfjahr + X)	0	Jahre

1*)	2*)
Gleichzeitig erklärte der EZB-Rat, dass er beim Streben nach Preisstabilität darauf abzielen wird, eine Preissteigerungsrate von nahe 2 % beizubehalten. Quelle: Pressemitteilung EZB 08.04.03	Stand: 11.11.13 Quelle: www.finanzen.net/rohstoffe/oelpreis

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Table 6-8: Bestcase scenario: Profit and loss statement of year 1 to 10 (data source: AKKON AG (2013))

AKKON AG

Projekt Herne1 (Bestcase) : 1014 **Bestcase** Laufzeit 2014 bis 2034 (20 Jahre)

Years	SUMME	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Operating Year			1	2	3	4	5	6	7	8	9	10
Produced Oil	930.015	33.615	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820
Profit & Loss Statement												
Revenues (in €)												
Revenues	561.311.557	16.807.500	22.410.000	22.858.200	23.315.364	23.781.671	24.257.305	24.742.451	25.237.300	25.742.046	26.256.887	26.782.024
Additional Reserves	11.842.083	376.488	501.984	512.024	522.264	532.709	543.364	554.231	565.316	576.622	588.154	599.917
Reduction of Reserves	11.842.083	0	0	0	0	0	0	0	0	0	0	0
Total Revenues	561.311.557	16.431.012	21.908.016	22.346.176	22.793.100	23.248.962	23.713.941	24.188.220	24.671.984	25.165.424	25.668.732	26.182.107
Operating Costs (proportionate in base year) in €	228.049.503	4.198.623	5.161.800	6.532.206	7.906.020	9.283.311	10.664.147	10.848.600	11.036.742	11.228.646	11.424.389	11.624.047
Property Lease	4.606.500	166.500	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000
Property Maintenance	6.417.888	192.173	256.230	261.355	266.582	271.913	277.352	282.899	288.557	294.328	300.214	306.219
Repairs	146.527.113	4.387.500	5.850.000	5.967.000	6.086.340	6.208.067	6.332.228	6.458.873	6.588.050	6.719.811	6.854.207	6.991.292
Personal	34.794.554	1.041.863	1.389.150	1.416.933	1.445.272	1.474.177	1.503.661	1.533.734	1.564.409	1.595.697	1.627.611	1.660.163
Management Fees	19.253.663	576.518	768.690	784.064	799.745	815.740	832.055	848.696	865.670	882.983	900.643	918.656
Insurance	25.304.625	914.625	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500
Annual Reporting	6.417.888	192.173	256.230	261.355	266.582	271.913	277.352	282.899	288.557	294.328	300.214	306.219
Input material (additional payment; decreasing annually 25 %)	(15.272.727)	(3.272.727)	(4.800.000)	(3.600.000)	(2.400.000)	(1.200.000)	0	0	0	0	0	0
Leasing fees (if relevant)	0	0	0	0	0	0	0	0	0	0	0	0
EBITDA (€)	333.262.055	12.232.389	16.746.216	15.813.970	14.887.080	13.965.651	13.049.794	13.339.620	13.635.243	13.936.777	14.244.343	14.558.060
Depreciation (€)	49.691.000	1.796.060	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747
EBIT (€)	283.571.055	10.436.329	14.351.469	13.419.223	12.492.333	11.570.904	10.655.047	10.944.873	11.240.496	11.542.031	11.849.596	12.163.313
Interest Income			26.931	52.872	38.424	9.403	0	0	0	0	0	0
Interest Payments	26.527.628	2.357.217	2.571.509	2.571.509	2.446.982	2.315.294	2.176.035	2.028.768	1.873.033	1.708.343	1.534.184	1.350.011
Extraordinary Income	0	0	0	0	0	0	0	0	0	0	0	0
Income before Tax (€)	257.171.057	8.079.112	11.806.891	10.900.586	10.083.775	9.265.013	8.479.012	8.916.105	9.367.463	9.833.687	10.315.412	10.813.302
Tax (€)	71.929.895	1.767.022	2.482.634	2.544.379	2.627.962	2.714.198	2.803.198	2.895.074	2.989.950	3.087.950	3.189.209	3.293.865
Income after Tax (€)	185.241.162	6.312.090	9.324.257	8.356.207	7.455.813	6.550.815	5.675.815	6.021.031	6.377.513	6.745.737	7.126.203	7.519.437
Debt Service Coverage Ratio (DSCR)		519%	651%	334%	314%	295%	275%	282%	288%	294%	301%	307%
Cash Flow												
Income after Tax	185.241.162	6.312.090	9.324.257	8.356.207	7.455.813	6.550.815	5.675.815	6.021.031	6.377.513	6.745.737	7.126.203	7.519.437
+ Depreciations	49.691.000	1.796.060	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747
- Investments	49.691.000	49.691.000										
Operating Cash Flow		-41.582.850	11.719.004	10.750.954	9.850.560	8.945.562	8.070.562	8.415.778	8.772.260	9.140.484	9.520.950	9.914.184
+ Increase in Passiva (Debt)	44.721.900	44.721.900										
+ Increase from Investor (Equity)	4.969.100	4.969.100										
- Debt Repayment	44.721.900	0	0	2.165.691	2.290.218	2.421.906	2.561.165	2.708.432	2.864.167	3.028.857	3.203.016	3.387.189
Cash Flow before Dividends	190.210.262	8.108.150	11.719.004	8.585.264	7.560.342	6.523.656	5.509.397	5.707.346	5.908.093	6.111.627	6.317.934	6.526.995
Dividends to Investor	275.236.612	5.863.914	9.557.240	9.789.238	9.978.764	10.171.099	10.366.243	10.564.192	10.764.939	10.968.474	11.174.781	11.383.841
Change in Working Capital	-85.026.350	2.244.237	2.161.764	-1.203.974	-2.418.422	-3.647.443	-4.856.846	-4.856.846	-4.856.846	-4.856.846	-4.856.846	-4.856.846
Working Capital cummulative, at year-end)		2.244.237	4.406.000	3.202.026	783.604	-2.863.840	-7.720.686	-12.577.532	-17.434.379	-22.291.225	-27.148.072	-32.004.918
Analysis from an Investor´s Perspective												
Equity Paid-In		4.969.100	0	0	0	0	0	0	0	0	0	0
Dividends	275.236.612	5.863.914	9.557.240	9.789.238	9.978.764	10.171.099	10.366.243	10.564.192	10.764.939	10.968.474	11.174.781	11.383.841
- of which Payback of Equity Paid-In	4.969.100		4.969.100	0	0	0	0	0	0	0	0	0
- of which Profit to Investor	270.267.512	5.863.914	4.588.140	9.789.238	9.978.764	10.171.099	10.366.243	10.564.192	10.764.939	10.968.474	11.174.781	11.383.841
Cash Flow	270.267.512	894.814	9.557.240	9.789.238	9.978.764	10.171.099	10.366.243	10.564.192	10.764.939	10.968.474	11.174.781	11.383.841

Table 6-9: Bestcase scenario: Profit and loss statement of year 11 to 20 (data source: AKKON AG (2013))

AKKON AG

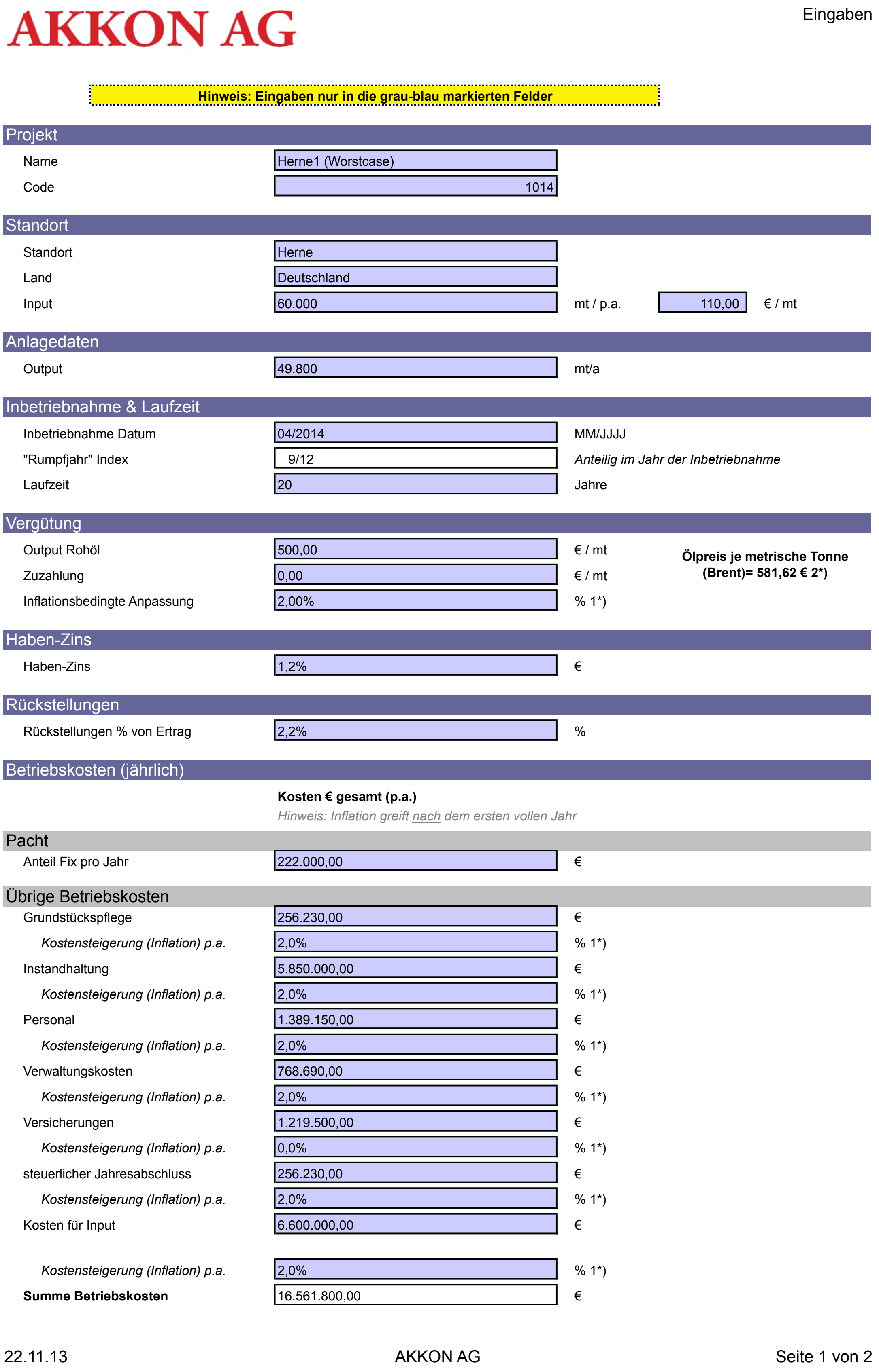
Projekt Herne1 (Bestcase) : 1014

Years	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Operating Year	11	12	13	14	15	16	17	18	19	20
Produced Oil	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820
Profit & Loss Statement										
Revenues (in €)										
Revenues	27.317.665	27.864.018	28.421.299	28.989.725	29.569.519	30.160.909	30.764.128	31.379.410	32.006.998	32.647.138
Additional Reserves	611.916	624.154	636.637	649.370	662.357	675.604	689.116	702.899	716.957	0
Reduction of Reserves	0	0	0	0	0	0	0	0	0	11.842.083
Total Revenues	26.705.749	27.239.864	27.784.662	28.340.355	28.907.162	29.485.305	30.075.011	30.676.511	31.290.042	44.489.221
Operating Costs (proportionate in base year) in €	11.827.698	12.035.422	12.247.301	12.463.417	12.683.855	12.908.702	13.138.046	13.371.977	13.610.587	13.853.968
Property Lease	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000
Property Maintenance	312.343	318.590	324.962	331.461	338.090	344.852	351.749	358.784	365.960	373.279
Repairs	7.131.117	7.273.740	7.419.214	7.567.599	7.718.951	7.873.330	8.030.796	8.191.412	8.355.241	8.522.345
Personal	1.693.366	1.727.233	1.761.778	1.797.014	1.832.954	1.869.613	1.907.005	1.945.145	1.984.048	2.023.729
Management Fees	937.029	955.769	974.885	994.382	1.014.270	1.034.556	1.055.247	1.076.352	1.097.879	1.119.836
Insurance	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500
Annual Reporting	312.343	318.590	324.962	331.461	338.090	344.852	351.749	358.784	365.960	373.279
Input material (additional payment; decreasing annually 25 %)	0	0	0	0	0	0	0	0	0	0
Leasing fees (if relevant)	0	0	0	0	0	0	0	0	0	0
EBITDA (€)	14.878.051	15.204.442	15.537.361	15.876.938	16.223.307	16.576.603	16.936.965	17.304.534	17.679.455	30.635.253
Depreciation (€)	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747
EBIT (€)	12.483.304	12.809.695	13.142.614	13.482.191	13.828.560	14.181.856	14.542.218	14.909.787	15.284.708	28.240.506
Interest Income	0	0	0	0	0	0	0	0	0	0
Interest Payments	1.155.247	949.285	731.480	501.151	257.578	0	0	0	0	0
Extraordinary Income	0	0	0	0	0	0	0	0	0	0
Income before Tax (€)	11.328.057	11.860.410	12.411.134	12.981.040	13.570.982	14.181.856	14.542.218	14.909.787	15.284.708	28.240.506
Tax (€)	3.402.067	3.513.967	3.629.729	3.749.524	3.873.529	3.989.986	4.065.734	4.142.997	4.221.806	6.945.114
Income after Tax (€)	7.925.990	8.346.443	8.781.405	9.231.516	9.697.452	10.191.870	10.476.484	10.766.790	11.062.902	21.295.392
Debt Service Coverage Ratio (DSCR)	314%	321%	328%	335%	342%	0%	0%	0%	0%	0%
Cash Flow										
Income after Tax	7.925.990	8.346.443	8.781.405	9.231.516	9.697.452	10.191.870	10.476.484	10.766.790	11.062.902	21.295.392
+ Depreciations	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747
- Investments										
Operating Cash Flow	10.320.737	10.741.190	11.176.151	11.626.263	12.092.199	12.586.617	12.871.231	13.161.537	13.457.649	23.690.139
+ Increase in Passiva (Debt)										
+ Increase from Investor (Equity)										
- Debt Repayment	3.581.953	3.787.915	4.005.720	4.236.049	4.479.622	0	0	0	0	0
Cash Flow before Dividends	6.738.784	6.953.275	7.170.431	7.390.214	7.612.577	12.586.617	12.871.231	13.161.537	13.457.649	23.690.139
Dividends to Investor	11.595.631	11.810.121	12.027.278	12.247.061	17.206.624	17.386.617	17.671.231	17.961.537	18.257.649	28.490.139
Change in Working Capital	-4.856.846	-4.856.846	-4.856.846	-4.856.846	-9.594.047	-4.800.000	-4.800.000	-4.800.000	-4.800.000	-4.800.000
Working Capital cummulative, at year-end)	-36.861.764	-41.718.611	-46.575.457	-51.432.304	-61.026.350	-65.826.350	-70.626.350	-75.426.350	-80.226.350	-85.026.350
Analysis from an Investor´s Perspective										
Equity Paid-In	0	0	0	0	0	0	0	0	0	0
Dividends	11.595.631	11.810.121	12.027.278	12.247.061	17.206.624	17.386.617	17.671.231	17.961.537	18.257.649	28.490.139
- of which Payback of Equity Paid-In	0	0	0	0	0	0	0	0	0	0
- of which Profit to Investor	11.595.631	11.810.121	12.027.278	12.247.061	17.206.624	17.386.617	17.671.231	17.961.537	18.257.649	28.490.139
Cash Flow	11.595.631	11.810.121	12.027.278	12.247.061	17.206.624	17.386.617	17.671.231	17.961.537	18.257.649	28.490.139

6.3.8 Worstcase scenario

The worstcase scenario has the same parameters like the basecase and bestcase scenario, except the feedstock has to be paid on a higher tariff then in the basecase. The price/Mt is calculated on 110 € for the feedstock. Similar to the bestcase it could be possible, that feedstock material like shredded fractions of the yellow sack or from the car recycling industry will rise in the price. In that case biomass could be a feedstock with marketable input prices.

Table 6-10: Worstcase scenario: Project input data (data source: AKKON AG (2013))



AKKON AG

Eingaben

Hinweis: Eingaben nur in die grau-blau markierten Felder

Projekt

Name	Herne1 (Worstcase)			
Code	1014			

Standort

Standort	Herne			
Land	Deutschland			
Input	60.000	mt / p.a.	110,00	€ / mt

Anlagedaten

Output	49.800	mt/a

Inbetriebnahme & Laufzeit

Inbetriebnahme Datum	04/2014	MM/JJJJ
"Rumpfjahr" Index	9/12	*Anteilig im Jahr der Inbetriebnahme*
Laufzeit	20	Jahre

Vergütung

Output Rohöl	500,00	€ / mt
Zuzahlung	0,00	€ / mt
Inflationsbedingte Anpassung	2,00%	% 1*)

Ölpreis je metrische Tonne (Brent)= 581,62 € 2*)

Haben-Zins

Haben-Zins	1,2%	€

Rückstellungen

Rückstellungen % von Ertrag	2,2%	%

Betriebskosten (jährlich)

Kosten € gesamt (p.a.)
Hinweis: Inflation greift nach dem ersten vollen Jahr

Pacht

Anteil Fix pro Jahr	222.000,00	€

Übrige Betriebskosten

Grundstückspflege	256.230,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Instandhaltung	5.850.000,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Personal	1.389.150,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Verwaltungskosten	768.690,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Versicherungen	1.219.500,00	€
Kostensteigerung (Inflation) p.a.	0,0%	% 1*)
steuerlicher Jahresabschluss	256.230,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Kosten für Input	6.600.000,00	€
Kostensteigerung (Inflation) p.a.	2,0%	% 1*)
Summe Betriebskosten	16.561.800,00	€

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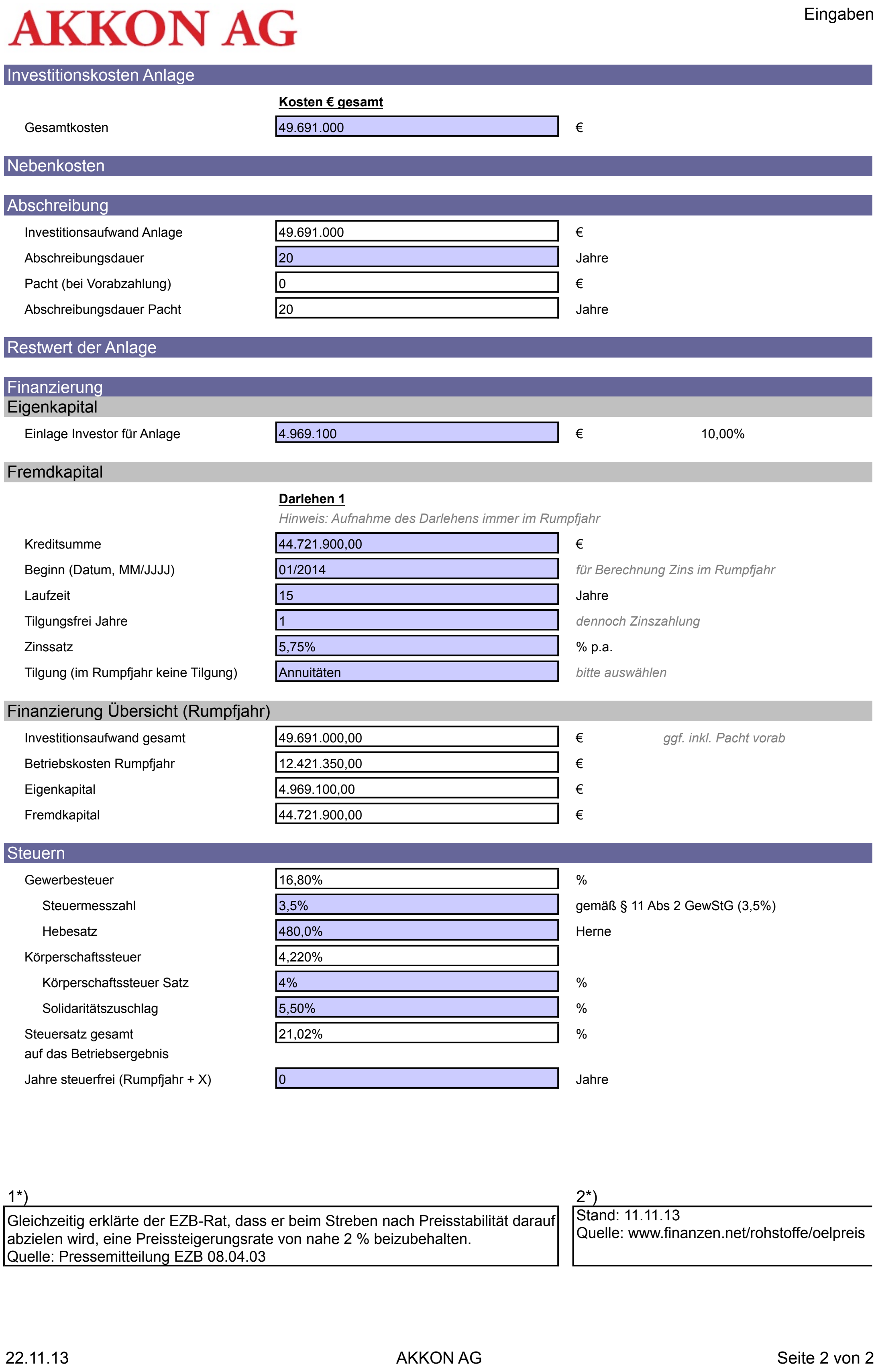
Table 6-11: Worstcase scenario: Project cost data (data source: AKKON AG (2013))



AKKON AG

Eingaben

Investitionskosten Anlage

	Kosten € gesamt	
Gesamtkosten	49.691.000	€

Nebenkosten

Abschreibung

Investitionsaufwand Anlage	49.691.000	€
Abschreibungsdauer	20	Jahre
Pacht (bei Vorabzahlung)	0	€
Abschreibungsdauer Pacht	20	Jahre

Restwert der Anlage

Finanzierung

Eigenkapital

Einlage Investor für Anlage	4.969.100	€	10,00%

Fremdkapital

	Darlehen 1 *Hinweis: Aufnahme des Darlehens immer im Rumpfjahr*	
Kreditsumme	44.721.900,00	€
Beginn (Datum, MM/JJJJ)	01/2014	*für Berechnung Zins im Rumpfjahr*
Laufzeit	15	Jahre
Tilgungsfrei Jahre	1	*dennoch Zinszahlung*
Zinssatz	5,75%	% p.a.
Tilgung (im Rumpfjahr keine Tilgung)	Annuitäten	*bitte auswählen*

Finanzierung Übersicht (Rumpfjahr)

Investitionsaufwand gesamt	49.691.000,00	€	*ggf. inkl. Pacht vorab*
Betriebskosten Rumpfjahr	12.421.350,00	€	
Eigenkapital	4.969.100,00	€	
Fremdkapital	44.721.900,00	€	

Steuern

Gewerbesteuer	16,80%	%
Steuermesszahl	3,5%	gemäß § 11 Abs 2 GewStG (3,5%)
Hebesatz	480,0%	Herne
Körperschaftssteuer	4,220%	
Körperschaftssteuer Satz	4%	%
Solidaritätszuschlag	5,50%	%
Steuersatz gesamt auf das Betriebsergebnis	21,02%	%
Jahre steuerfrei (Rumpfjahr + X)	0	Jahre

1*)
Gleichzeitig erklärte der EZB-Rat, dass er beim Streben nach Preisstabilität darauf abzielen wird, eine Preissteigerungsrate von nahe 2 % beizubehalten.
Quelle: Pressemitteilung EZB 08.04.03

2*)
Stand: 11.11.13
Quelle: www.finanzen.net/rohstoffe/oelpreis

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Table 6-12: Worstcase scenario: Profit and loss statement of year 1 to 10 (data source: AKKON AG (2013))

AKKON AG

Projekt Herne1 (Worstcase) : 1014 **Worstcase** Laufzeit 2014 bis 2034 (20 Jahre)

Years	SUMME	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Operating Year			1	2	3	4	5	6	7	8	9	10
Produced Oil	930.015	33.615	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820
Profit & Loss Statement												
Revenues (in €)												
Revenues	561.311.557	16.807.500	22.410.000	22.858.200	23.315.364	23.781.671	24.257.305	24.742.451	25.237.300	25.742.046	26.256.887	26.782.024
Additional Reserves	11.842.083	376.488	501.984	512.024	522.264	532.709	543.364	554.231	565.316	576.622	588.154	599.917
Reduction of Reserves	11.842.083	0	0	0	0	0	0	0	0	0	0	0
Total Revenues	561.311.557	16.431.012	21.908.016	22.346.176	22.793.100	23.248.962	23.713.941	24.188.220	24.671.984	25.165.424	25.668.732	26.182.107
Operating Costs (proportionate in base year) in €	408.634.871	12.421.350	16.561.800	16.864.206	17.172.660	17.487.283	17.808.199	18.135.533	18.469.414	18.809.972	19.157.341	19.511.658
Property Lease	4.606.500	166.500	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000
Property Maintenance	6.417.888	192.173	256.230	261.355	266.582	271.913	277.352	282.899	288.557	294.328	300.214	306.219
Repairs	146.527.113	4.387.500	5.850.000	5.967.000	6.086.340	6.208.067	6.332.228	6.458.873	6.588.050	6.719.811	6.854.207	6.991.292
Personal	34.794.554	1.041.863	1.389.150	1.416.933	1.445.272	1.474.177	1.503.661	1.533.734	1.564.409	1.595.697	1.627.611	1.660.163
Management Fees	19.253.663	576.518	768.690	784.064	799.745	815.740	832.055	848.696	865.670	882.983	900.643	918.656
Insurance	25.304.625	914.625	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500
Annual Reporting	6.417.888	192.173	256.230	261.355	266.582	271.913	277.352	282.899	288.557	294.328	300.214	306.219
Input material	165.312.641	4.950.000	6.600.000	6.732.000	6.866.640	7.003.973	7.144.052	7.286.933	7.432.672	7.581.325	7.732.952	7.887.611
Leasing fees (if relevant)	0	0	0	0	0	0	0	0	0	0	0	0
EBITDA (€)	152.676.687	4.009.662	5.346.216	5.481.970	5.620.440	5.761.679	5.905.742	6.052.687	6.202.571	6.355.452	6.511.391	6.670.449
Depreciation (€)	49.691.000	1.796.060	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747
EBIT (€)	102.985.687	2.213.602	2.951.469	3.087.223	3.225.693	3.366.932	3.510.995	3.657.940	3.807.824	3.960.705	4.116.644	4.275.702
Interest Income			19.829	52.355	56.846	56.846	56.846	56.846	56.846	56.846	56.846	56.846
Interest Payments	26.527.628	2.357.217	2.571.509	2.571.509	2.446.982	2.315.294	2.176.035	2.028.768	1.873.033	1.708.343	1.534.184	1.350.011
Extraordinary Income	0	0	0	0	0	0	0	0	0	0	0	0
Income before Tax (€)	77.269.247	-143.615	399.789	568.069	835.557	1.108.483	1.391.807	1.686.018	1.991.637	2.309.208	2.639.306	2.982.538
Tax (€)	16.272.184	0	84.036	119.408	175.634	233.003	292.558	354.401	418.642	485.396	554.782	626.929
Income after Tax (€)	60.997.063	-143.615	315.753	448.661	659.923	875.480	1.099.249	1.331.617	1.572.995	1.823.813	2.084.524	2.355.608
Debt Service Coverage Ratio (DSCR)		170%	208%	116%	119%	122%	125%	128%	131%	134%	137%	141%
Cash Flow												
Income after Tax	60.997.063	-143.615	315.753	448.661	659.923	875.480	1.099.249	1.331.617	1.572.995	1.823.813	2.084.524	2.355.608
+ Depreciations	49.691.000	1.796.060	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747
- Investments	49.691.000	49.691.000										
Operating Cash Flow		-48.038.555	2.710.500	2.843.408	3.054.670	3.270.227	3.493.996	3.726.364	3.967.742	4.218.560	4.479.271	4.750.355
+ Increase in Passiva (Debt)	44.721.900	44.721.900										
+ Increase from Investor (Equity)	4.969.100	4.969.100										
- Debt Repayment	44.721.900	0	0	2.165.691	2.290.218	2.421.906	2.561.165	2.708.432	2.864.167	3.028.857	3.203.016	3.387.189
Cash Flow before Dividends	65.966.163	1.652.445	2.710.500	677.717	764.452	848.322	932.831	1.017.932	1.103.575	1.189.703	1.276.255	1.363.166
Dividends to Investor	65.966.163	0	0	303.463	764.452	848.322	932.831	1.017.932	1.103.575	1.189.703	1.276.255	1.363.166
Change in Working Capital	0	1.652.445	2.710.500	374.255	0	0	0	0	0	0	0	0
Working Capital cummulative, at year-end)		1.652.445	4.362.946	4.737.200	4.737.200	4.737.200	4.737.200	4.737.200	4.737.200	4.737.200	4.737.200	4.737.200
Analysis from an Investor´s Perspective												
Equity Paid-In		4.969.100	4.969.100	4.665.637	3.901.185	3.052.864	2.120.033	1.102.101	0	0	0	0
Dividends	65.966.163	0	0	303.463	764.452	848.322	932.831	1.017.932	1.103.575	1.189.703	1.276.255	1.363.166
- of which Payback of Equity Paid-In	4.969.100		0	303.463	764.452	848.322	932.831	1.017.932	1.102.101	0	0	0
- of which Profit to Investor	60.997.063	0	0	0	0	0	0	0	1.474	1.189.703	1.276.255	1.363.166
Cash Flow	60.997.063	-4.969.100	0	303.463	764.452	848.322	932.831	1.017.932	1.103.575	1.189.703	1.276.255	1.363.166

Table 6-13: Worstcase scenario: Profit and loss statement of year 11 to 20 (data source: AKKON AG (2013))

AKKON AG

Projekt Herne1 (Worstcase) : 1014

Years	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Operating Year	11	12	13	14	15	16	17	18	19	20
Produced Oil	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820	44.820
Profit & Loss Statement										
Revenues (in €)										
Revenues	27.317.665	27.864.018	28.421.299	28.989.725	29.569.519	30.160.909	30.764.128	31.379.410	32.006.998	32.647.138
Additional Reserves	611.916	624.154	636.637	649.370	662.357	675.604	689.116	702.899	716.957	0
Reduction of Reserves	0	0	0	0	0	0	0	0	0	11.842.083
Total Revenues	26.705.749	27.239.864	27.784.662	28.340.355	28.907.162	29.485.305	30.075.011	30.676.511	31.290.042	44.489.221
Operating Costs (proportionate in base year) in €	19.873.061	20.241.693	20.617.696	21.001.220	21.392.415	21.791.433	22.198.432	22.613.570	23.037.012	23.468.922
Property Lease	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000	222.000
Property Maintenance	312.343	318.590	324.962	331.461	338.090	344.852	351.749	358.784	365.960	373.279
Repairs	7.131.117	7.273.740	7.419.214	7.567.599	7.718.951	7.873.330	8.030.796	8.191.412	8.355.241	8.522.345
Personal	1.693.366	1.727.233	1.761.778	1.797.014	1.832.954	1.869.613	1.907.005	1.945.145	1.984.048	2.023.729
Management Fees	937.029	955.769	974.885	994.382	1.014.270	1.034.556	1.055.247	1.076.352	1.097.879	1.119.836
Insurance	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500	1.219.500
Annual Reporting	312.343	318.590	324.962	331.461	338.090	344.852	351.749	358.784	365.960	373.279
Input material	8.045.363	8.206.270	8.370.396	8.537.804	8.708.560	8.882.731	9.060.386	9.241.593	9.426.425	9.614.954
Leasing fees (if relevant)	0	0	0	0	0	0	0	0	0	0
EBITDA (€)	6.832.688	6.998.172	7.166.965	7.339.134	7.514.747	7.693.872	7.876.579	8.062.941	8.253.030	21.020.299
Depreciation (€)	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747
EBIT (€)	4.437.941	4.603.425	4.772.218	4.944.387	5.120.000	5.299.125	5.481.833	5.668.194	5.858.283	18.625.552
Interest Income	56.846	56.846	56.846	56.846	56.846	0	0	0	0	0
Interest Payments	1.155.247	949.285	731.480	501.151	257.578	0	0	0	0	0
Extraordinary Income	0	0	0	0	0	0	0	0	0	0
Income before Tax (€)	3.339.540	3.710.986	4.097.585	4.500.083	4.919.268	5.299.125	5.481.833	5.668.194	5.858.283	18.625.552
Tax (€)	701.971	780.049	861.312	945.917	1.034.030	1.113.876	1.152.281	1.191.454	1.231.411	3.915.091
Income after Tax (€)	2.637.569	2.930.937	3.236.272	3.554.165	3.885.238	4.185.249	4.329.551	4.476.740	4.626.872	14.710.461
Debt Service Coverage Ratio (DSCR)	144%	148%	151%	155%	159%	0%	0%	0%	0%	0%
Cash Flow										
Income after Tax	2.637.569	2.930.937	3.236.272	3.554.165	3.885.238	4.185.249	4.329.551	4.476.740	4.626.872	14.710.461
+ Depreciations	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747	2.394.747
- Investments										
Operating Cash Flow	5.032.316	5.325.684	5.631.019	5.948.912	6.279.985	6.579.996	6.724.298	6.871.487	7.021.619	17.105.208
+ Increase in Passiva (Debt)										
+ Increase from Investor (Equity)										
- Debt Repayment	3.581.953	3.787.915	4.005.720	4.236.049	4.479.622	0	0	0	0	0
Cash Flow before Dividends	1.450.363	1.537.769	1.625.299	1.712.863	1.800.363	6.579.996	6.724.298	6.871.487	7.021.619	17.105.208
Dividends to Investor	1.450.363	1.537.769	1.625.299	1.712.863	6.537.563	6.579.996	6.724.298	6.871.487	7.021.619	17.105.208
Change in Working Capital	0	0	0	0	-4.737.200	0	0	0	0	0
Working Capital cummulative, at year-end)	4.737.200	4.737.200	4.737.200	4.737.200	0	0	0	0	0	0
Analysis from an Investor´s Perspective										
Equity Paid-In	0	0	0	0	0	0	0	0	0	0
Dividends	1.450.363	1.537.769	1.625.299	1.712.863	6.537.563	6.579.996	6.724.298	6.871.487	7.021.619	17.105.208
- of which Payback of Equity Paid-In	0	0	0	0	0	0	0	0	0	0
- of which Profit to Investor	1.450.363	1.537.769	1.625.299	1.712.863	6.537.563	6.579.996	6.724.298	6.871.487	7.021.619	17.105.208
Cash Flow	1.450.363	1.537.769	1.625.299	1.712.863	6.537.563	6.579.996	6.724.298	6.871.487	7.021.619	17.105.208

7 Comparison and Financial Results

The financial feasibility of the project in this study is done by a cash flow analysis. A cash flow analysis is one of different kinds of statements for the measure of the financials of a project. To implement a project and for the life time of the project it is important to get sufficient cash out of the project for to finalize the transaction.

The input parameters for the financial scenario are given in chapter 6.3 “Financial assessment via cash flow analysis”. As already described three different cases have been set up and calculated over the life time of the project. Revenues and costs are based on values for the entire year 2013.

The presented and calculated CCC-project in Herne is up to now not set up and there is not any kind of similar power-plant running in an industrial scale over the world. Most data derived on information from the engineers and the group of investors.

In order to compare the results of the previously examined cash flow analysis Table 7-1 gives an overview on the results of the main financial aspects investigated by this method. The bestcase scenario should be mentioned in this case as the input material costs are negative because of subsidized feedstock.

Table 7-1: Overview on the results for the main financial aspects considered in cash flow analysis: Accumulated values for revenue, input material costs, costs for maintenance & repairs, other operating costs and the accumulated cash flow over the course of 20 years of project life time (data source: AKKON AG (2013))

Scenario in Cash Flow analysis	**Revenue [M€]**	**Input material costs [M€]**	**Costs for maintenance & repairs [M€]**	**Other operation costs [M€]**	**Accumulated Cash flow [M€]**
Bestcase	561.3	- 15.3	146.5	96.8	270.3
Basecase	561.3	45.1	146.5	96.8	156.0
Worstcase	561.3	165.3	146.5	96.8	61.0

To assess the temporal progress of annual cash flows related to the three scenarios Figure 13 provides the shape of development of annual revenues, annual input material costs for the three investigated scenarios, annual costs of maintenance and repairs and annual operating costs over the course of time.

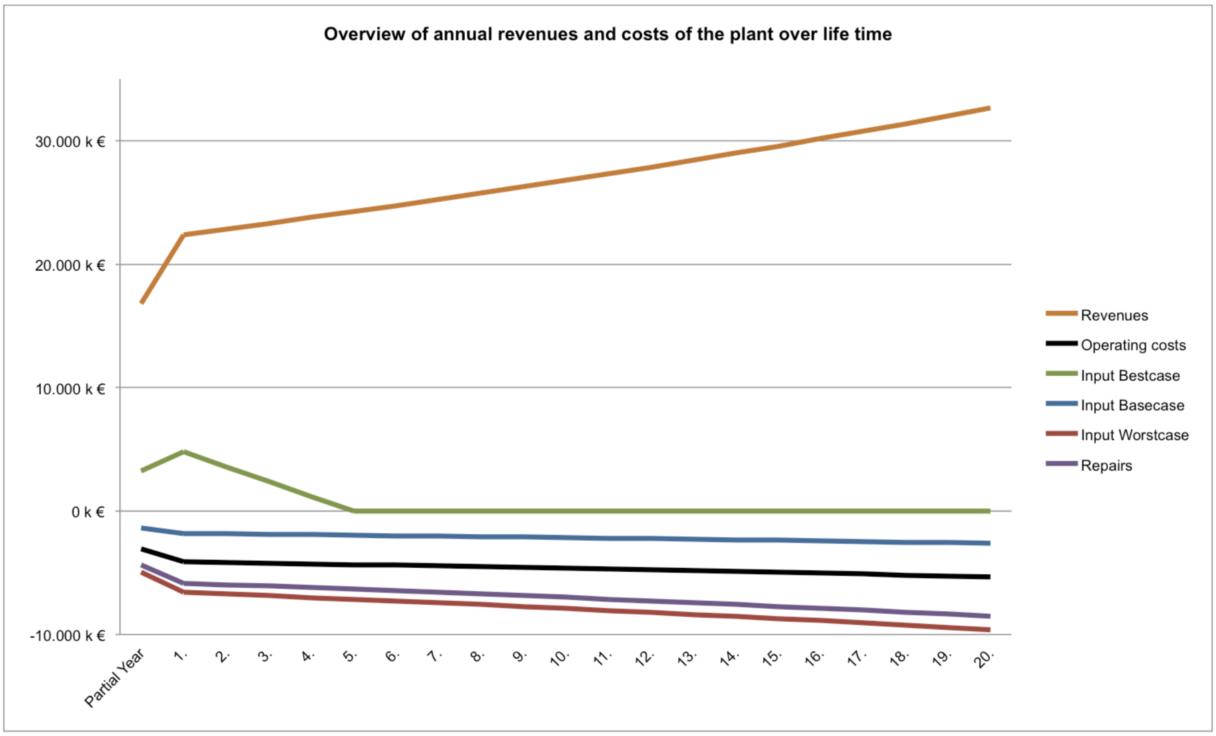

Figure 13: Summary of main financial aspects for cash flow analysis: Shape of development of annual revenues, annual input material costs for the 3 investigated scenarios, annual costs for maintenance & repairs and annual operating costs over the course of time (data source: AKKON AG (2013))

Based on the summary of these financial aspects in the further subchapters more detailed discussion and evaluation of the cash flow analysis results will be outlined.

7.1 Revenues

All three scenarios stay constant in the revenue and will only change in case of a higher or lower market price for crude oil. The development of the oil market gives the indication of increasing revenues of the CCC-power-plant because of higher oil prices. As the market developed in the past decreasing oil prices could not be expected. On the other hand new oil fields are explored but increasing oil consumption will still push the demand for oil and consequently the prices will rise. The energy outlook to the future is promising for any scenario in any case.

7.2 Input Material Costs

Table 7-1 clearly shows that in the bestcase scenario the input costs are the lowest compared to the basecase because of the highest share of subsidies. The bestcase scenario is characterised by input material from the car recycling industry, which means high energy content in the feedstock put into the process. Due to the high energy content (conversion efficiency in depolymerisation is almost reached up to 94 %) and the potential for toxic emissions thermo-chemical conversion (i.e. incineration) is not permitted.

That is a reason why the supplier for this input materials of the CCC-process has to give additional payments. These materials are actually available in a high quantity in the world wide market for secondary raw materials.

The basecase describes the scenario of input material based on shredded yellow sack fractions. This type of secondary raw material is collected all over Europe with a high level of purity with low content of enclosed non-convertible matter. The energy content is as high as in case of shredded fractions of the car recycling industry. It has to be paid with 30 €/Mt by the operator of the plant.

In the worstcase scenario an input material price of 110 €/Mt is assumed. This price could be the result of a lack of secondary raw materials of any type of the market or could be the consequence of a competitive situation on the market for raw material in general (i.e. biomass).

As biomass is a multiple feedstock for energy generation it is in competition between common use and the CCC-process. The input price is related to the current market price of unit feedstock for the wood fuel industry. Due to the energy content of woody biomass the effective efficiency in the CCC-process will be about 46%. This is about half of the conversion efficiency, which can be achieved with the material from bestcase and basecase.

7.3 Costs for Maintenance & Repairs

In all three scenarios the maintenance costs represent a high share within the operating costs in general. Due to the permanent operation of the plant and the high throughput of material the wear and tear is assumed to be above average. Consequently the estimated percentage rate for the annual maintenance costs clearly indicates this basic assumption.

As the basic investment is equal in all three scenarios and the resulting maintenance costs are the same in bestcase, basecase and worstcase a variation of price change rate for maintenance costs would affect all three scenarios to the same extent. That means that in all three scenarios a remarkable increase of maintenance costs will lead to a significant change in the annual cash flow.

For example, if the accumulated maintenance costs increase about 20% the accumulated cash flow in the bestcase scenario will affect the cash flow at all but will not influence the positive economical results of the project. In the basecase scenario higher maintenance costs will decrease the accumulated cash flow equally as the maintenance costs will increase.

Considering the same frame conditions in the worstcase scenario the accumulated cash flow will be reduced to the half if maintenance costs increase for about 20% in the accumulated maintenance costs. In the reverse case of decreasing maintenance costs the influences on the accumulated cash flow will be vice versa with respect to the different investigated scenarios.

7.4 Other Operating Costs

In other operating costs besides personal, management, insurance and property costs also consumption costs are not assumed. The relation of used energy for the process to energy content of input materials stays the same for all three scenarios. The own consumption will not influence the cash flow, as the energy supply is provided of about 10% of the product oil.

Compared to the other portion of costs insurance costs are relatively high but equal in all three scenarios. The installation of a CCC-power-plant is already new and for the insurance company this type of technology is more or less unknown. That could be the reason for the applied level of insurance costs. Despite of this fact the impact on the accumulated cash flow is low.

7.5 Cash Flow

The main result of the cash flow analysis is the development of accumulated cash flow over the period of the investment project. Figure 14 displays the course of the cash flow curves based on the three scenarios calculated in chapter 6.3. Obviously the scope of the curve is similar in the three case studies.

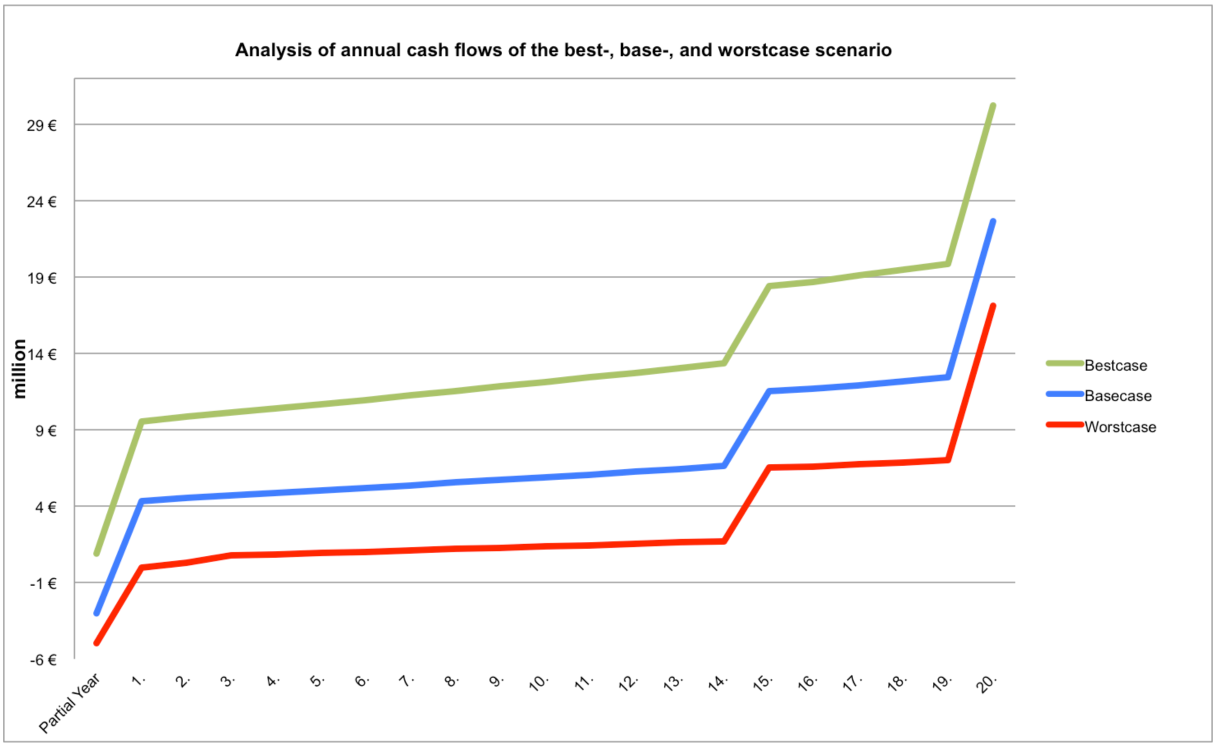

Figure 14: Summary of scenarios: Shape of cash flow analysis for worstcase, basecase and bestcase over the course of time (data source: AKKON AG (2013))

In the start up phase of the project the first year of operation is considered as period were the full equity – 10% of investment – will be paid back.

After the first full year of operation all three scenarios are in a positive cash flow. In Figure 14 this effect is represented by the first sharp bend of curve. In the upcoming period of the following 13 years the annual cash flows increase linearly within the positive cash flow range (year 14 min. 1.7 mio. €, max. 12.2 mio. €).

In year 15 the total loan will be paid back and annual cash flows are rising to a new level because of missing debt and interest payments. This hike of 4.7 mio. € is valid for all three calculated models.

In the following 4 years the cash flow still grows due to the assumed inflation rate on a high level. The final year is characterized by the release of reserves accumulated by annual surplus funds. The different level of the annual cash flow behaviour is the consequence of different prices for the feedstock.

The financial highlights of a CCC-project are the positive cash flow after full year one in all three scenarios as well as the return of equity within a period of maximal two years in the worstcase scenario. Typically other projects in renewable energy will calculate with at least six to ten years to reach a positive cash flow and the return of equity.

Figure 15 is a graph displaying the cash flow column of Table 7-1 with the accumulated cash flows over a period of 20 years for all three scenarios. The accumulated cash flow is positive in all cases.

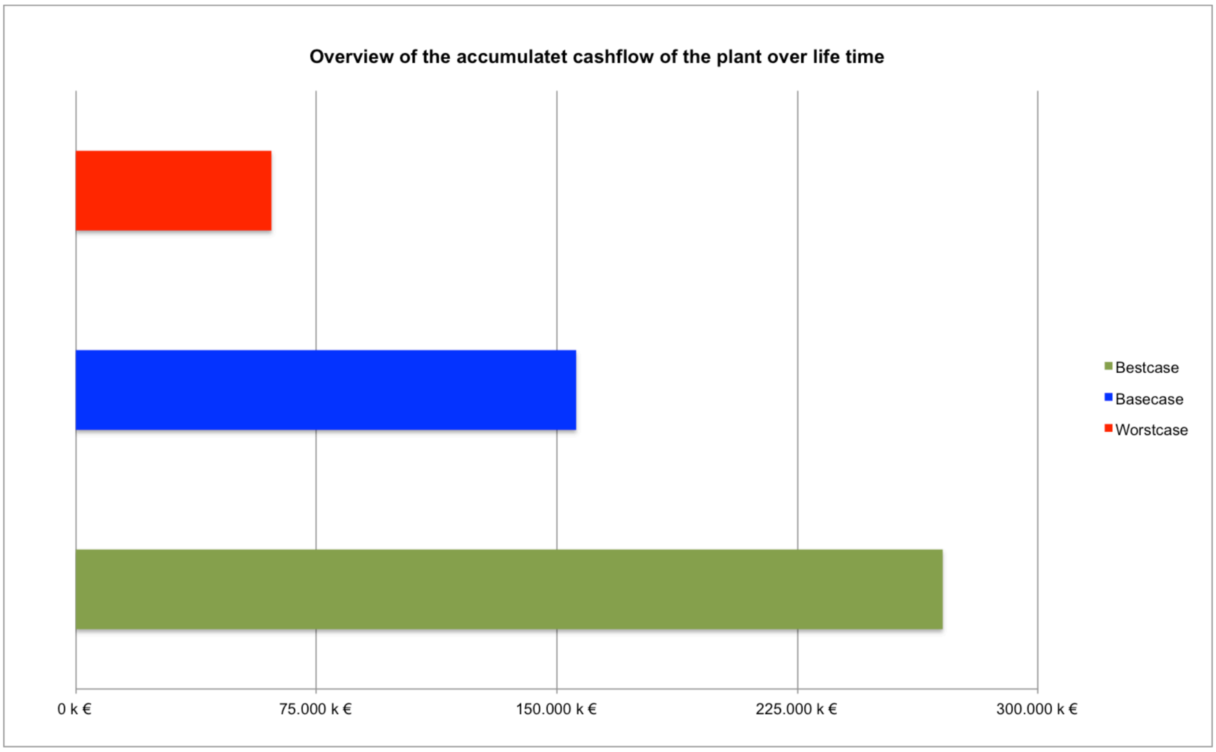

Figure 15: Overview on accumulated cash flow for the investigated finance models: worstcase, basecase and bestcase (data source: AKKON AG (2013))

If the equity finance is compared to the accumulated cash flow of the three scenarios the following results can be determined:

- In the worstcase the applied equity is multiplied 12 times in relation to the accumulated cash flow.
- In the basecase the applied equity is multiplied 31 times in relation to the accumulated cash flow.
- In the bestcase the applied equity is multiplied 54 times in relation to the accumulated cash flow.

Based on the results for accumulated cash flow the financial risk for the potential investor is low in any case and the attractiveness rises with the type of converted input material.

8 Conclusions

The technology described in this study implies a number of issues relating to the development of second generation biofuels industries. The CCC-Technology is a full commercial, unsubsidized and economic potential. Every investor will need to be able to adapt CCC-conversion-technologies to local conditions and long term feedstock. The focus of this study has been on describing the CCC-Technology and its economic status. The return of equity is realized even in the worstcase scenario within the first two years that means almost small risk for the investor.

Second generation biofuels transform in use of biomass the total biomass of the plant, which is not used for food production. In case of use of secondary raw material as feedstock – shown in the financial scenarios – the system is running in an economical and ecological way. Depending on that kind of feedstock the conversion costs are on the right way to implement the CCC-Technology for the efficient production of second generation of biofuels. The costs of feedstock for production second generation biofuels are lower than the feedstock of first generation biofuels. Secondary raw materials will be paid at the moment. That means in the future – the costs of second generation biofuels from the CCC-process in large scaled commercial production will be similar or relatively lower than fuels out of fossil oil.

At the moment The CCC-Technology is a stand alone process with a high potential for its establishment in the market for liquid fuels. The possible feedstock is available world wide and mostly residues of agricultural production, industry or waste collection. The energy content and the purity of the input material are important for the efficiency in the conversion process.

The product can be implemented in the market by use of the existing distribution and filling infrastructure of conventional fuels, so the product is for multifunctional use for energy supply. The development of the revenues by operating a CCC-power-plant depends on the market prices for crude oil. The higher the price for crude oil, the higher the cash flow for the investor. Even the worstcase scenario with high input prices shows a positive accumulated cash flow.

The CCC-process running in the power-plant pilot was a clear demonstration of a new technology that has to be implemented comprehensive. This system is proven in an industrial way and in a stable process. It is easy to implement the plant at almost every site. The CCC-Technology has to be multiplied for a greener and cleaner future for next generations. It is helpful to establish waste disposal systems in developing countries that have not to be paid by the people.

As reflected the implementation and operation of a CCC-power-plant will be in all three scenarios like a cash cow. The investor has low risk because of a short period of payback; the high maintenance costs will not influence the high cash flow over twenty years. From this point of view the investment is a must.

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Annex

Annex 1: Documentation of pilot project: The patent

(19)
Bundesrepublik Deutschland
Deutsches Patent- und Markenamt

(10) **DE 10 2005 057 653 A1** 2007.09.06

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(71) Anmelder:
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DE 27 13 031 B
DE 198 22 568 A1
DE 195 17 096 A1
DE 100 21 383 A1

Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

Prüfungsantrag gemäß § 44 PatG ist gestellt.

(54) Bezeichnung: **Verfahren zur Konversion organischer Sekundärrohstoffe zu Ölnebel und Verrichtung zur Durchführung des Verfahrens**

(57) Zusammenfassung: Es handelt sich um ein Verfahren zur Konversion organischer Sekundärrohstoffe zu Ölnebel und eine Vorrichtung dafür, wobei die Konversion durch eine katalytische Depolymerisation bei 320-380°C unter Sauerstoffabschluss erfolgt und die Vorrichtung eine Trommel umfasst, deren Innenseite von einer hochtemperaturfesten hochsäurefesten hochabriebfesten Legierung, wie z. B. Hastelloy®, besteht und die Trommel eine Einrichtung aufweist, durch welche Abgase einer Wärmekraftmaschine, vorzugsweise einer Gasturbine, zu Heizungszwecken durch die Trommel geleitet werden können, ohne dass die Abgase in einen Konversionsraum gelangen (Figur).

Beschreibung

[0001] Die Erfindung betrifft ein Verfahren zur Konversion organischer Sekundärrohstoffe zu Ölnebel und eine Vorrichtung zur Durchführung eines solchen Verfahrens. Ein solches Verfahren und eine solche Vorrichtung sind bereits aus der DE 100 21 383 A1 bekannt. Bei dem bekannten Verfahren und der bekannten Vorrichtung werden die organischen Sekundärrohstoffe mittels Pyrolyse bei 450–480° Celsius konvertiert. Bei Temperaturen über 420° Celsius entstehen aber Dioxine, so dass diese Methode bzw. eine solche Vorrichtung einen Nachteil aufweisen.

[0002] Aufgabe der vorliegenden Erfindung ist es, einen solchen Nachteil zu vermeiden.

[0003] Diese Aufgabe wird dadurch gelöst, dass bei einem Verfahren die Konversion durch katalytische Depolymerisation bei 320–380° Celsius unter Sauerstoffabschluss erfolgt.

[0004] Ein solches erfindungsgemäßes Verfahren kann in einer Vorrichtung durchgeführt werden, welche eine Trommel umfasst, deren Innenseite aus einer hochtemperaturfesten hochsäurefesten hochabriebfesten Legierung, wie z.B. Hastelloy® besteht und die Trommel eine Einrichtung aufweist, durch welche Abgase einer Wärmekraftmaschine, z.B. einer Gasturbine zur Heizung durch die Trommel geleitet werden können, ohne dass die Abgase in einen Konversionsraum gelangen.

[0005] Bevorzugte Ausführungsbeispiele sind in den Unteransprüchen dargestellt.

[0006] Ein besonders bevorzugtes Ausführungsbeispiel soll anhand der Zeichnung erläutert werden, welche eine Konversionstrommel mit Anschlüssen darstellt. Die Konversionstrommel **1** hat zwei innere Nabenanschlüsse **2** und **3**, wobei in dem inneren Nabenanschluss **2** eine (nicht dargestellte) Schnecke befindlich ist, deren Umfang mit dem Umfang der Öffnung abschließt.

[0007] Außerdem sind zwei Öffnungen **4** und **5** zur Durchleitung von Abgasen einer Wärmekraftmaschine wie einer Gasturbine durch die Trommel vorgesehen. Organische Sekundärrohstoffe werden im gegebenenfalls verkleinerter Form von dem Behälter **7** in die Eintrittsöffnung **2** der Trommel geleitet, so dass sie in die Trommel **1** gelangen.

[0008] In der Trommel **1** befinden sich am inneren Umfang insbes. hypoid-geformte spiralisch angeordnete Führungsleisten **9**, z.B. Hebe- bzw. Transpartleisten, welche befestigt bzw. angeheftet sind. Diese Hebe- bzw. Transportleisten sind in Rotationsrichtung der Trommel leicht gekrümmt und konvex. Diese können vorteilhafterweise in ihrem Verlauf auch Unterbrechungen **8** aufweisen. Sie transportieren die organischen Sekundärrohstoffe zusammen mit dem Katalysator, welcher aus einer Schwertwäsche zusammen mit Prozessöl in die Eintrittsöffnung **2** geleitet wird.

[0009] Das Katalysatorpulver und die organischen Rohstoffe wandern nun durch die Trommel, wo bei 320–384° Celsius die katalytische Umwandlung stattfindet. Ein Anbacken des Katalysatorpulvers an der beheizten Trommel wird durch ein mineralförmiges Additiv verhindert, welches ebenfalls pulverförmig ist.

[0010] Der entstehende Ölnebel wird durch die Auslasöffnung **3** zu einer Wärmekraftmaschine bzw. der Gasturbine bzw. zu einer Fraktionierungsklonne geleitet und der mit Prozessabfällen verunreinigte Katalysator wird zusammen mit Prozessöl in die Schwertwäsche geleitet. Dies geschieht mit Hilfe eines Schwingschlauches und Schwerkraft. Aus der Schwertwäsche heraus wird das gereinigte Katalysatorpulver mit dem Prozessöl durch einen spiralförmigen Förderer in die Eintrittsöffnung **2** der Trommel zurückgefördert.

[0011] Gemäß der Abbildung sind innerhalb der Trommel Rohre **6** angeordnet, durch welche das Abgas strömt. Diese auch als Transportstäbe dienenden Rohre können ebenso wie die Innenseite der Trommel aus Hastelloy® sein. Aus Hastelloy® sind auch die Transport- bzw. Hebeleisten **9**. Die Trommel kann auch beheizt werden, indem die Abgase durch einen Zwischenraum eines nicht dargestellten Außenmantels und des Innenmantels geleitet werden, wobei der Außenmantel aus Edelstahl ist.

[0012] Die Abgase können auch ebenfalls durch die Profile der Hebe- bzw. Transportleisten **9** geleitet werden, welche vom Konversionsraum abgeschlossen sind. Evtl. entstehendes Chlorgas wird durch die katalytische Umwandlung zu Salzen verarbeitet, welche zusammen mit dem Katalysator und dem Prozessöl in die Schwertwäsche gelangen. Dorthin gelangen auch abgesonderte Minerale und Metalle. Der äußere Ausgang **5** ist mit einer Einrichtung zur Gewinnung destillierten Wassers aus Wasserdampf bzw. Wassergas verbunden. Der Eingang **4** mit dem Abgasrohr der Wärmekraftmaschine bzw. der Gasturbine.

[0013] Außerdem kann nach vor dem Nabeneingang **2** in Richtung des Behälters **7** für Sekundärrohstoffe eine Zellenradschleuse mit ausgeschnittenen drehbaren Scheiben angeordnet sein, wobei, wenn die Zellenradschleuse in Richtung des Behälters **7** geschlossen und in Richtung der inneren Nabenöffnung **2** offen ist, in der Zellenradschleuse CO_2-Überdruck erzeugt wird.

Patentansprüche

1. Verfahren zur Konversion organischer Sekundärrohstoffe zu Ölnebel, **dadurch gekennzeichnet**, dass die Konversion durch katalytische Depolymerisation bei 320–380° Celsius unter Sauerstoffabschluss erfolgt.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass der für die katalytische Depolymerisation erforderliche Katalysator ein Aluminium-Silikatpulver ist.

3. Verfahren nach Anspruch 2, gekennzeichnet durch ein ein Anbacken des Katalysatorpulvers verhütendes pulverförmiges Additiv.

4. Verfahren nach Anspruch 3, dadurch gekennzeichnet, dass das Additiv ein Mineral ist.

5. Verfahren nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, dass die Konversion in einer beheizten Trommel (**1**) erfolgt, welche langsam rotiert.

6. Verfahren nach Anspruch 5, dadurch gekennzeichnet, dass eine einen Generator antreibende Wärmekraftmaschine vorzugsweise eine Gasturbine vorgesehen ist, mit den Verfahrensschritten, dass die Gasturbine mit einem durch ein Verfahren nach Anspruch 5 gewonnenen Ölnebel betrieben wird und die Abgase der Gasturbine die Trommel (**1**) heizen.

7. Verfahren nach einem der Ansprüche 2 bis 6, dadurch gekennzeichnet, dass das Aluminiumsilikatpulver langsam durch die Trommel transportiert, aus der Trommel ausgeleitet, durch Prozessöl von Prozessabfällen gereinigt und wieder in die Trommel eingeführt wird.

8. Verfahren nach einem der Ansprüche 6 oder 7, dadurch gekennzeichnet, dass aus den Abgasen der Gasturbine destilliertes Wasser gewonnen wird.

9. Vorrichtung zur Durchführung eines Verfahrens der Konversion organischer Sekundärrohstoffe zu Ölnebel, dadurch gekennzeichnet, dass die Vorrichtung eine Trommel (**1**) umfasst, deren Innenseite aus einer hochtemperaturfesten hochsäurefesten hochabriebfesten Lagierung wie zum Beispiel Hastelloy® besteht und die Trommel eine Einrichtung aufweist, durch welche Abgase einer Wärmekraftmaschine, vorzugsweise einer Gasturbine zur Heizung durch die Trommel geleitet werden können, ohne dass die Abgase in einen Konversionsraum gelangen.

10. Vorrichtung nach Anspruch 4, gekennzeichnet durch zwei Öffnungen (**2**, **3**) an Naben der Trommel (**1**), wobei eine Öffnung (**2**) eine Eintrittsöffnung in die Trommel (**1**) ist und eine rotierende Schraube aufweist, deren Umfang mit einem Umfang der Öffnung (**2**) abschließt und eine Öffnung (**3**) eine Austrittöffnung aus der Trommel (**1**) ist.

11. Vorrichtung nach Anspruch 9 oder 10, gekennzeichnet durch in Rotationsrichtung der Trommel (**1**) leichte gekrümmte konvexe Transport- bzw. Hebeleisten (**9**), welche vorzugsweise mit Unterbrechungen (**8**) am Innenumfang der Trommel (**1**) befestigt sind.

12. Vorrichtung nach Anspruch 11, dadurch gekennzeichnet, dass die Transport- bzw. Hebeleisten (**9**) aus einer hochtemperaturfesten hochsäurefesten hochabriebfesten Legierung, wie z.B. Hastelloy® bestehen.

13. Vorrichtung nach Anspruch 12, gekennzeichnet durch eine Anzahl von 24 bis 36 Windungen der Transport- bzw. Hebeleisten (**9**).

14. Vorrichtung nach einem der Ansprüche 10 bis 13, gekennzeichnet durch zwei weitere Öffnungen (**4**, **5**) an den Naben der Trommel (**1**), wobei eine Außenwand jeweils eine Öffnung (**2**, **3**), eine Innenwand jeweils eine weitere Öffnung (**4**, **5**) ist.

15. Vorrichtung nach Anspruch 14, gekennzeichnet durch einen Innenmantel und einen Außenmantel der Trommel (**1**) mit einem Zwischenraum zwischen dem Innenmantel und dem Außenmantel, wobei die weiteren Öffnungen (**4**, **5**) zur Durchleitung der Abgas-Heizgase mit dem Zwischenraum in Verbindung stehen.

16. Vorrichtung nach Anspruch 15, dadurch gekennzeichnet, dass der Innenmantel aus einer hochtemperaturfesten hochsäurefesten hochabriebfesten Legierung, wie z.B. Hastelloy® und der Außenmantel aus Edelstahl besteht.

17. Vorrichtung nach Anspruch 14, gekennzeichnet durch Rohre (**6**), welche durch den Innenraum der Trommel (**1**) verlaufen und mit den zwei weiteren Öffnungen (**4**, **5**) in Verbindung stehen.

18. Vorrichtung nach Anspruch 17, dadurch gekennzeichnet, dass die Rohre (**6**) aus einer hochtemperaturfesten hochsäurefesten hochabriebfesten Legierung, wie z.B. Hastelloy® gestehen.

19. Vorrichtung nach Anspruch 14, gekennzeichnet, dass die Transport- bzw. Hebeleisten (**9**) gasdicht vom Innenraum der Trommel (**1**) abgeschlossene Profile aufweisen und die Profile mit den weiteren Öffnungen (**4**, **5**) in Verbindung stehen.

20. Vorrichtung nach einem der Ansprüche 14 bis 19, dadurch gekennzeichnet, dass eine weitere Öff-

nung (**4**) mit einem Abgasrohr der Wärmekraftmaschine bzw. der Gasturbine in Verbindung steht.

21. Vorrichtung nach Anspruch 20, dadurch gekennzeichnet, dass die andere weitere Öffnung (**15**) mit einer Einrichtung zur Gewinnung von destilliertem Wasser aus Wasserdampf bzw. aus Wassergas in Verbindung steht.

22. Vorrichtung nach Anspruch 20 oder 21, dadurch gekennzeichnet, dass der Strömungsquerschnitt eines Verbindungsraumes zwischen den beiden weiteren Öffnungen (**4**, **5**) größer als der kleinste Strömungsquerschnitt des Abgasrohrs der Gasturbine ist.

23. Vorrichtung nach einem der Ansprüche 10 bis 22, dadurch gekennzeichnet, dass eine innere Nabenöffnung (**2**), welche eine Schnecke aufweist, mit einem Behälter (**7**) für organische Sekundärrohstoffe und einer Einrichtung für eine Schwertwäsche in Verbindung steht und die andere innere Nabenöffnung (**3**) mit einer Fraktionierungskolonne, einem Eingang der Grasturbine und der Einrichtung für Schwertwäsche in Verbindung steht.

24. Vorrichtung nach Anspruch 23, dadurch gekennzeichnet, dass die organischen Sekundärrohstoffe in die Trommel (**1**) zugefördert werden, ein in der Schwertwäsche gewaschenes Gemisch aus Katalysatorpulver und Prozessöl in die Trommel zurückgefördert wird, Prozessöl in die Fraktionierungskolonne und in die Gasturbine gefördert wird und ein Gemisch aus Katalysatorpulver und Prozessöl in die Einrichtung für die Schwertwäsche gefördert wird.

25. Vorrichtung nach einem der Ansprüche 10 bis 24, dadurch gekennzeichnet, dass die Eintrittsöffnung (**2**) der Trommel (**1**) einen leichtem CO_2-Überdruck aufweist.

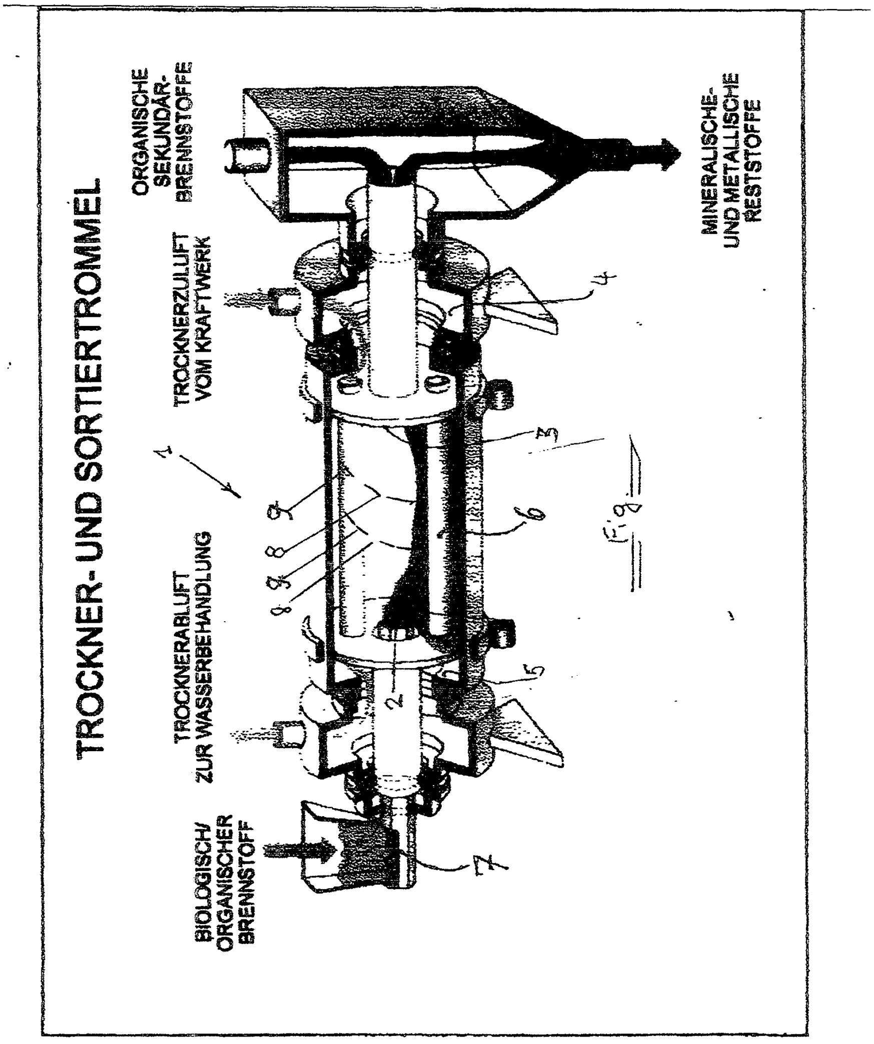
26. Vorrichtung nach einem der Ansprüche 10 bis 24, dadurch gekennzeichnet, dass die rotierende Schraube an der Eintrittsöffnung (**2**) aus Keramik besteht.

27. Vorrichtung nach Anspruch 25 oder 26, dadurch gekennzeichnet, dass vor der Eintrittsöffnung (**2**) in Richtung des Behälters (**7**) für Sekundärrohstoffe eine Zellenradschleuse angeordnet ist, welche aus zwei rohr-umfassenden drehbaren, mit jeweils einem Ausschnitt versehenen Scheiben besteht, wobei diejenige Scheibe, welche in Richtung des Behälters (**7**) angeordnet ist, für die Zuführung von Sekundärrohstoffen ihren Ausschnitt aufweist und anschließend wieder verschließbar ist und dann die Scheibe, welche in Richtung der Eintrittsöffnung angeordnet ist, ihren Ausschnitt zeigt und gleichzeitig in der Zellenradschleuse CO_2-Überdruck erzeugbar ist.

Es folgt ein Blatt Zeichnungen

DE 10 2005 057 653 A1 2007.09.06

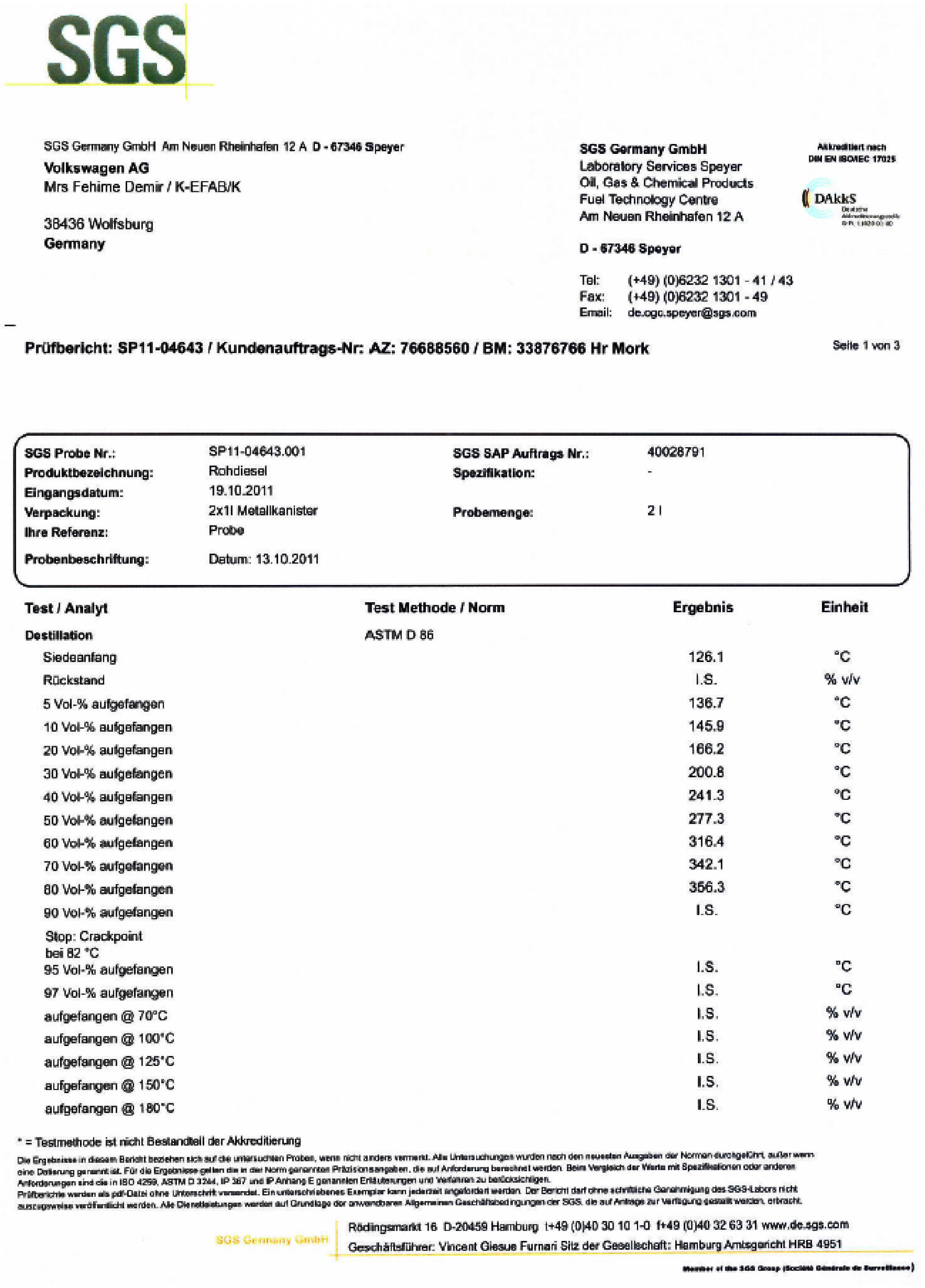
Anhängende Zeichnungen



5/5

Figure 16: Offenlegungsschrift by Deutsches Patent- und Markenamt, page 1 to 5 (source: Winkelkötter (2007)).

Annex 2: Analysis of the product



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DAkkS

Prüfbericht: SP11-04643 / Kundenauftrags-Nr: AZ: 76688560 / BM: 33876766 Hr Mork

Seite 1 von 3

SGS Probe Nr.:	SP11-04643.001	**SGS SAP Auftrags Nr.:**	40028791
Produktbezeichnung:	Rohdiesel	**Spezifikation:**	-
Eingangsdatum:	19.10.2011		
Verpackung:	2x1l Metallkanister	**Probemenge:**	2 l
Ihre Referenz:	Probe		
Probenbeschriftung:	Datum: 13.10.2011		

Test / Analyt	**Test Methode / Norm**	**Ergebnis**	**Einheit**
Destillation	ASTM D 86		
Siedeanfang		126.1	°C
Rückstand		I.S.	% v/v
5 Vol-% aufgefangen		136.7	°C
10 Vol-% aufgefangen		145.9	°C
20 Vol-% aufgefangen		166.2	°C
30 Vol-% aufgefangen		200.8	°C
40 Vol-% aufgefangen		241.3	°C
50 Vol-% aufgefangen		277.3	°C
60 Vol-% aufgefangen		316.4	°C
70 Vol-% aufgefangen		342.1	°C
80 Vol-% aufgefangen		356.3	°C
90 Vol-% aufgefangen		I.S.	°C
Stop: Crackpoint bei 82 °C			
95 Vol-% aufgefangen		I.S.	°C
97 Vol-% aufgefangen		I.S.	°C
aufgefangen @ 70°C		I.S.	% v/v
aufgefangen @ 100°C		I.S.	% v/v
aufgefangen @ 125°C		I.S.	% v/v
aufgefangen @ 150°C		I.S.	% v/v
aufgefangen @ 180°C		I.S.	% v/v

* = Testmethode ist nicht Bestandteil der Akkreditierung

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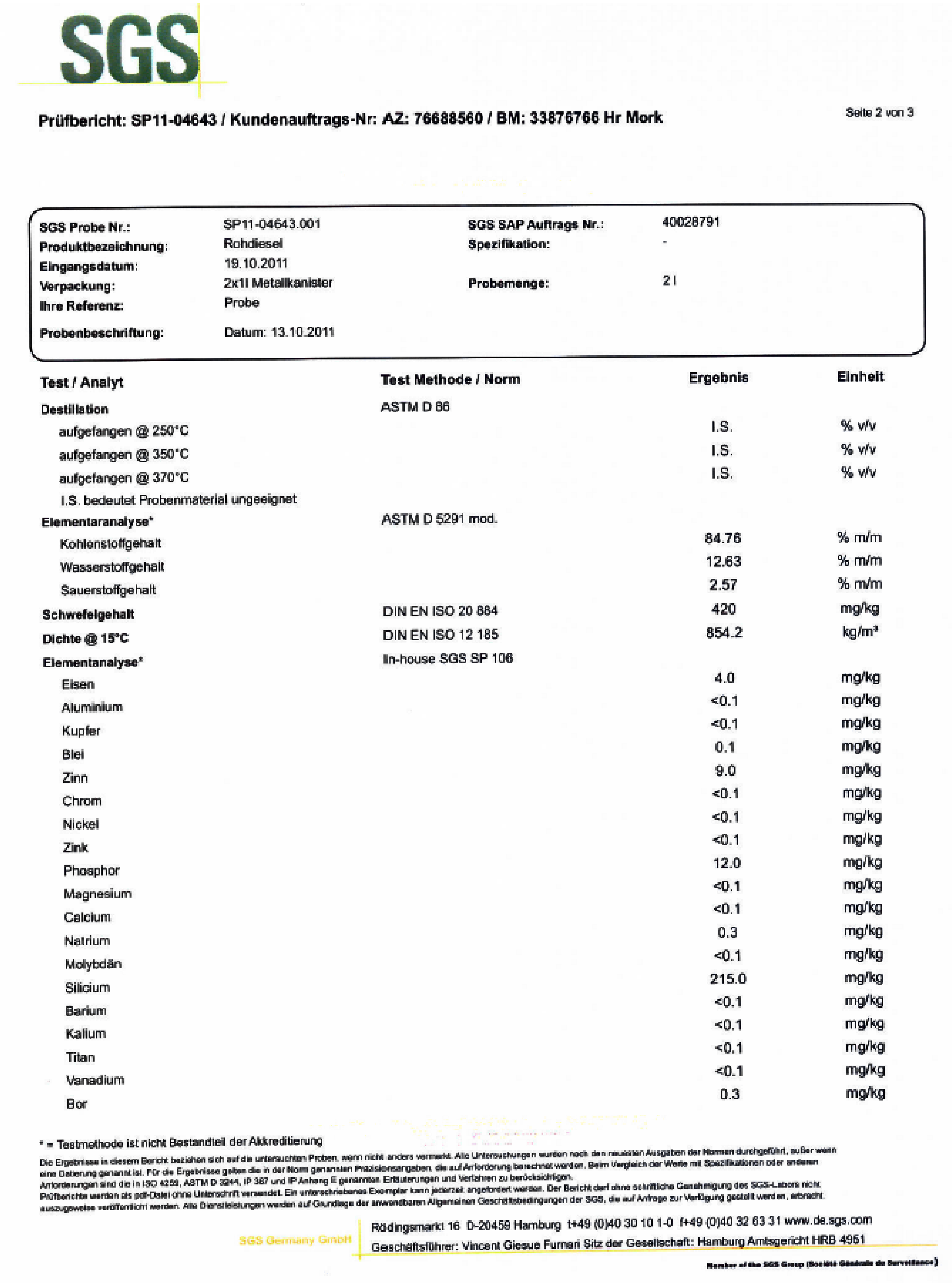

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Prüfbericht: SP11-04643 / Kundenauftrags-Nr: AZ: 76688560 / BM: 33876766 Hr Mork

Seite 2 von 3

SGS Probe Nr.:	SP11-04643.001	**SGS SAP Auftrags Nr.:**	40028791
Produktbezeichnung:	Rohdiesel	**Spezifikation:**	-
Eingangsdatum:	19.10.2011		
Verpackung:	2x1l Metallkanister	**Probemenge:**	2 l
Ihre Referenz:	Probe		
Probenbeschriftung:	Datum: 13.10.2011		

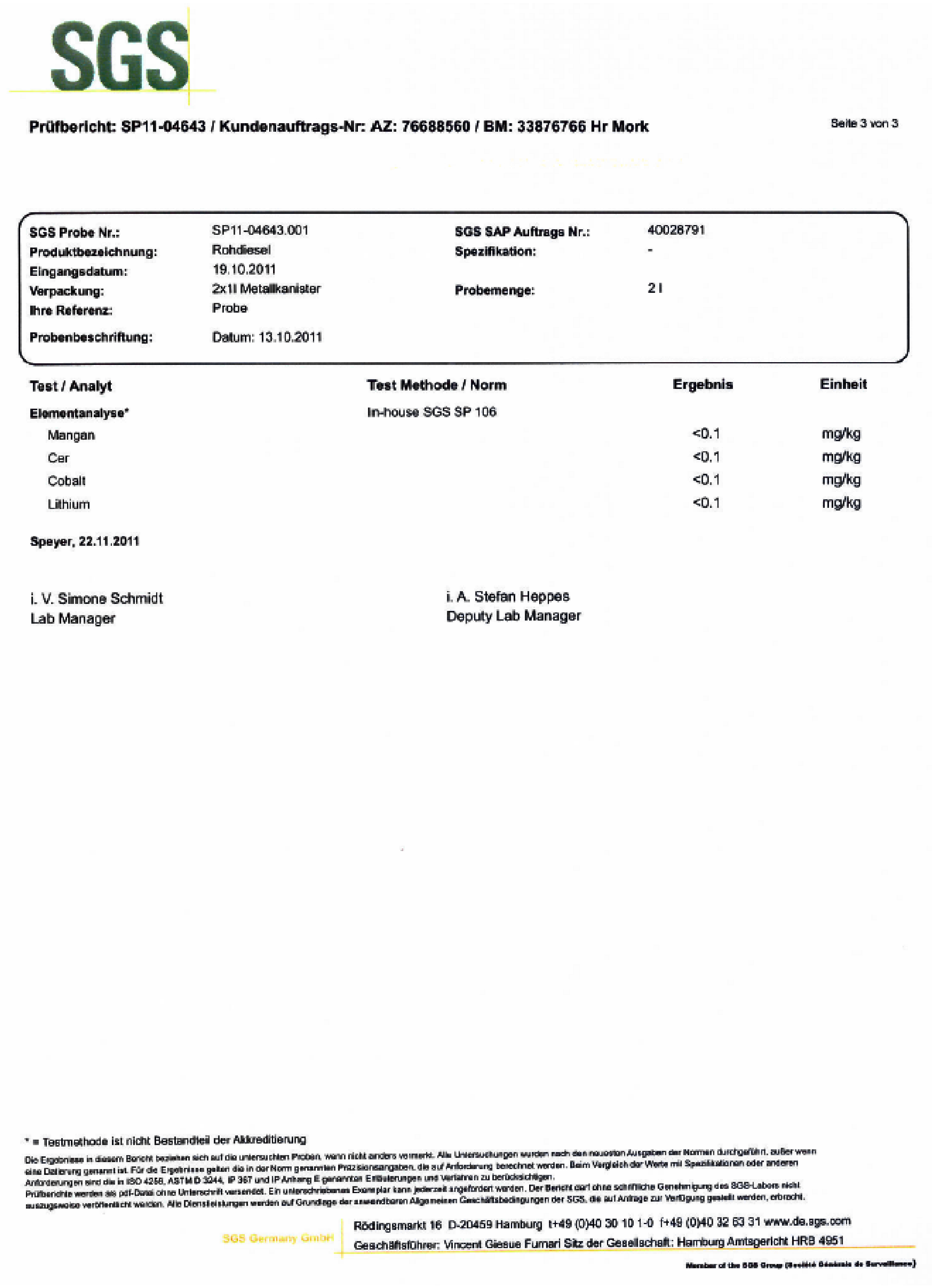
Test / Analyt	**Test Methode / Norm**	**Ergebnis**	**Einheit**
Destillation	ASTM D 86		
aufgefangen @ 250°C		I.S.	% v/v
aufgefangen @ 350°C		I.S.	% v/v
aufgefangen @ 370°C		I.S.	% v/v
I.S. bedeutet Probenmaterial ungeeignet			
Elementaranalyse*	ASTM D 5291 mod.		
Kohlenstoffgehalt		84.76	% m/m
Wasserstoffgehalt		12.63	% m/m
Sauerstoffgehalt		2.57	% m/m
Schwefelgehalt	DIN EN ISO 20 884	420	mg/kg
Dichte @ 15°C	DIN EN ISO 12 185	854.2	kg/m³
Elementanalyse*	In-house SGS SP 106		
Eisen		4.0	mg/kg
Aluminium		<0.1	mg/kg
Kupfer		<0.1	mg/kg
Blei		0.1	mg/kg
Zinn		9.0	mg/kg
Chrom		<0.1	mg/kg
Nickel		<0.1	mg/kg
Zink		<0.1	mg/kg
Phosphor		12.0	mg/kg
Magnesium		<0.1	mg/kg
Calcium		<0.1	mg/kg
Natrium		0.3	mg/kg
Molybdän		<0.1	mg/kg
Silicium		215.0	mg/kg
Barium		<0.1	mg/kg
Kalium		<0.1	mg/kg
Titan		<0.1	mg/kg
Vanadium		<0.1	mg/kg
Bor		0.3	mg/kg

* = Testmethode ist nicht Bestandteil der Akkreditierung

Die Ergebnisse in diesem Bericht beziehen sich auf die untersuchten Proben, wenn nicht anders vermerkt. Alle Untersuchungen wurden nach den neuesten Ausgaben der Normen durchgeführt, außer wenn eine Datierung genannt ist. Für die Ergebnisse gelten die in der Norm genannten Präzisionsangaben, die auf Anforderung berechnet werden. Beim Vergleich der Werte mit Spezifikationen oder anderen Anforderungen sind die in ISO 4259, ASTM D 3244, IP 367 und IP Anhang E genannten Erläuterungen und Verfahren zu berücksichtigen. Prüfberichte werden als pdf-Datei ohne Unterschrift versandet. Ein unterschriebenes Exemplar kann jederzeit angefordert werden. Der Bericht darf ohne schriftliche Genehmigung des SGS-Labors nicht auszugsweise veröffentlicht werden. Alle Dienstleistungen werden auf Grundlage der anwendbaren Allgemeinen Geschäftsbedingungen der SGS, die auf Anfrage zur Verfügung gestellt werden, erbracht.

SGS Germany GmbH
Rödingsmarkt 16 D-20459 Hamburg t+49 (0)40 30 10 1-0 f+49 (0)40 32 63 31 www.de.sgs.com
Geschäftsführer: Vincent Giesue Furnari Sitz der Gesellschaft: Hamburg Amtsgericht HRB 4961

Member of the SGS Group (Société Générale de Surveillance)



SGS

Prüfbericht: SP11-04643 / Kundenauftrags-Nr: AZ: 76688560 / BM: 33876766 Hr Mork

Seite 3 von 3

SGS Probe Nr.:	SP11-04643.001	**SGS SAP Auftrags Nr.:**	40028791
Produktbezeichnung:	Rohdiesel	**Spezifikation:**	-
Eingangsdatum:	19.10.2011		
Verpackung:	2x1l Metallkanister	**Probemenge:**	2 l
Ihre Referenz:	Probe		
Probenbeschriftung:	Datum: 13.10.2011		

Test / Analyt	**Test Methode / Norm**	**Ergebnis**	**Einheit**
Elementanalyse*	In-house SGS SP 106		
Mangan		<0.1	mg/kg
Cer		<0.1	mg/kg
Cobalt		<0.1	mg/kg
Lithium		<0.1	mg/kg

Speyer, 22.11.2011

i. V. Simone Schmidt
Lab Manager

i. A. Stefan Heppes
Deputy Lab Manager

* = Testmethode ist nicht Bestandteil der Akkreditierung

Die Ergebnisse in diesem Bericht beziehen sich auf die untersuchten Proben, wenn nicht anders vermerkt. Alle Untersuchungen wurden nach den neuesten Ausgaben der Normen durchgeführt, außer wenn eine Datierung genannt ist. Für die Ergebnisse gelten die in der Norm genannten Präzisionsangaben, die auf Anforderung berechnet werden. Beim Vergleich der Werte mit Spezifikationen oder anderen Anforderungen sind die in ISO 4259, ASTM D 3244, IP 367 und IP Anhang E genannten Erläuterungen und Verfahren zu berücksichtigen. Prüfberichte werden als pdf-Datei ohne Unterschrift versendet. Ein unterschriebenes Exemplar kann jederzeit angefordert werden. Der Bericht darf ohne schriftliche Genehmigung des SGS-Labors nicht auszugsweise veröffentlicht werden. Alle Dienstleistungen werden auf Grundlage der anwendbaren Allgemeinen Geschäftsbedingungen der SGS, die auf Anfrage zur Verfügung gestellt werden, erbracht.

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Geschäftsführer: Vincent Giesue Fumari Sitz der Gesellschaft: Hamburg Amtsgericht HRB 4951

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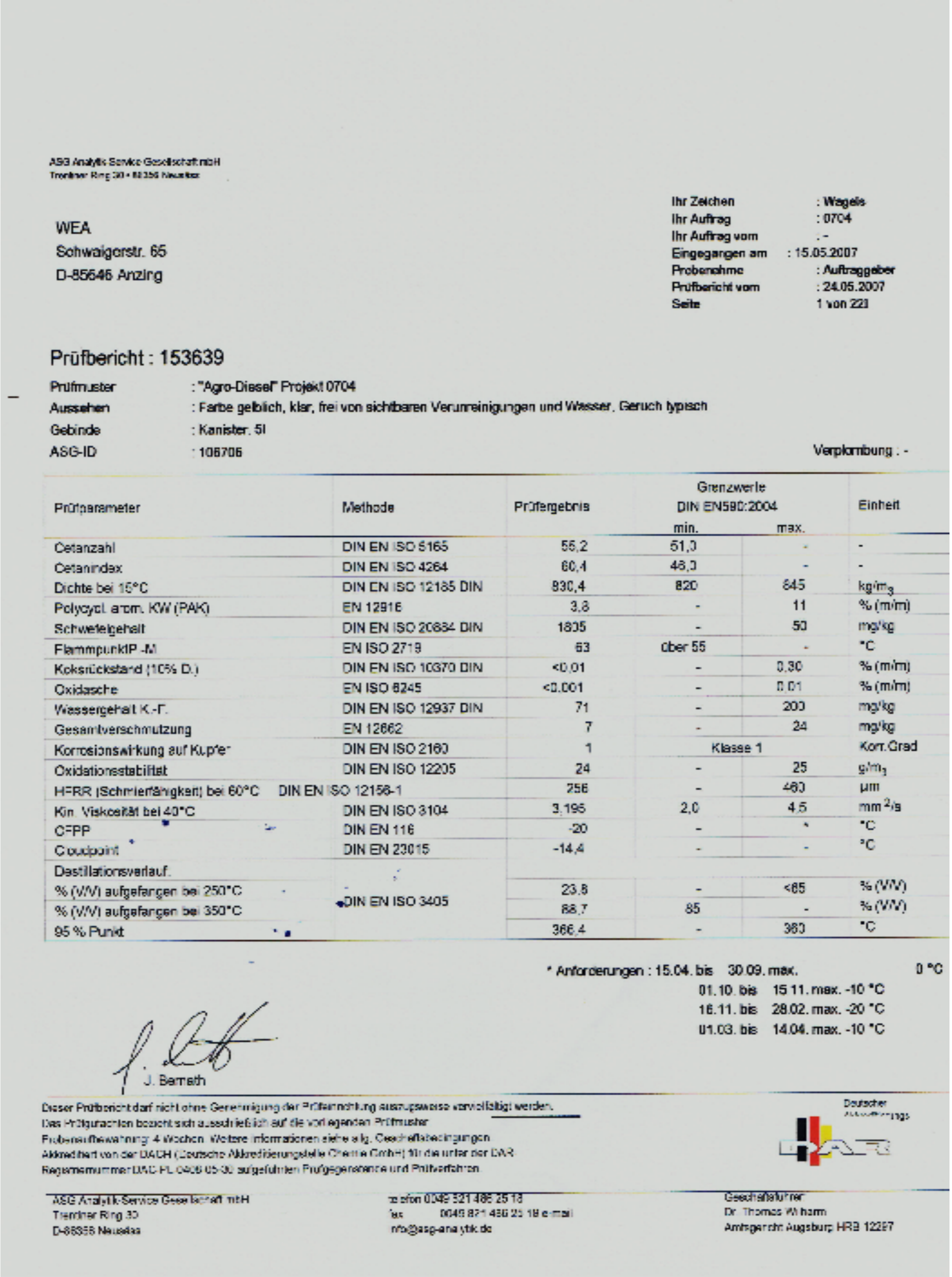
Figure 17: Analysis report of gas oil generated out of yellow sack material, page 1 to 3 (source: SGS (2011).

Annex 2a: Analysis of the product



ASG Analytik Service Gesellschaft mbH
Trentiner Ring 30 • 86356 Neusäss

WEA
Schwaigerstr. 65
D-85646 Anzing

Ihr Zeichen : Wagels
Ihr Auftrag : 0704
Ihr Auftrag vom : -
Eingegangen am : 15.05.2007
Probenahme : Auftraggeber
Prüfbericht vom : 24.05.2007
Seite 1 von 2

Prüfbericht : 153639

Prüfmuster : "Agro-Diesel" Projekt 0704
Aussehen : Farbe gelblich, klar, frei von sichtbaren Verunreinigungen und Wasser, Geruch typisch
Gebinde : Kanister, 5l
ASG-ID : 106706
Verplombung : -

Prüfparameter	Methode	Prüfergebnis	Grenzwerte DIN EN590:2004 min.	Grenzwerte DIN EN590:2004 max.	Einheit
Cetanzahl	DIN EN ISO 5165	55,2	51,0	-	-
Cetanindex	DIN EN ISO 4264	60,4	46,0	-	-
Dichte bei 15°C	DIN EN ISO 12185 DIN	830,4	820	845	kg/m3
Polycycl. arom. KW (PAK)	EN 12916	3,8	-	11	% (m/m)
Schwefelgehalt	DIN EN ISO 20884 DIN	1805	-	50	mg/kg
Flammpunkt P.-M.	EN ISO 2719	63	über 55	-	°C
Koksrückstand (10% D.)	DIN EN ISO 10370 DIN	<0,01	-	0,30	% (m/m)
Oxidasche	EN ISO 6245	<0,001	-	0,01	% (m/m)
Wassergehalt K.-F.	DIN EN ISO 12937 DIN	71	-	200	mg/kg
Gesamtverschmutzung	EN 12662	7	-	24	mg/kg
Korrosionswirkung auf Kupfer	DIN EN ISO 2160	1	Klasse 1		Korr.Grad
Oxidationsstabilität	DIN EN ISO 12205	24	-	25	g/m3
HFRR (Schmierfähigkeit) bei 60°C	DIN EN ISO 12156-1	256	-	460	µm
Kin. Viskosität bei 40°C	DIN EN ISO 3104	3,195	2,0	4,5	mm²/s
CFPP	DIN EN 116	-20	-	*	°C
Cloudpoint	DIN EN 23015	-14,4	-	-	°C
Destillationsverlauf					
% (V/V) aufgefangen bei 250°C	DIN EN ISO 3405	23,8	-	<65	% (V/V)
% (V/V) aufgefangen bei 350°C		88,7	85	-	% (V/V)
95 % Punkt		366,4	-	360	°C

* Anforderungen : 15.04. bis 30.09. max. 0 °C
01.10. bis 15.11. max. -10 °C
16.11. bis 28.02. max. -20 °C
01.03. bis 14.04. max. -10 °C

J. Barnath

Dieser Prüfbericht darf nicht ohne Genehmigung der Prüfeinrichtung auszugsweise vervielfältigt werden.
Das Prüfgutachten bezieht sich ausschließlich auf die vorliegenden Prüfmuster.
Probenaufbewahrung: 4 Wochen. Weitere Informationen siehe allg. Geschäftsbedingungen.
Akkreditiert von der DACH (Deutsche Akkreditierungsstelle Chemie GmbH) für die unter der DAR-Registriernummer DAC-PL-0406-05-30 aufgeführten Prüfgegenstände und Prüfverfahren.

Deutscher Akkreditierungs Rat

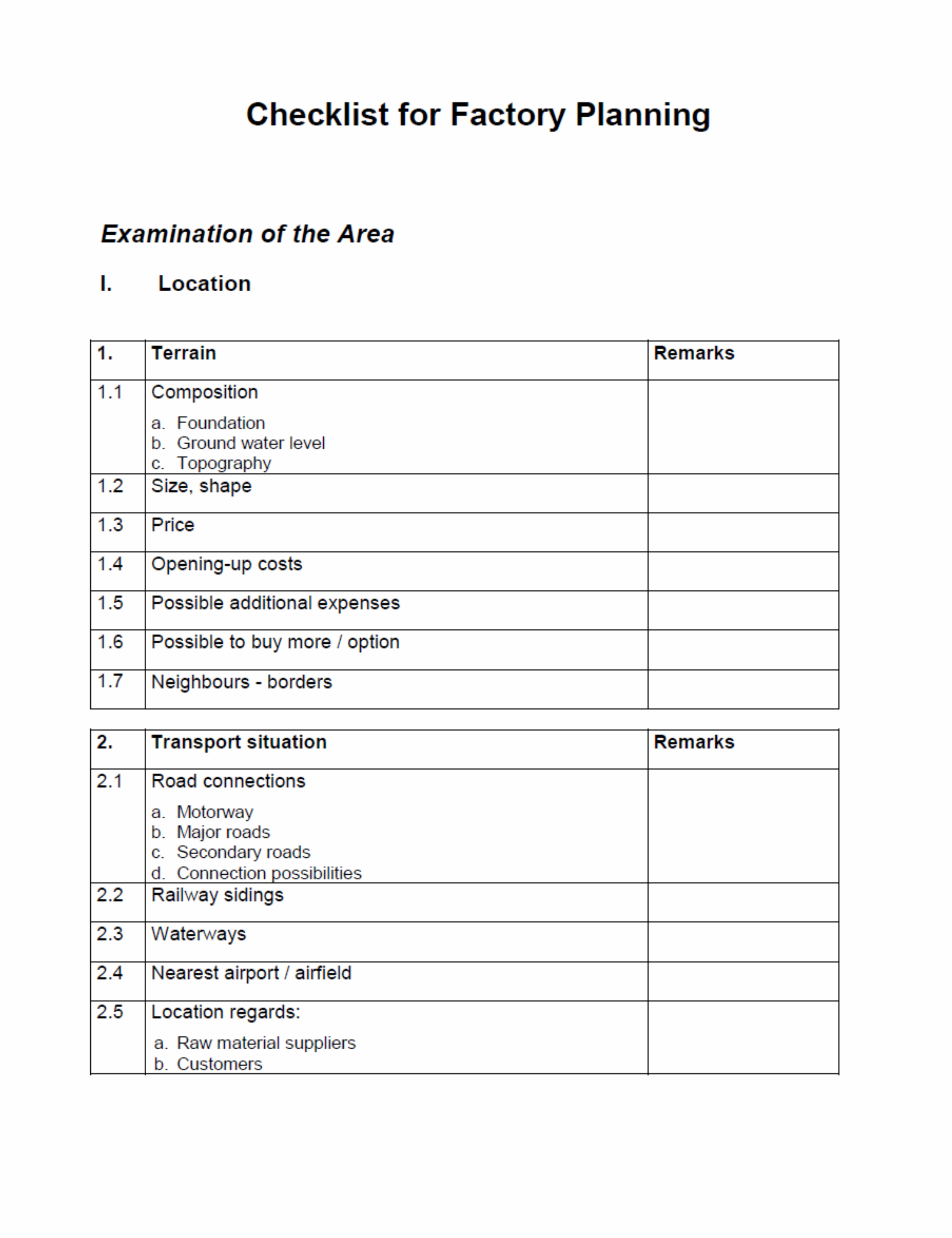
ASG Analytik-Service Gesellschaft mbH
Trentiner Ring 30
D-86356 Neusäss

Telefon 0049 821 486 25 18
Fax 0049 821 486 25 19
e-mail info@asg-analytik.de

Geschäftsführer
Dr. Thomas Wilharm
Amtsgericht Augsburg HRB 12297

Figure 18: Analysis report of “Agro-Diesel” Projekt 0704 (source: ASG (2007).

Annex 3: Checklist for factory planning



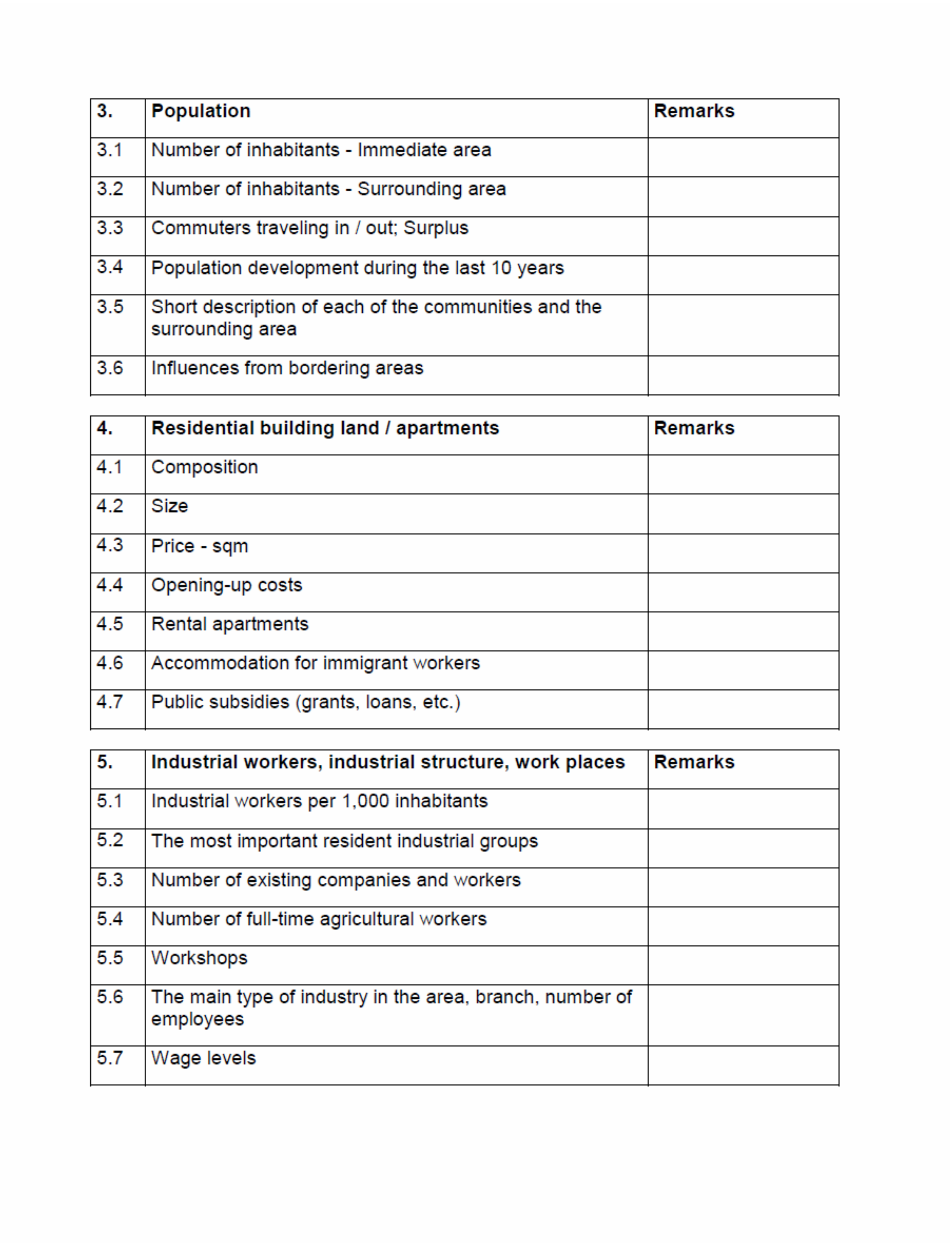
Checklist for Factory Planning

Examination of the Area

I. Location

1.	**Terrain**	**Remarks**
1.1	Composition a. Foundation b. Ground water level c. Topography	
1.2	Size, shape	
1.3	Price	
1.4	Opening-up costs	
1.5	Possible additional expenses	
1.6	Possible to buy more / option	
1.7	Neighbours - borders	

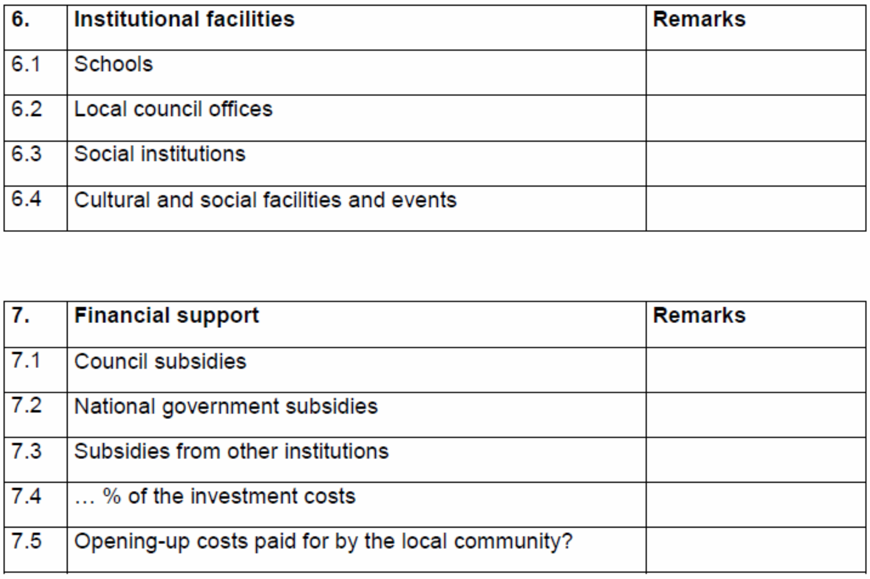
2.	**Transport situation**	**Remarks**
2.1	Road connections a. Motorway b. Major roads c. Secondary roads d. Connection possibilities	
2.2	Railway sidings	
2.3	Waterways	
2.4	Nearest airport / airfield	
2.5	Location regards: a. Raw material suppliers b. Customers	



3.	Population	Remarks
3.1	Number of inhabitants - Immediate area	
3.2	Number of inhabitants - Surrounding area	
3.3	Commuters traveling in / out; Surplus	
3.4	Population development during the last 10 years	
3.5	Short description of each of the communities and the surrounding area	
3.6	Influences from bordering areas	

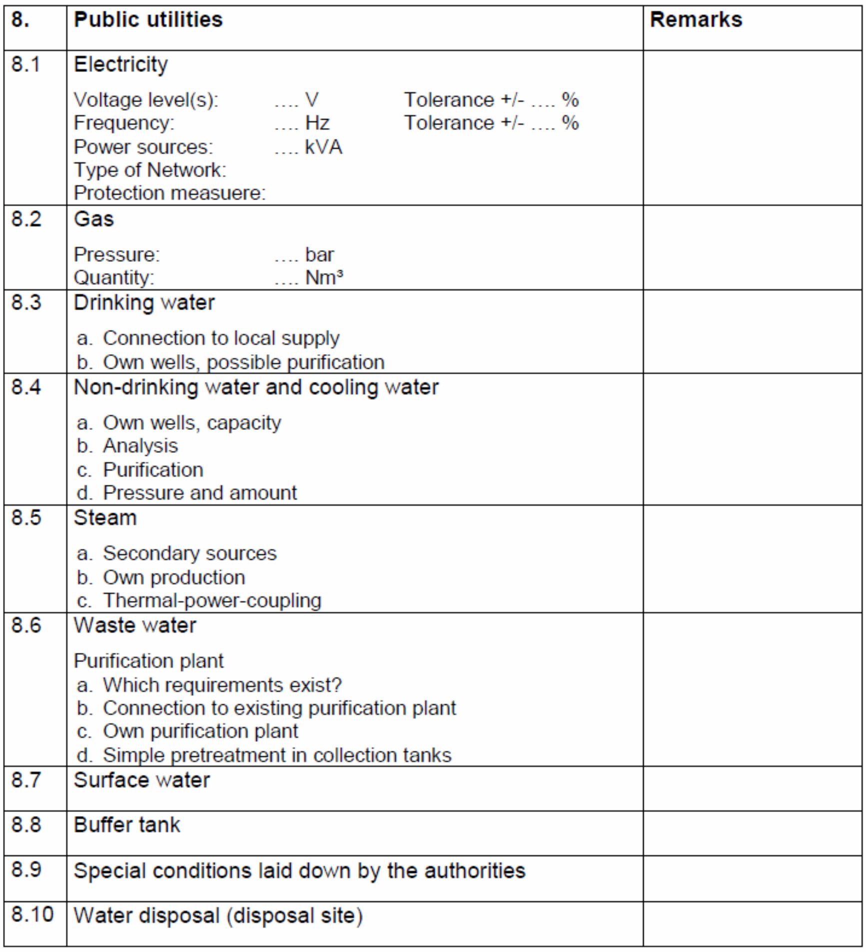
4.	Residential building land / apartments	Remarks
4.1	Composition	
4.2	Size	
4.3	Price - sqm	
4.4	Opening-up costs	
4.5	Rental apartments	
4.6	Accommodation for immigrant workers	
4.7	Public subsidies (grants, loans, etc.)	

5.	Industrial workers, industrial structure, work places	Remarks
5.1	Industrial workers per 1,000 inhabitants	
5.2	The most important resident industrial groups	
5.3	Number of existing companies and workers	
5.4	Number of full-time agricultural workers	
5.5	Workshops	
5.6	The main type of industry in the area, branch, number of employees	
5.7	Wage levels	

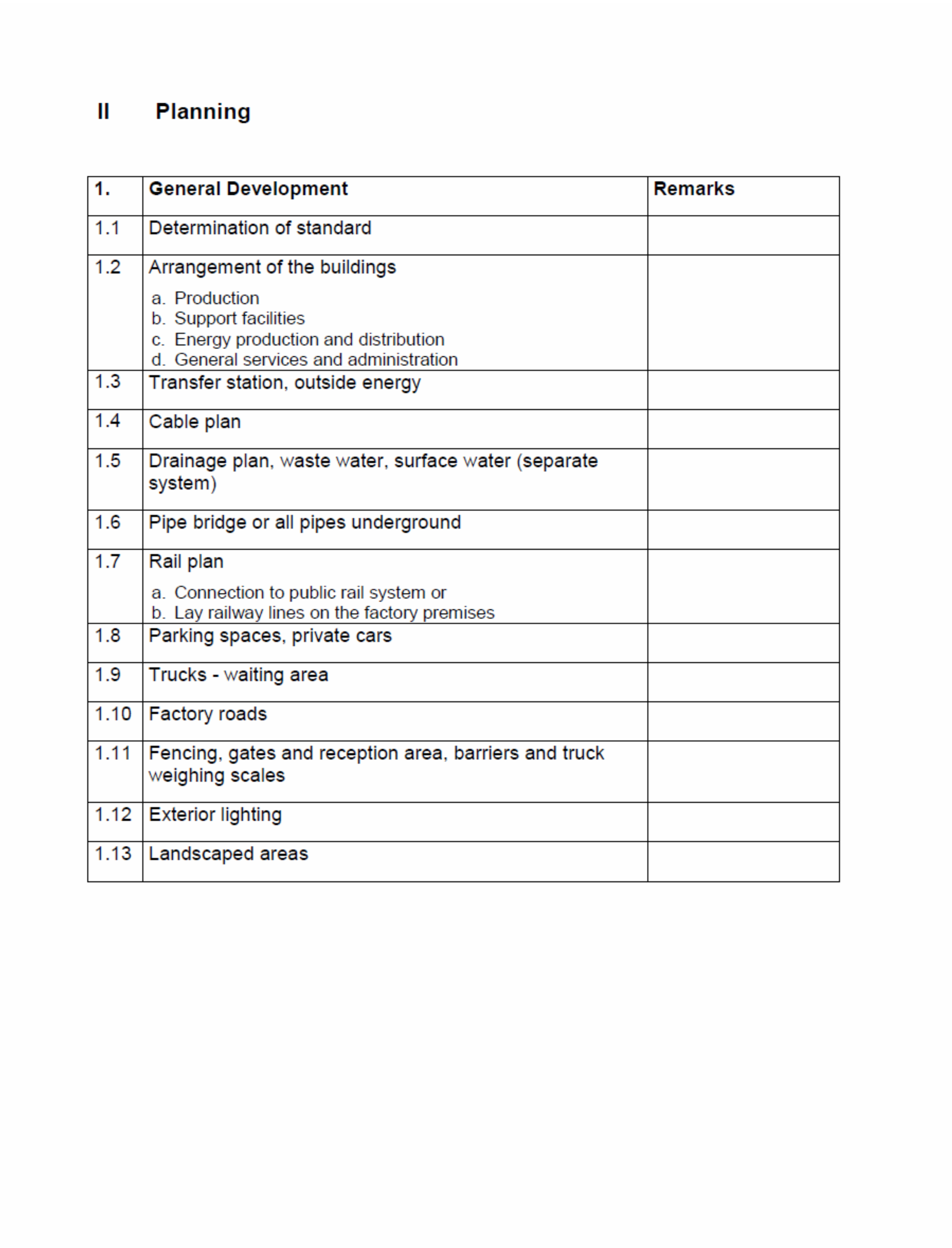


6.	**Institutional facilities**	**Remarks**
6.1	Schools	
6.2	Local council offices	
6.3	Social institutions	
6.4	Cultural and social facilities and events	

7.	**Financial support**	**Remarks**
7.1	Council subsidies	
7.2	National government subsidies	
7.3	Subsidies from other institutions	
7.4	… % of the investment costs	
7.5	Opening-up costs paid for by the local community?	

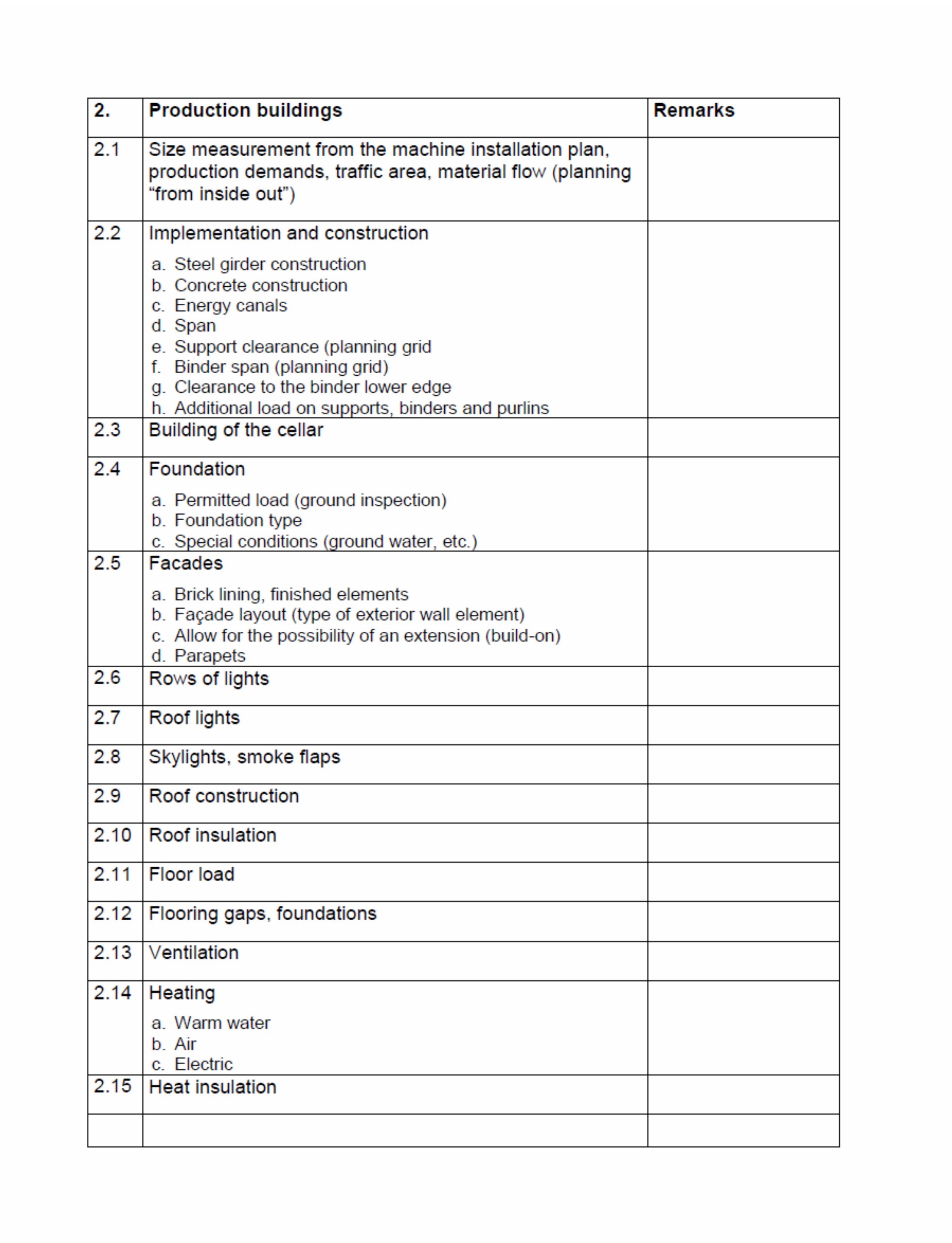


8.	Public utilities	Remarks
8.1	Electricity Voltage level(s): …. V Tolerance +/- …. % Frequency: …. Hz Tolerance +/- …. % Power sources: …. kVA Type of Network: Protection measuere:	
8.2	Gas Pressure: …. bar Quantity: …. Nm³	
8.3	Drinking water a. Connection to local supply b. Own wells, possible purification	
8.4	Non-drinking water and cooling water a. Own wells, capacity b. Analysis c. Purification d. Pressure and amount	
8.5	Steam a. Secondary sources b. Own production c. Thermal-power-coupling	
8.6	Waste water Purification plant a. Which requirements exist? b. Connection to existing purification plant c. Own purification plant d. Simple pretreatment in collection tanks	
8.7	Surface water	
8.8	Buffer tank	
8.9	Special conditions laid down by the authorities	
8.10	Water disposal (disposal site)	

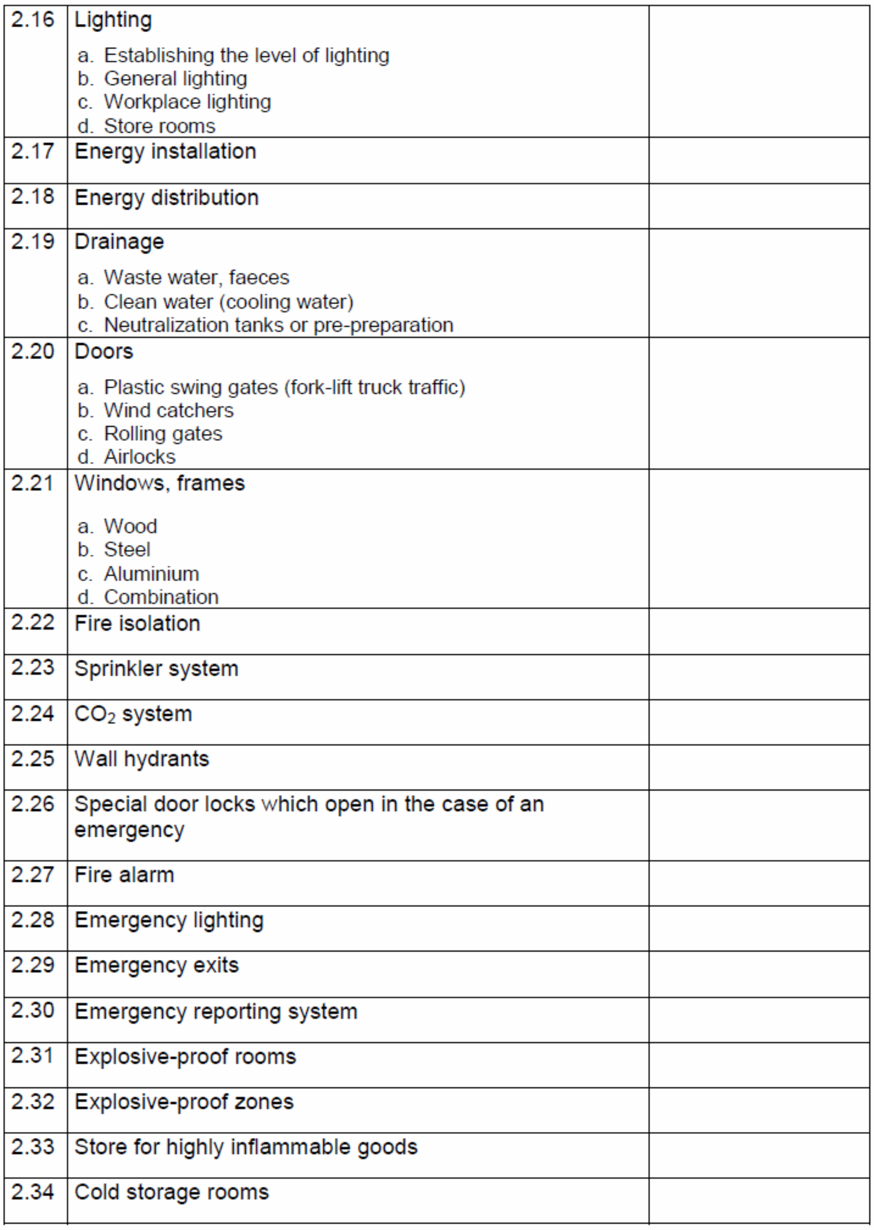


II Planning

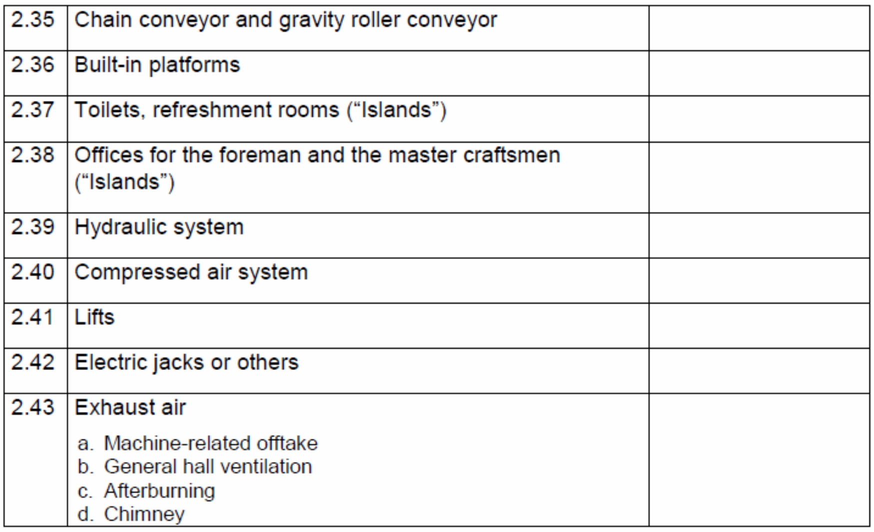
1.	General Development	Remarks
1.1	Determination of standard	
1.2	Arrangement of the buildings a. Production b. Support facilities c. Energy production and distribution d. General services and administration	
1.3	Transfer station, outside energy	
1.4	Cable plan	
1.5	Drainage plan, waste water, surface water (separate system)	
1.6	Pipe bridge or all pipes underground	
1.7	Rail plan a. Connection to public rail system or b. Lay railway lines on the factory premises	
1.8	Parking spaces, private cars	
1.9	Trucks - waiting area	
1.10	Factory roads	
1.11	Fencing, gates and reception area, barriers and truck weighing scales	
1.12	Exterior lighting	
1.13	Landscaped areas	



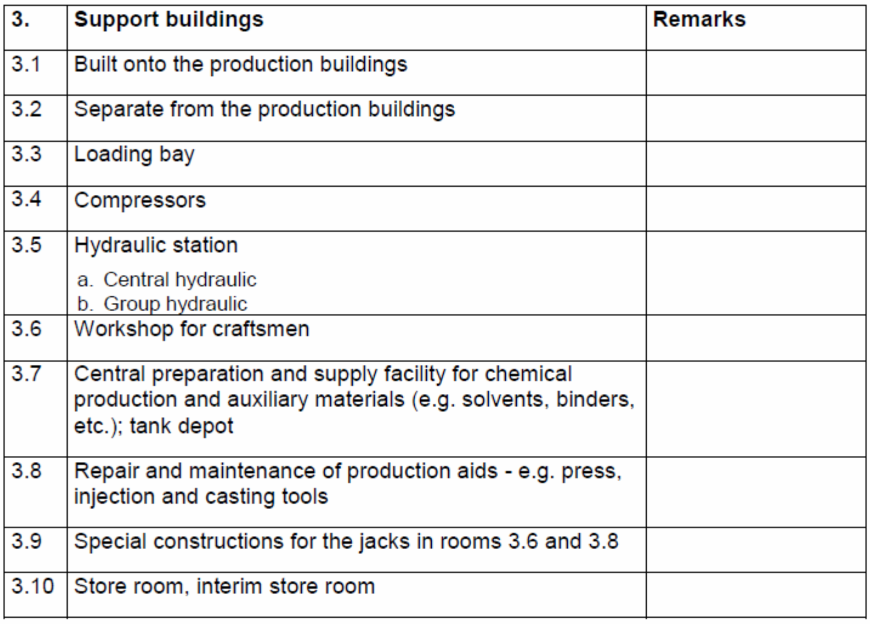
2.	**Production buildings**	**Remarks**
2.1	Size measurement from the machine installation plan, production demands, traffic area, material flow (planning "from inside out")	
2.2	Implementation and construction a. Steel girder construction b. Concrete construction c. Energy canals d. Span e. Support clearance (planning grid f. Binder span (planning grid) g. Clearance to the binder lower edge h. Additional load on supports, binders and purlins	
2.3	Building of the cellar	
2.4	Foundation a. Permitted load (ground inspection) b. Foundation type c. Special conditions (ground water, etc.)	
2.5	Facades a. Brick lining, finished elements b. Façade layout (type of exterior wall element) c. Allow for the possibility of an extension (build-on) d. Parapets	
2.6	Rows of lights	
2.7	Roof lights	
2.8	Skylights, smoke flaps	
2.9	Roof construction	
2.10	Roof insulation	
2.11	Floor load	
2.12	Flooring gaps, foundations	
2.13	Ventilation	
2.14	Heating a. Warm water b. Air c. Electric	
2.15	Heat insulation	



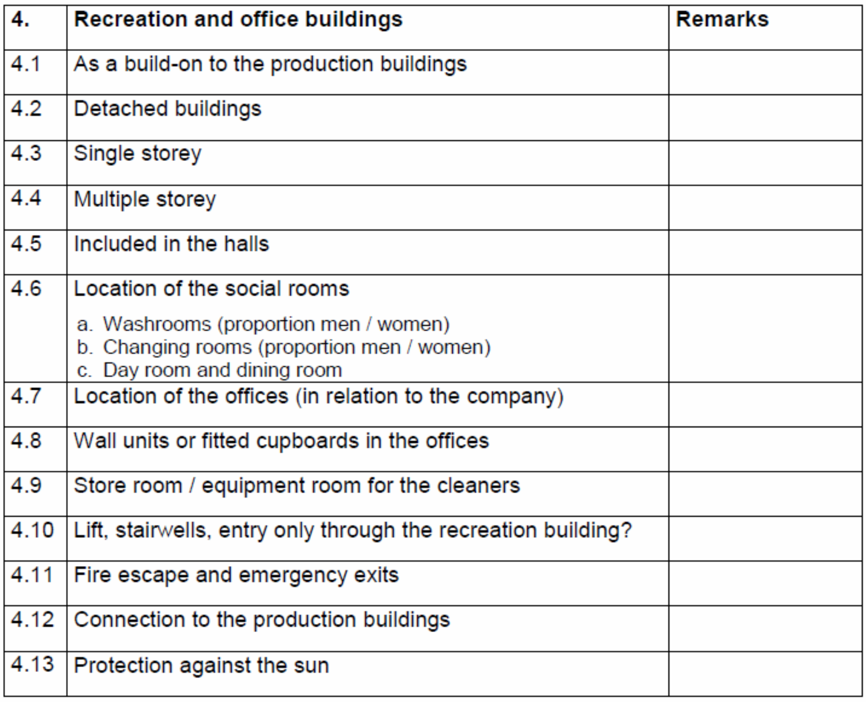
2.16	Lighting a. Establishing the level of lighting b. General lighting c. Workplace lighting d. Store rooms	
2.17	Energy installation	
2.18	Energy distribution	
2.19	Drainage a. Waste water, faeces b. Clean water (cooling water) c. Neutralization tanks or pre-preparation	
2.20	Doors a. Plastic swing gates (fork-lift truck traffic) b. Wind catchers c. Rolling gates d. Airlocks	
2.21	Windows, frames a. Wood b. Steel c. Aluminium d. Combination	
2.22	Fire isolation	
2.23	Sprinkler system	
2.24	CO_2 system	
2.25	Wall hydrants	
2.26	Special door locks which open in the case of an emergency	
2.27	Fire alarm	
2.28	Emergency lighting	
2.29	Emergency exits	
2.30	Emergency reporting system	
2.31	Explosive-proof rooms	
2.32	Explosive-proof zones	
2.33	Store for highly inflammable goods	
2.34	Cold storage rooms	



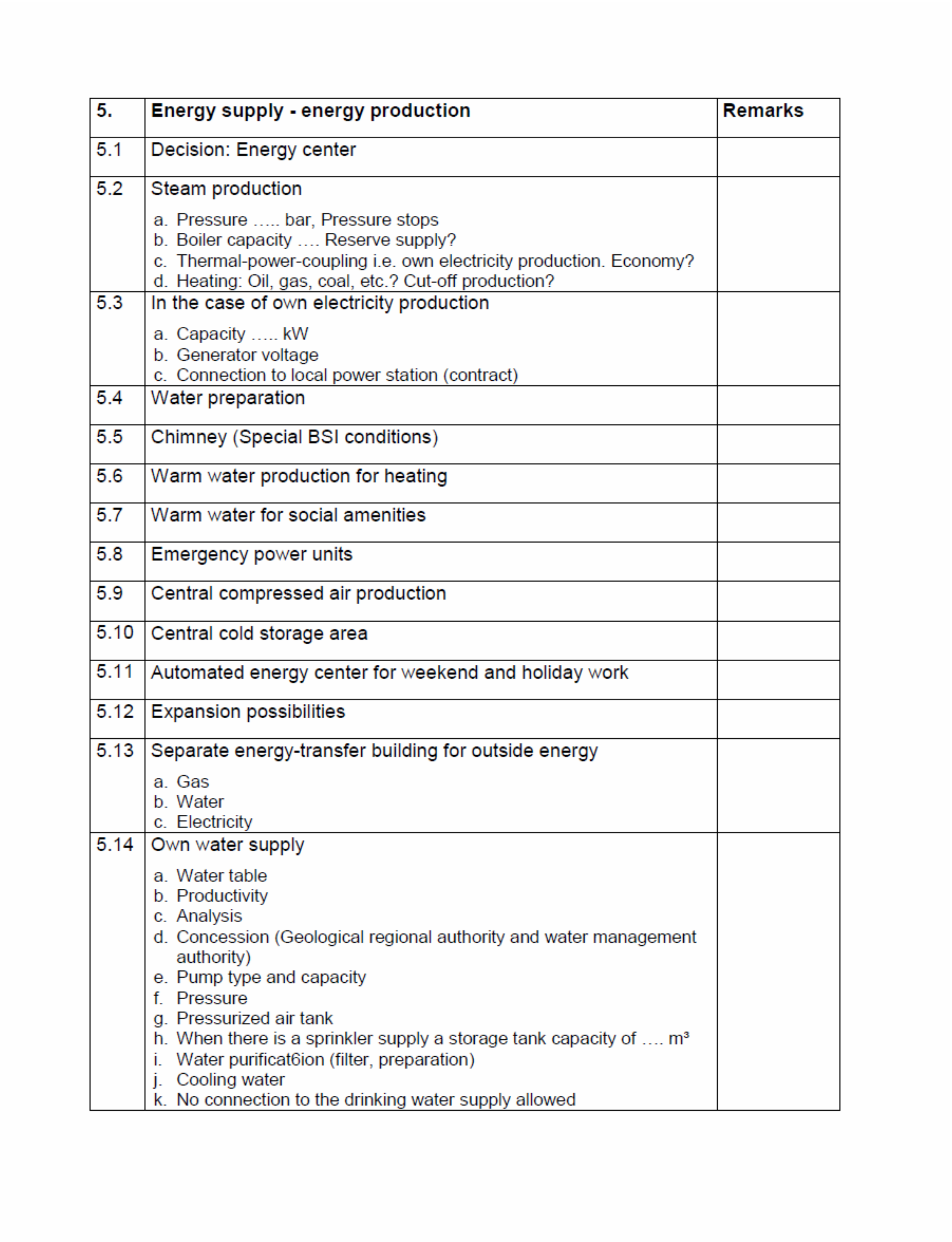
2.35	Chain conveyor and gravity roller conveyor	
2.36	Built-in platforms	
2.37	Toilets, refreshment rooms (“Islands”)	
2.38	Offices for the foreman and the master craftsmen (“Islands”)	
2.39	Hydraulic system	
2.40	Compressed air system	
2.41	Lifts	
2.42	Electric jacks or others	
2.43	Exhaust air a. Machine-related offtake b. General hall ventilation c. Afterburning d. Chimney	



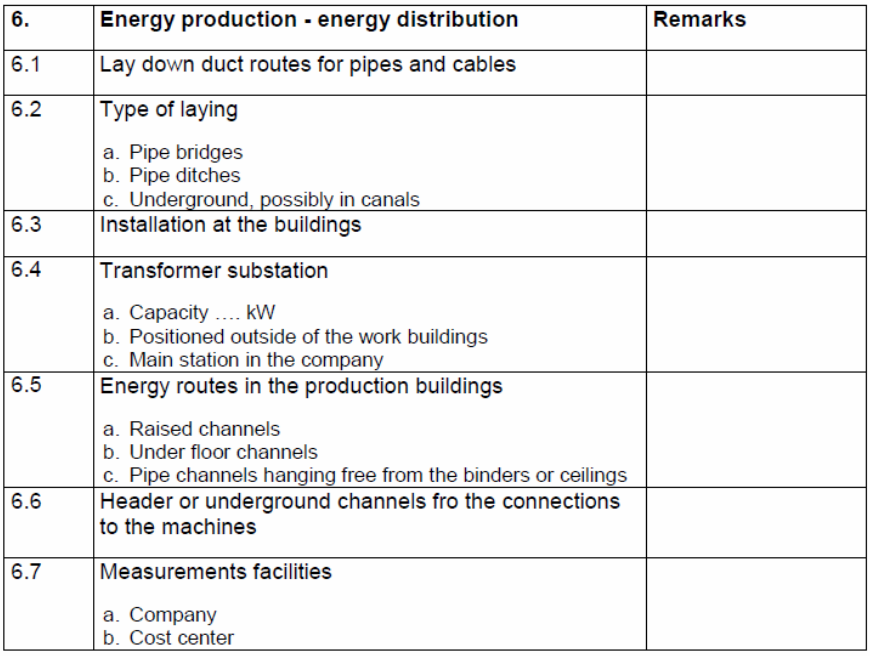
3.	**Support buildings**	**Remarks**
3.1	Built onto the production buildings	
3.2	Separate from the production buildings	
3.3	Loading bay	
3.4	Compressors	
3.5	Hydraulic station a. Central hydraulic b. Group hydraulic	
3.6	Workshop for craftsmen	
3.7	Central preparation and supply facility for chemical production and auxiliary materials (e.g. solvents, binders, etc.); tank depot	
3.8	Repair and maintenance of production aids - e.g. press, injection and casting tools	
3.9	Special constructions for the jacks in rooms 3.6 and 3.8	
3.10	Store room, interim store room	



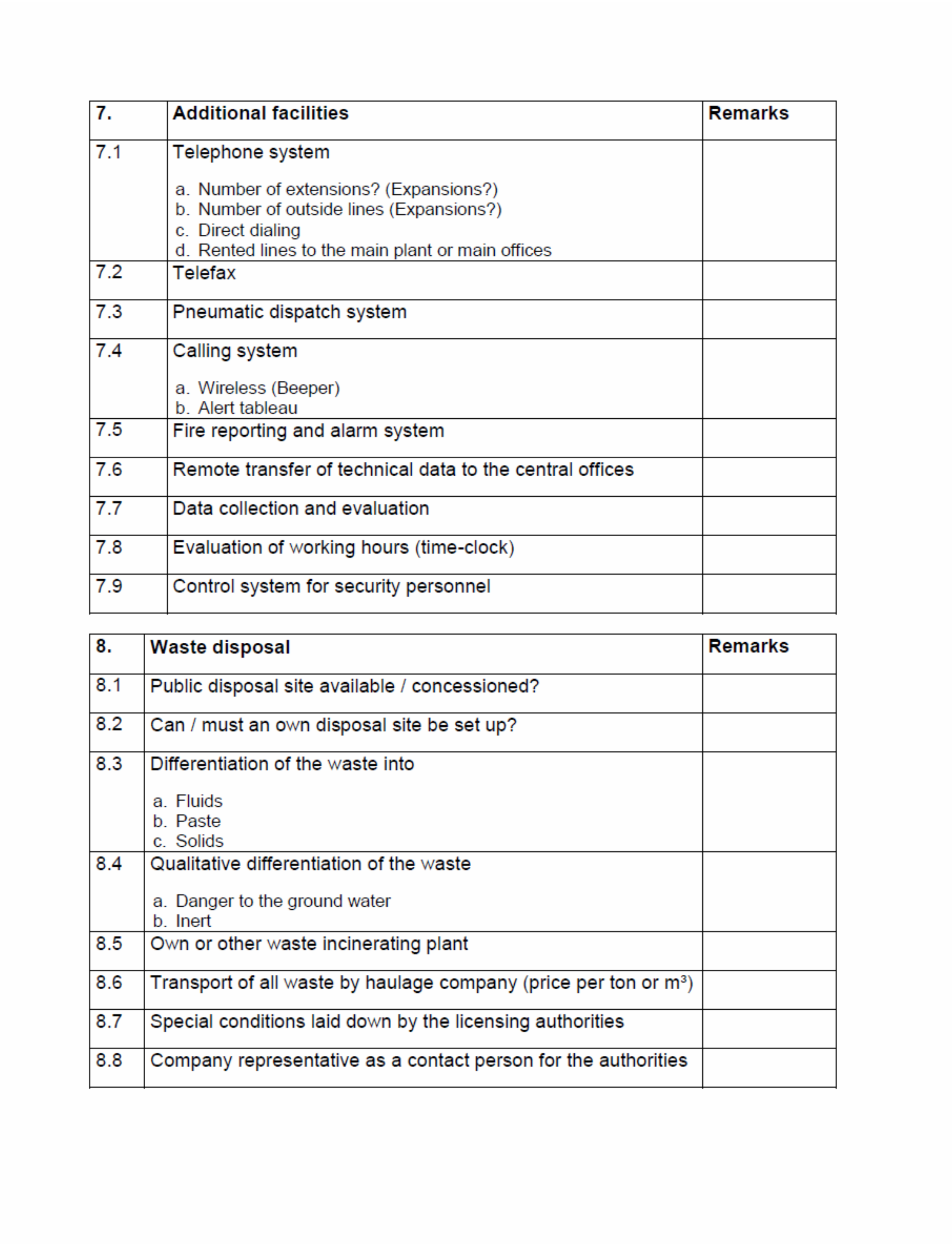
4.	**Recreation and office buildings**	**Remarks**
4.1	As a build-on to the production buildings	
4.2	Detached buildings	
4.3	Single storey	
4.4	Multiple storey	
4.5	Included in the halls	
4.6	Location of the social rooms a. Washrooms (proportion men / women) b. Changing rooms (proportion men / women) c. Day room and dining room	
4.7	Location of the offices (in relation to the company)	
4.8	Wall units or fitted cupboards in the offices	
4.9	Store room / equipment room for the cleaners	
4.10	Lift, stairwells, entry only through the recreation building?	
4.11	Fire escape and emergency exits	
4.12	Connection to the production buildings	
4.13	Protection against the sun	



5.	**Energy supply - energy production**	**Remarks**
5.1	Decision: Energy center	
5.2	Steam production a. Pressure ….. bar, Pressure stops b. Boiler capacity …. Reserve supply? c. Thermal-power-coupling i.e. own electricity production. Economy? d. Heating: Oil, gas, coal, etc.? Cut-off production?	
5.3	In the case of own electricity production a. Capacity ….. kW b. Generator voltage c. Connection to local power station (contract)	
5.4	Water preparation	
5.5	Chimney (Special BSI conditions)	
5.6	Warm water production for heating	
5.7	Warm water for social amenities	
5.8	Emergency power units	
5.9	Central compressed air production	
5.10	Central cold storage area	
5.11	Automated energy center for weekend and holiday work	
5.12	Expansion possibilities	
5.13	Separate energy-transfer building for outside energy a. Gas b. Water c. Electricity	
5.14	Own water supply a. Water table b. Productivity c. Analysis d. Concession (Geological regional authority and water management authority) e. Pump type and capacity f. Pressure g. Pressurized air tank h. When there is a sprinkler supply a storage tank capacity of …. m³ i. Water purificat6ion (filter, preparation) j. Cooling water k. No connection to the drinking water supply allowed	

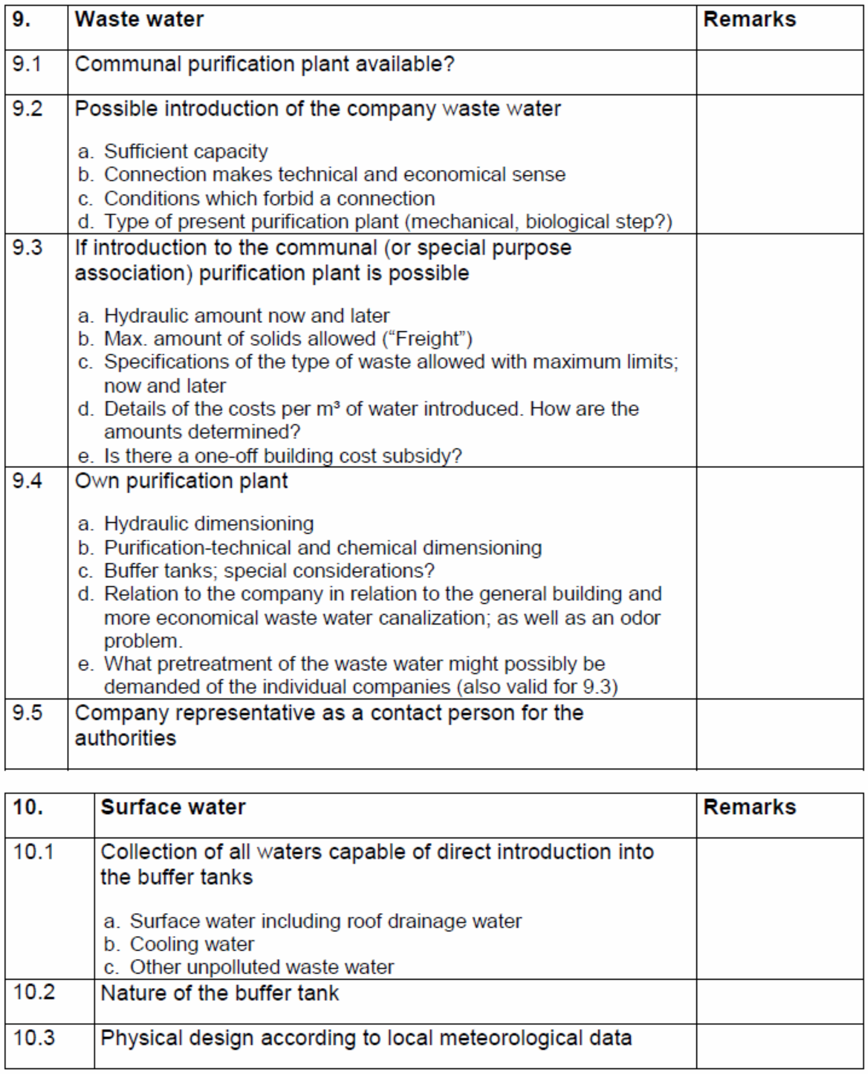


6.	**Energy production - energy distribution**	**Remarks**
6.1	Lay down duct routes for pipes and cables	
6.2	Type of laying a. Pipe bridges b. Pipe ditches c. Underground, possibly in canals	
6.3	Installation at the buildings	
6.4	Transformer substation a. Capacity …. kW b. Positioned outside of the work buildings c. Main station in the company	
6.5	Energy routes in the production buildings a. Raised channels b. Under floor channels c. Pipe channels hanging free from the binders or ceilings	
6.6	Header or underground channels fro the connections to the machines	
6.7	Measurements facilities a. Company b. Cost center	



7.	**Additional facilities**	**Remarks**
7.1	Telephone system a. Number of extensions? (Expansions?) b. Number of outside lines (Expansions?) c. Direct dialing d. Rented lines to the main plant or main offices	
7.2	Telefax	
7.3	Pneumatic dispatch system	
7.4	Calling system a. Wireless (Beeper) b. Alert tableau	
7.5	Fire reporting and alarm system	
7.6	Remote transfer of technical data to the central offices	
7.7	Data collection and evaluation	
7.8	Evaluation of working hours (time-clock)	
7.9	Control system for security personnel	

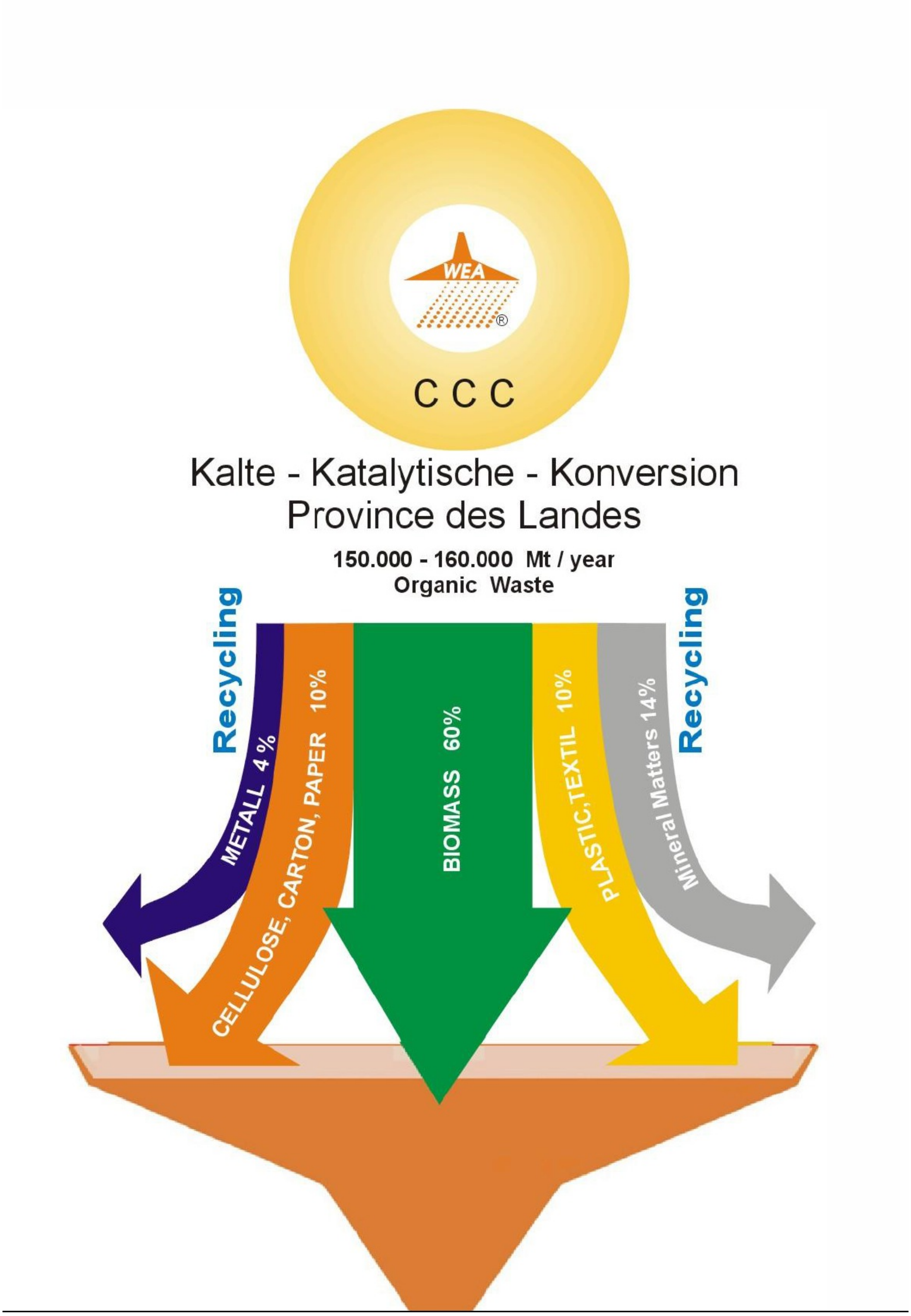
8.	**Waste disposal**	**Remarks**
8.1	Public disposal site available / concessioned?	
8.2	Can / must an own disposal site be set up?	
8.3	Differentiation of the waste into a. Fluids b. Paste c. Solids	
8.4	Qualitative differentiation of the waste a. Danger to the ground water b. Inert	
8.5	Own or other waste incinerating plant	
8.6	Transport of all waste by haulage company (price per ton or m^3)	
8.7	Special conditions laid down by the licensing authorities	
8.8	Company representative as a contact person for the authorities	

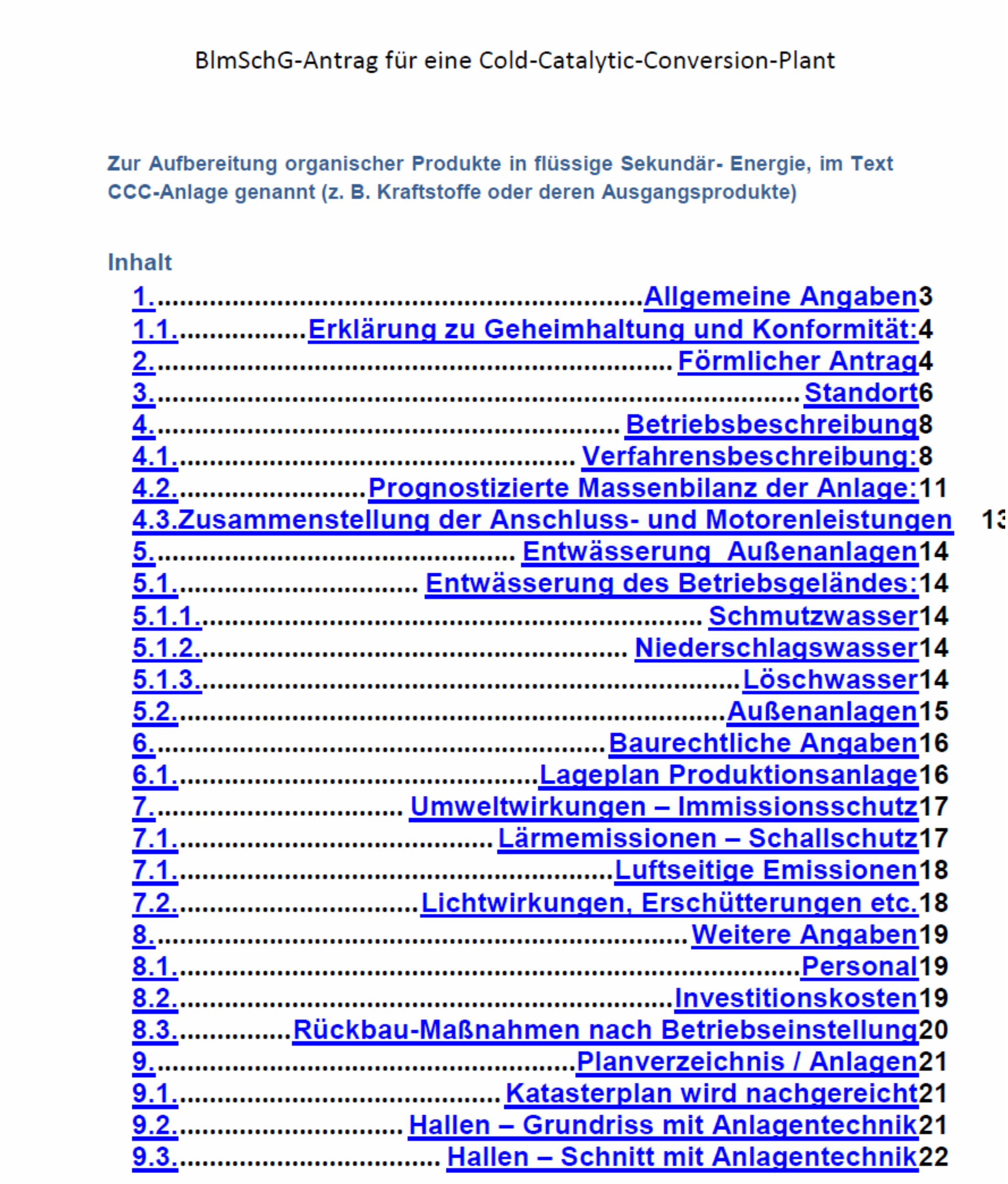


9.	**Waste water**	**Remarks**
9.1	Communal purification plant available?	
9.2	Possible introduction of the company waste water a. Sufficient capacity b. Connection makes technical and economical sense c. Conditions which forbid a connection d. Type of present purification plant (mechanical, biological step?)	
9.3	If introduction to the communal (or special purpose association) purification plant is possible a. Hydraulic amount now and later b. Max. amount of solids allowed (“Freight”) c. Specifications of the type of waste allowed with maximum limits; now and later d. Details of the costs per m³ of water introduced. How are the amounts determined? e. Is there a one-off building cost subsidy?	
9.4	Own purification plant a. Hydraulic dimensioning b. Purification-technical and chemical dimensioning c. Buffer tanks; special considerations? d. Relation to the company in relation to the general building and more economical waste water canalization; as well as an odor problem. e. What pretreatment of the waste water might possibly be demanded of the individual companies (also valid for 9.3)	
9.5	Company representative as a contact person for the authorities	

10.	**Surface water**	**Remarks**
10.1	Collection of all waters capable of direct introduction into the buffer tanks a. Surface water including roof drainage water b. Cooling water c. Other unpolluted waste water	
10.2	Nature of the buffer tank	
10.3	Physical design according to local meteorological data	

Annex 4: Example of a application according to Federal Control of Pollution Act (Bundes-Immissionsschutzgesetz (BImSchG) –Antrag) for a Cold-Catalytic-Conversion-Plant





BImSchG-Antrag für eine Cold-Catalytic-Conversion-Plant

Zur Aufbereitung organischer Produkte in flüssige Sekundär- Energie, im Text CCC-Anlage genannt (z. B. Kraftstoffe oder deren Ausgangsprodukte)

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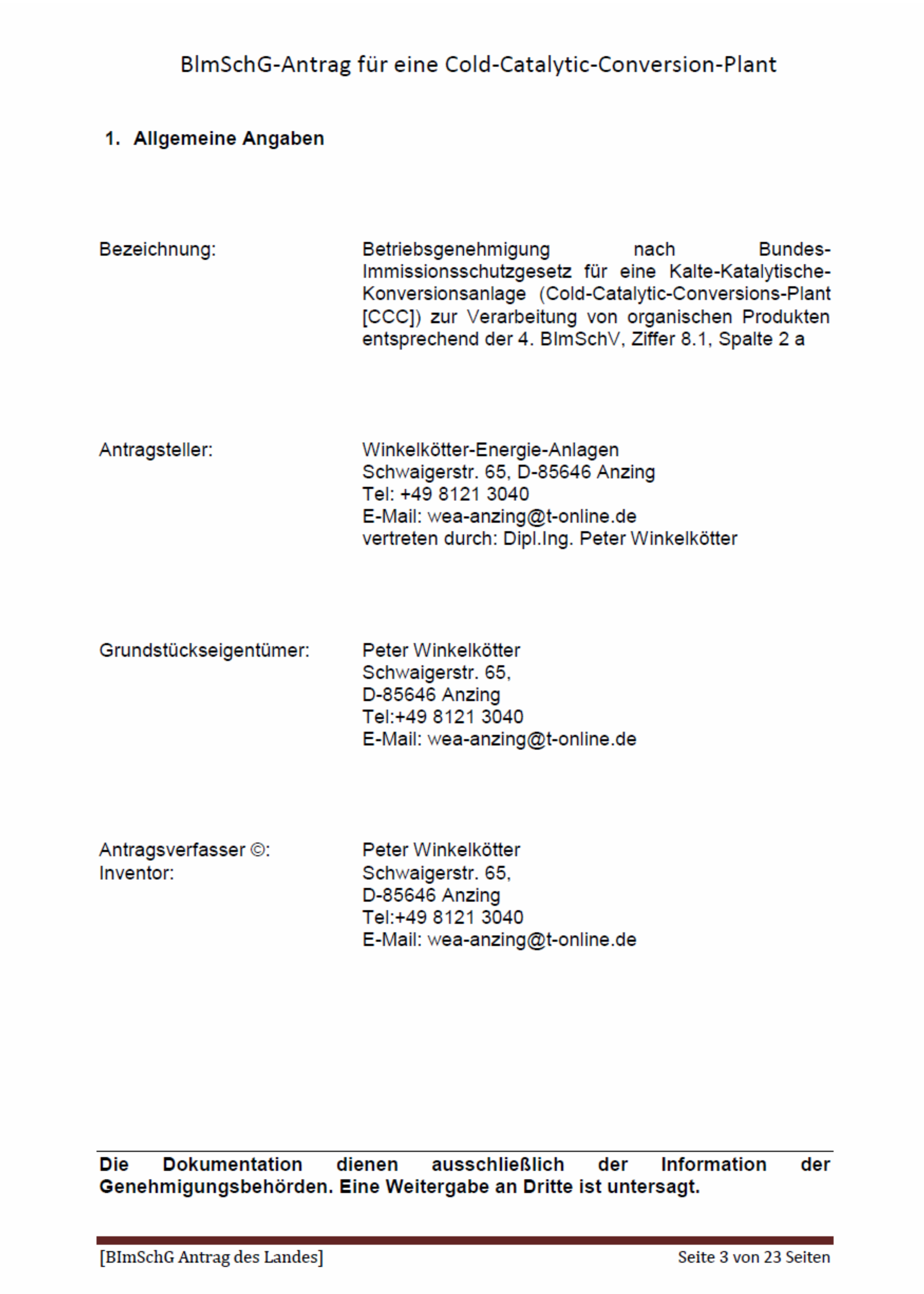

BImSchG-Antrag für eine Cold-Catalytic-Conversion-Plant

1. Allgemeine Angaben

Bezeichnung:	Betriebsgenehmigung nach Bundes-Immissionsschutzgesetz für eine Kalte-Katalytische-Konversionsanlage (Cold-Catalytic-Conversions-Plant [CCC]) zur Verarbeitung von organischen Produkten entsprechend der 4. BImSchV, Ziffer 8.1, Spalte 2 a
Antragsteller:	Winkelkötter-Energie-Anlagen Schwaigerstr. 65, D-85646 Anzing Tel: +49 8121 3040 E-Mail: wea-anzing@t-online.de vertreten durch: Dipl.Ing. Peter Winkelkötter
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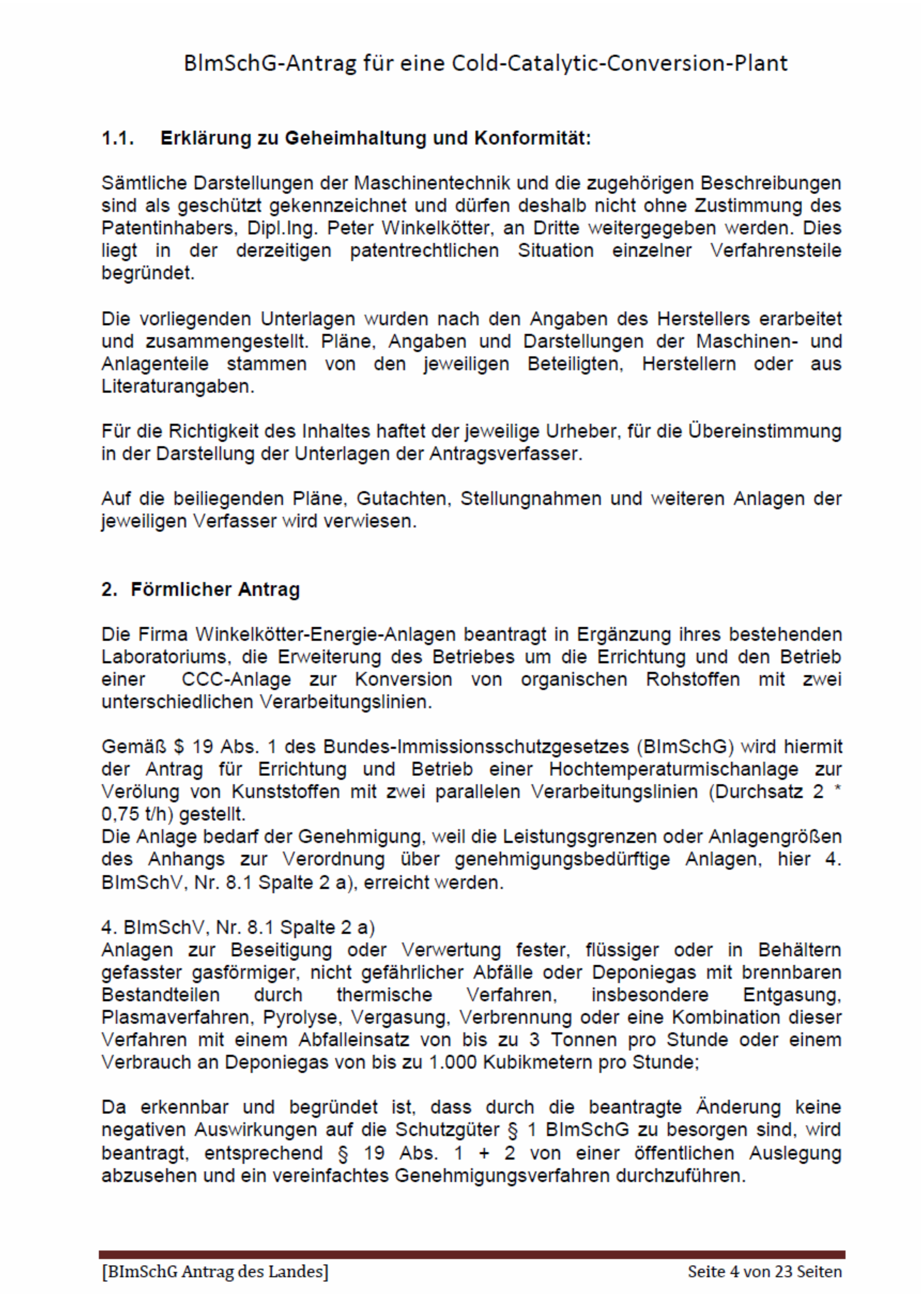
Antragsverfasser ©: Inventor:	Peter Winkelkötter Schwaigerstr. 65, D-85646 Anzing Tel:+49 8121 3040 E-Mail: wea-anzing@t-online.de

Die Dokumentation dienen ausschließlich der Information der Genehmigungsbehörden. Eine Weitergabe an Dritte ist untersagt.



BImSchG-Antrag für eine Cold-Catalytic-Conversion-Plant

1.1. Erklärung zu Geheimhaltung und Konformität:

Sämtliche Darstellungen der Maschinentechnik und die zugehörigen Beschreibungen sind als geschützt gekennzeichnet und dürfen deshalb nicht ohne Zustimmung des Patentinhabers, Dipl.Ing. Peter Winkelkötter, an Dritte weitergegeben werden. Dies liegt in der derzeitigen patentrechtlichen Situation einzelner Verfahrensteile begründet.

Die vorliegenden Unterlagen wurden nach den Angaben des Herstellers erarbeitet und zusammengestellt. Pläne, Angaben und Darstellungen der Maschinen- und Anlagenteile stammen von den jeweiligen Beteiligten, Herstellern oder aus Literaturangaben.

Für die Richtigkeit des Inhaltes haftet der jeweilige Urheber, für die Übereinstimmung in der Darstellung der Unterlagen der Antragsverfasser.

Auf die beiliegenden Pläne, Gutachten, Stellungnahmen und weiteren Anlagen der jeweiligen Verfasser wird verwiesen.

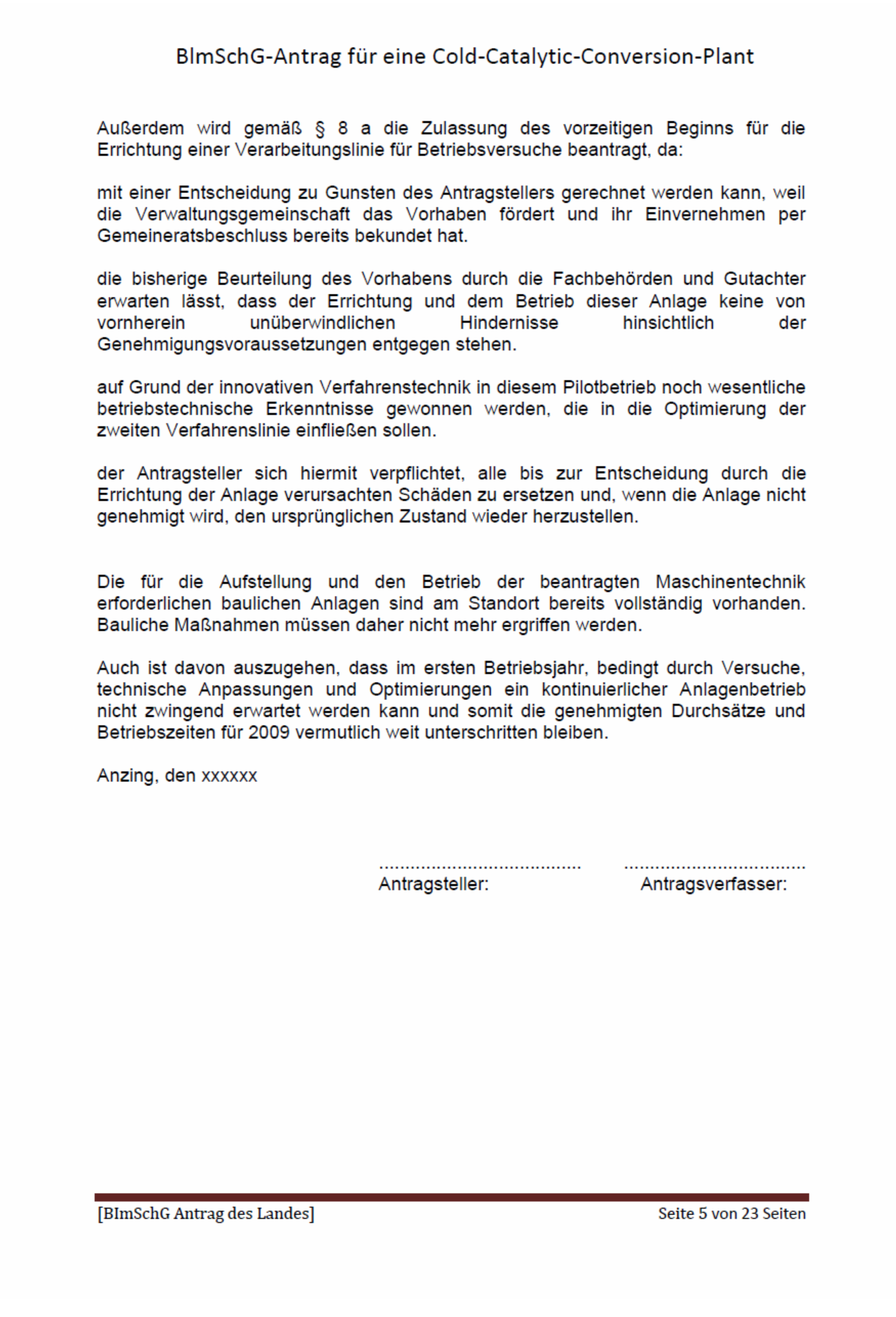
2. Förmlicher Antrag

Die Firma Winkelkötter-Energie-Anlagen beantragt in Ergänzung ihres bestehenden Laboratoriums, die Erweiterung des Betriebes um die Errichtung und den Betrieb einer CCC-Anlage zur Konversion von organischen Rohstoffen mit zwei unterschiedlichen Verarbeitungslinien.

Gemäß $ 19 Abs. 1 des Bundes-Immissionsschutzgesetzes (BImSchG) wird hiermit der Antrag für Errichtung und Betrieb einer Hochtemperaturmischanlage zur Verölung von Kunststoffen mit zwei parallelen Verarbeitungslinien (Durchsatz 2 * 0,75 t/h) gestellt.
Die Anlage bedarf der Genehmigung, weil die Leistungsgrenzen oder Anlagengrößen des Anhangs zur Verordnung über genehmigungsbedürftige Anlagen, hier 4. BImSchV, Nr. 8.1 Spalte 2 a), erreicht werden.

4. BImSchV, Nr. 8.1 Spalte 2 a)
Anlagen zur Beseitigung oder Verwertung fester, flüssiger oder in Behältern gefasster gasförmiger, nicht gefährlicher Abfälle oder Deponiegas mit brennbaren Bestandteilen durch thermische Verfahren, insbesondere Entgasung, Plasmaverfahren, Pyrolyse, Vergasung, Verbrennung oder eine Kombination dieser Verfahren mit einem Abfalleinsatz von bis zu 3 Tonnen pro Stunde oder einem Verbrauch an Deponiegas von bis zu 1.000 Kubikmetern pro Stunde;

Da erkennbar und begründet ist, dass durch die beantragte Änderung keine negativen Auswirkungen auf die Schutzgüter § 1 BImSchG zu besorgen sind, wird beantragt, entsprechend § 19 Abs. 1 + 2 von einer öffentlichen Auslegung abzusehen und ein vereinfachtes Genehmigungsverfahren durchzuführen.



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Außerdem wird gemäß § 8 a die Zulassung des vorzeitigen Beginns für die Errichtung einer Verarbeitungslinie für Betriebsversuche beantragt, da:

mit einer Entscheidung zu Gunsten des Antragstellers gerechnet werden kann, weil die Verwaltungsgemeinschaft das Vorhaben fördert und ihr Einvernehmen per Gemeineratsbeschluss bereits bekundet hat.

die bisherige Beurteilung des Vorhabens durch die Fachbehörden und Gutachter erwarten lässt, dass der Errichtung und dem Betrieb dieser Anlage keine von vornherein unüberwindlichen Hindernisse hinsichtlich der Genehmigungsvoraussetzungen entgegen stehen.

auf Grund der innovativen Verfahrenstechnik in diesem Pilotbetrieb noch wesentliche betriebstechnische Erkenntnisse gewonnen werden, die in die Optimierung der zweiten Verfahrenslinie einfließen sollen.

der Antragsteller sich hiermit verpflichtet, alle bis zur Entscheidung durch die Errichtung der Anlage verursachten Schäden zu ersetzen und, wenn die Anlage nicht genehmigt wird, den ursprünglichen Zustand wieder herzustellen.

Die für die Aufstellung und den Betrieb der beantragten Maschinentechnik erforderlichen baulichen Anlagen sind am Standort bereits vollständig vorhanden. Bauliche Maßnahmen müssen daher nicht mehr ergriffen werden.

Auch ist davon auszugehen, dass im ersten Betriebsjahr, bedingt durch Versuche, technische Anpassungen und Optimierungen ein kontinuierlicher Anlagenbetrieb nicht zwingend erwartet werden kann und somit die genehmigten Durchsätze und Betriebszeiten für 2009 vermutlich weit unterschritten bleiben.

Anzing, den xxxxxx

....
Antragsteller: Antragsverfasser:

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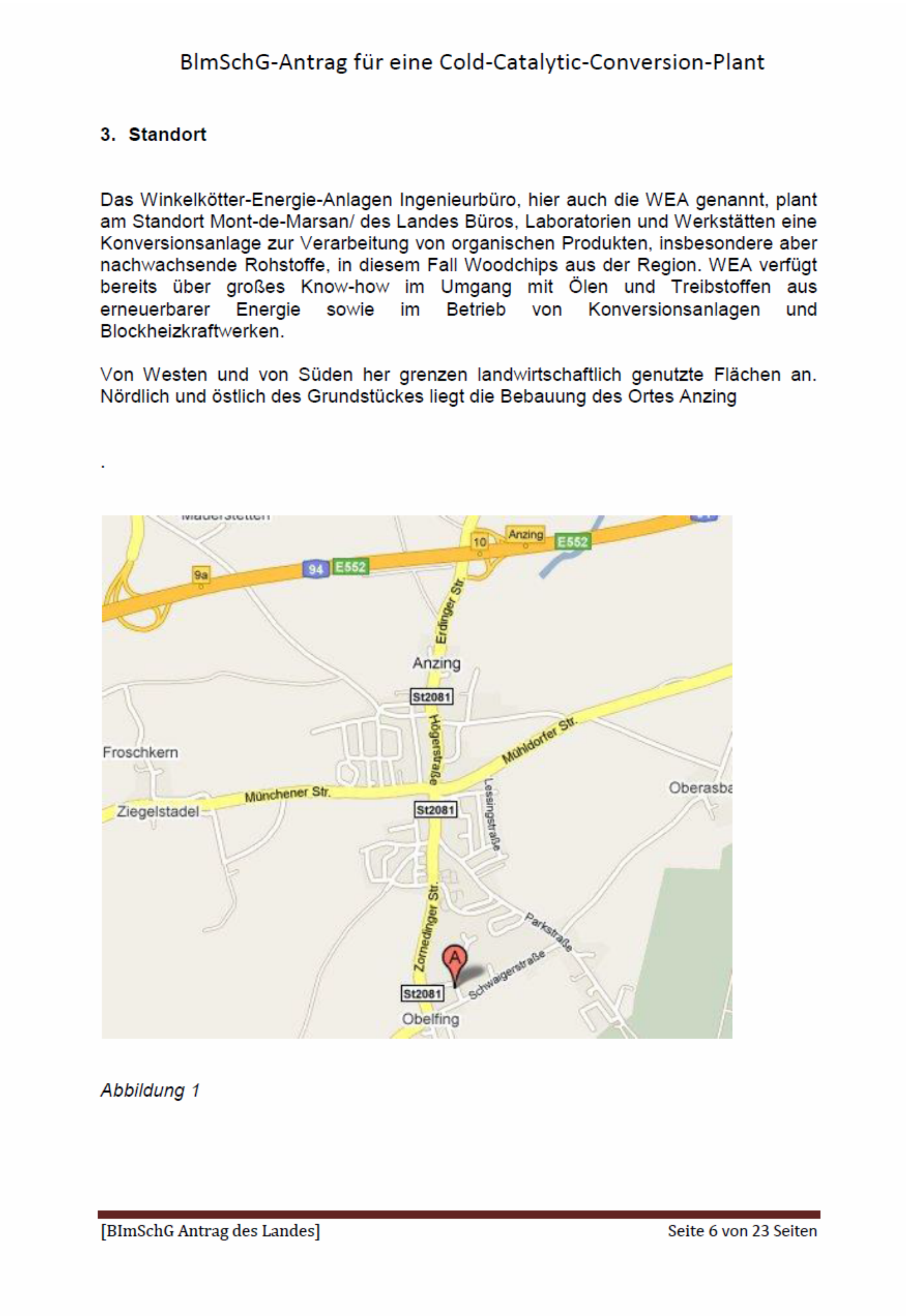

BImSchG-Antrag für eine Cold-Catalytic-Conversion-Plant

3. Standort

Das Winkelkötter-Energie-Anlagen Ingenieurbüro, hier auch die WEA genannt, plant am Standort Mont-de-Marsan/ des Landes Büros, Laboratorien und Werkstätten eine Konversionsanlage zur Verarbeitung von organischen Produkten, insbesondere aber nachwachsende Rohstoffe, in diesem Fall Woodchips aus der Region. WEA verfügt bereits über großes Know-how im Umgang mit Ölen und Treibstoffen aus erneuerbarer Energie sowie im Betrieb von Konversionsanlagen und Blockheizkraftwerken.

Von Westen und von Süden her grenzen landwirtschaftlich genutzte Flächen an. Nördlich und östlich des Grundstückes liegt die Bebauung des Ortes Anzing

.

Abbildung 1

BlmSchG-Antrag für eine Cold-Catalytic-Conversion-Plant

Abbildung 2

Am Standort besteht bereits die nahezu komplette Infrastruktur von Gebäuden. Die beantragte Anlage soll in die bestehende Halle (Außenmaße ca. 30,00m x 12,00m), welche vormals zur Wartung von Kfz´s genutzt wurde, eingebaut werden. Die Halle bleibt in ihren Baumaßen unverändert. Auch an der Zufahrt und an den Außenanlagen werden nur kleine Änderungen durchgeführt.

Ein Lagertank für Rohöl/Pflanzenrohöl mit ca. 56.000 l Inhalt, wird am südlichen Grundstücksrand in einer Erdwanne aufgestellt. Diese Erdwanne nimmt auch das schallgedämmte, im Container eingebaute, BHKW auf.
An der Südseite der Produktionshalle werden sich der Anlieferbereich mit den Dosiersilos und die eigentliche technische Anlage zur pneumatischen Entladung der, per Tankzug angelieferten Rohstoffe, hinter einer Attika am Gebäudedachrand, installiert. Die gesamte Vorratsmenge für einen sicheren Betrieb beträgt ca. 800 t.

Die beantragte CCC-Anlage wird im EG dieser Halle aufgebaut und betrieben, das erzeugte Rohöl dann in den genannten Lagertank geleitet.

Die Anlage besteht aus einer Verarbeitungslinie mit einem rechnerischen Durchsatz von kleiner 20 t/h. Eine weitere Modell-Verfahrenslinie der Anlage im Labor dient dem rein wissenschaftlichen Anlagenbetrieb. Die CCC-Anlage in der Halle soll im Idealfall im 3-Schicht-Betrieb rund um die Uhr laufen, somit ca. 150-160.000 t/a verarbeiten und nonstop Energie und Rohöl erzeugen. Die zweite Labor-Linie dient ausschließlich als Forschungs-Linie sowie für Messungen und Erprobungen von

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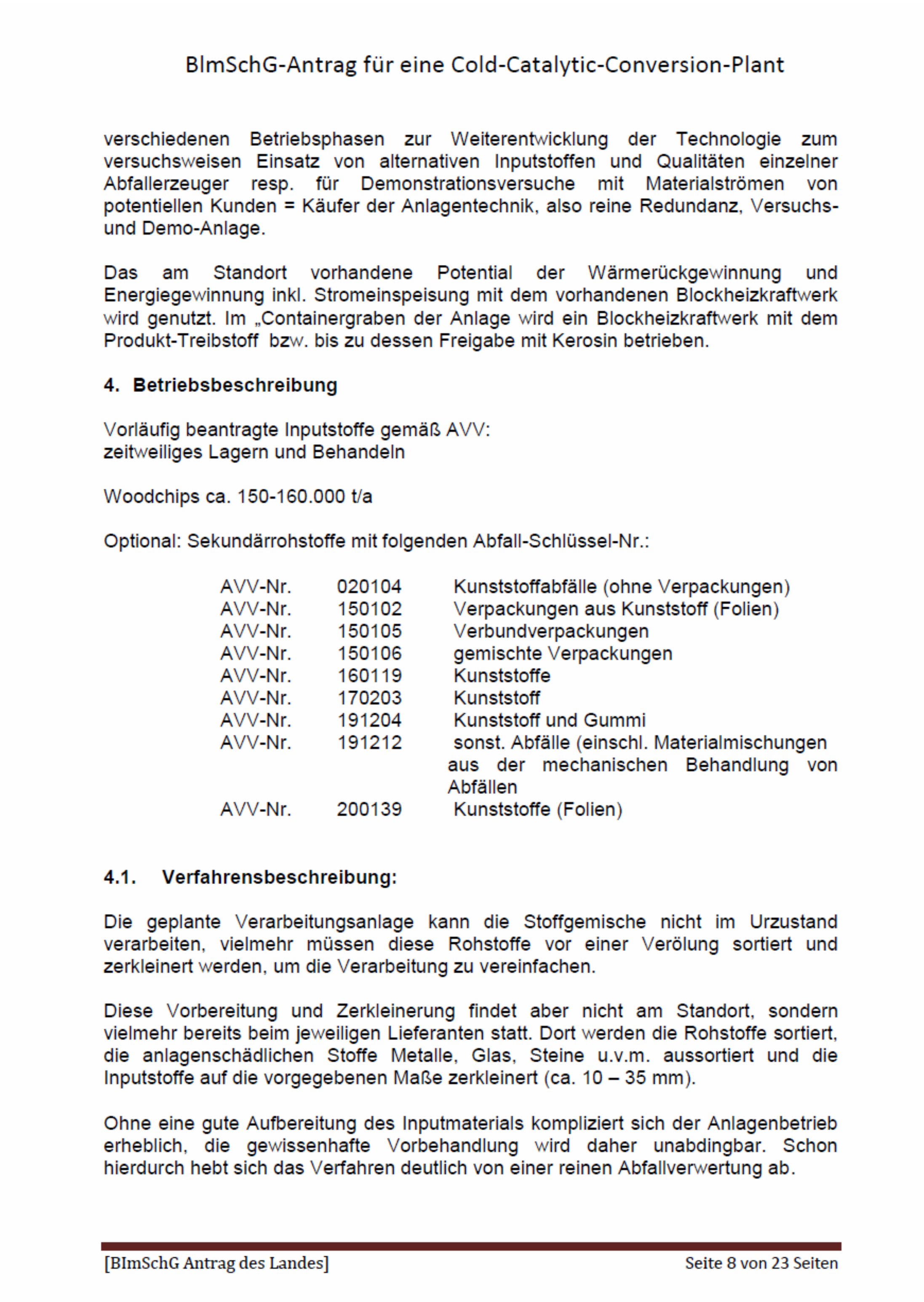

verschiedenen Betriebsphasen zur Weiterentwicklung der Technologie zum versuchsweisen Einsatz von alternativen Inputstoffen und Qualitäten einzelner Abfallerzeuger resp. für Demonstrationsversuche mit Materialströmen von potentiellen Kunden = Käufer der Anlagentechnik, also reine Redundanz, Versuchs- und Demo-Anlage.

Das am Standort vorhandene Potential der Wärmerückgewinnung und Energiegewinnung inkl. Stromeinspeisung mit dem vorhandenen Blockheizkraftwerk wird genutzt. Im „Containergraben der Anlage wird ein Blockheizkraftwerk mit dem Produkt-Treibstoff bzw. bis zu dessen Freigabe mit Kerosin betrieben.

4. Betriebsbeschreibung

Vorläufig beantragte Inputstoffe gemäß AVV:
zeitweiliges Lagern und Behandeln

Woodchips ca. 150-160.000 t/a

Optional: Sekundärrohstoffe mit folgenden Abfall-Schlüssel-Nr.:

AVV-Nr.	020104	Kunststoffabfälle (ohne Verpackungen)
AVV-Nr.	150102	Verpackungen aus Kunststoff (Folien)
AVV-Nr.	150105	Verbundverpackungen
AVV-Nr.	150106	gemischte Verpackungen
AVV-Nr.	160119	Kunststoffe
AVV-Nr.	170203	Kunststoff
AVV-Nr.	191204	Kunststoff und Gummi
AVV-Nr.	191212	sonst. Abfälle (einschl. Materialmischungen aus der mechanischen Behandlung von Abfällen
AVV-Nr.	200139	Kunststoffe (Folien)

4.1. Verfahrensbeschreibung:

Die geplante Verarbeitungsanlage kann die Stoffgemische nicht im Urzustand verarbeiten, vielmehr müssen diese Rohstoffe vor einer Verölung sortiert und zerkleinert werden, um die Verarbeitung zu vereinfachen.

Diese Vorbereitung und Zerkleinerung findet aber nicht am Standort, sondern vielmehr bereits beim jeweiligen Lieferanten statt. Dort werden die Rohstoffe sortiert, die anlagenschädlichen Stoffe Metalle, Glas, Steine u.v.m. aussortiert und die Inputstoffe auf die vorgegebenen Maße zerkleinert (ca. 10 – 35 mm).

Ohne eine gute Aufbereitung des Inputmaterials kompliziert sich der Anlagenbetrieb erheblich, die gewissenhafte Vorbehandlung wird daher unabdingbar. Schon hierdurch hebt sich das Verfahren deutlich von einer reinen Abfallverwertung ab.

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Sämtliche Sekundärrohstoffe organischer Natur können als Beiprodukt oder als Hauptprodukt in dieser Anlage zu Rohöl konvertiert werden!

Die Anlieferung der vorbereiteten organischen Rohstoffe erfolgt kontinuierlich, d.h. ohne groß Lagerhaltung am Standort. Beim geplanten Anlagendurchsatz von < 20 t/h werden rechnerisch 32 LKWs (evtl. auch Walking-Floor Sattelzüge) je Tag anliefern.

CCC = Cold Catalytic Conversion

Der wesentliche Verfahrensteil ist ein seit mehr als 50 Jahren bekanntes Verfahren der katalytischen Umwandlung von organischen (auch fossilen) Ausgangsprodukten in Synthesedampf mit anschließender Kondensation zu flüssigen Kohlenwasserstoffen in Destillationskolonnen.

Ziel dieses Verarbeitungsverfahrens ist immer, nahezu 100 %iger Sauerstoffausschluss. Denn je mehr Sauerstoff beim Eintritt in den Reaktor in der zu konvertierenden Organik eingebunden ist, umso stärker würde die Reaktion dahingehend ablaufen, dass bei der kalten Konversion die absolut unerwünschten Fraktionen der Teeröle/Koks entstehen und außerdem exotherme Reaktionen möglich werden.

Die gewählte Anlagenbezeichnung „Cold-Catalytic-Conversion“ ist aus diesem zentralen Verarbeitungsschritt entstanden, denn hier werden die Rohstoffe in einem Spezial-WEA-Zyklon vermischt und in einer Doppelschneckenpresse verdichtet (die Luft evakuiert) sowie der katalytischen Spaltung bei Temperaturen von max. 380 ^{o} C zugeführt.

Zwischen der Einspeisung über eine Doppel-Extruder-Schnecke und dem eigentlichen Reaktor ist eine Zellenradschleuse mit Mühle zwischengeschaltet, um einen Rückstrom des Materials zu verhindern. Zusätzlich wird, um den Sauerstoffausschluss innerhalb des katalytischen Prozesses zu gewährleisten, eine stetige Sauerstoffgehaltsmessung durchgeführt. Aus Sicherheitsaspekten wird bei O2-Detektion die Materialzufuhr gestoppt und die Anlage heruntergefahren.

Darüber hinaus wird im Bedarfsfall durch Eindüsen von bevorratetem Stickstoff (in Druckgasflaschen gelagert) ein möglicher Sauerstoffgehalt im Reaktor zuverlässig verhindert.

Der eigentliche Reaktormantel des Konversionsrohres führt an seiner Innenwand das Katalysatorpulver, welches die Aufspaltung der Rohstoffe, den Crack-Prozess erst ermöglicht. Der Drehrohrreaktor wird in der Doppelwand indirekt beheizt, durch Abwärme des Blockheizkraftwerkes. Der Reaktor arbeitet drucklos, d.h. mit atmosphärischem Aussendruck.

Für die Umgebung gefährliche Reaktionszustände entstehen nicht.

Im Reaktor werden die Rohstoffe auf max. 380°C erhitzt und dabei kontinuierlich umgewälzt zur gründlichen Durchmischung mit dem Katalysatormehl. Das Katalysatormaterial (ein Aluminiumhydrooxyd) zur Erzeugung der Materialreaktion

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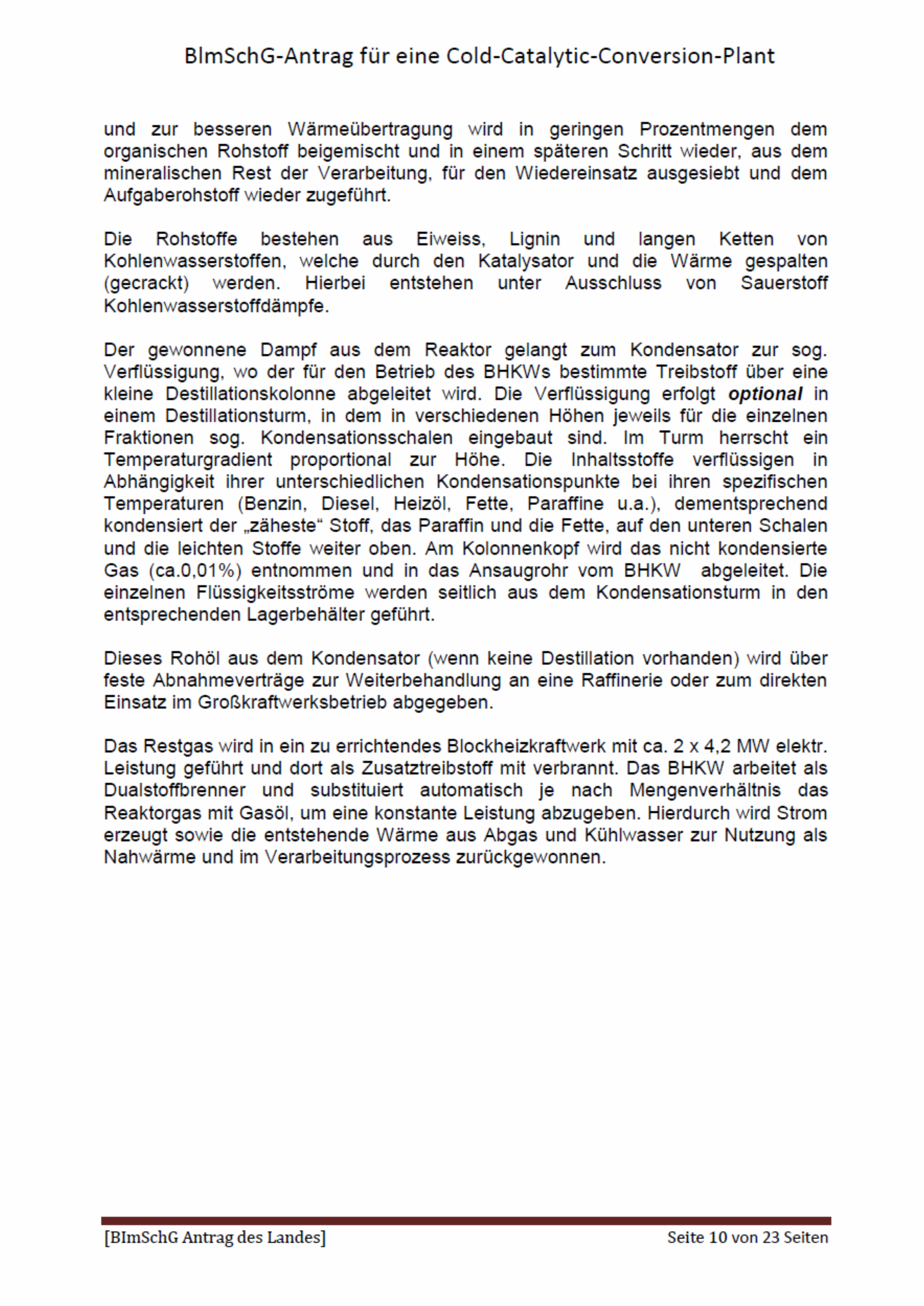


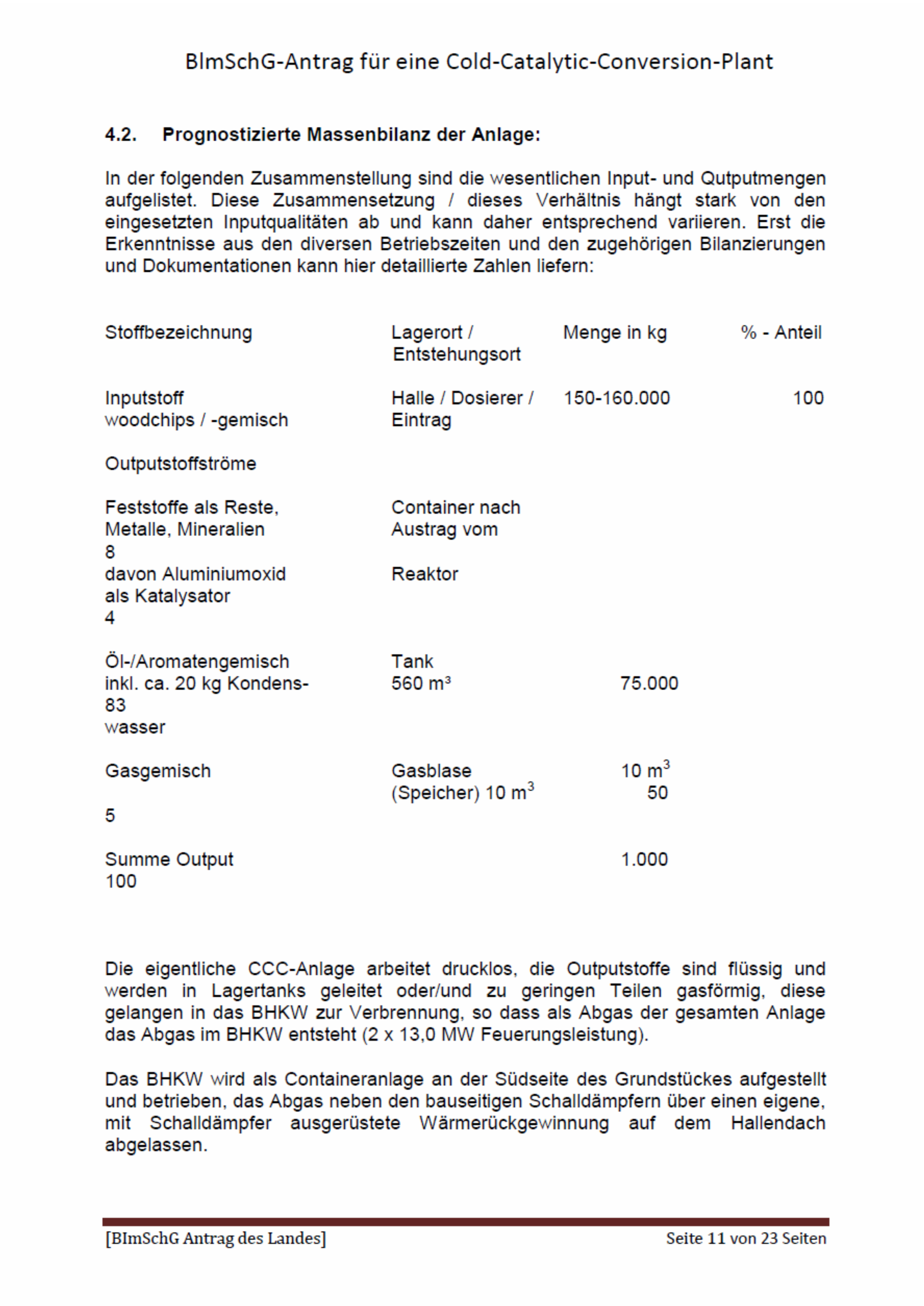
und zur besseren Wärmeübertragung wird in geringen Prozentmengen dem organischen Rohstoff beigemischt und in einem späteren Schritt wieder, aus dem mineralischen Rest der Verarbeitung, für den Wiedereinsatz ausgesiebt und dem Aufgaberohstoff wieder zugeführt.

Die Rohstoffe bestehen aus Eiweiss, Lignin und langen Ketten von Kohlenwasserstoffen, welche durch den Katalysator und die Wärme gespalten (gecrackt) werden. Hierbei entstehen unter Ausschluss von Sauerstoff Kohlenwasserstoffdämpfe.

Der gewonnene Dampf aus dem Reaktor gelangt zum Kondensator zur sog. Verflüssigung, wo der für den Betrieb des BHKWs bestimmte Treibstoff über eine kleine Destillationskolonne abgeleitet wird. Die Verflüssigung erfolgt ***optional*** in einem Destillationsturm, in dem in verschiedenen Höhen jeweils für die einzelnen Fraktionen sog. Kondensationsschalen eingebaut sind. Im Turm herrscht ein Temperaturgradient proportional zur Höhe. Die Inhaltsstoffe verflüssigen in Abhängigkeit ihrer unterschiedlichen Kondensationspunkte bei ihren spezifischen Temperaturen (Benzin, Diesel, Heizöl, Fette, Paraffine u.a.), dementsprechend kondensiert der „zäheste“ Stoff, das Paraffin und die Fette, auf den unteren Schalen und die leichten Stoffe weiter oben. Am Kolonnenkopf wird das nicht kondensierte Gas (ca.0,01%) entnommen und in das Ansaugrohr vom BHKW abgeleitet. Die einzelnen Flüssigkeitsströme werden seitlich aus dem Kondensationsturm in den entsprechenden Lagerbehälter geführt.

Dieses Rohöl aus dem Kondensator (wenn keine Destillation vorhanden) wird über feste Abnahmeverträge zur Weiterbehandlung an eine Raffinerie oder zum direkten Einsatz im Großkraftwerksbetrieb abgegeben.

Das Restgas wird in ein zu errichtendes Blockheizkraftwerk mit ca. 2 x 4,2 MW elektr. Leistung geführt und dort als Zusatztreibstoff mit verbrannt. Das BHKW arbeitet als Dualstoffbrenner und substituiert automatisch je nach Mengenverhältnis das Reaktorgas mit Gasöl, um eine konstante Leistung abzugeben. Hierdurch wird Strom erzeugt sowie die entstehende Wärme aus Abgas und Kühlwasser zur Nutzung als Nahwärme und im Verarbeitungsprozess zurückgewonnen.



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4.2. Prognostizierte Massenbilanz der Anlage:

In der folgenden Zusammenstellung sind die wesentlichen Input- und Qutputmengen aufgelistet. Diese Zusammensetzung / dieses Verhältnis hängt stark von den eingesetzten Inputqualitäten ab und kann daher entsprechend variieren. Erst die Erkenntnisse aus den diversen Betriebszeiten und den zugehörigen Bilanzierungen und Dokumentationen kann hier detaillierte Zahlen liefern:

Stoffbezeichnung	Lagerort / Entstehungsort	Menge in kg	% - Anteil
Inputstoff woodchips / -gemisch	Halle / Dosierer / Eintrag	150-160.000	100
Outputstoffströme			
Feststoffe als Reste, Metalle, Mineralien 8 davon Aluminiumoxid als Katalysator 4	Container nach Austrag vom Reaktor		
Öl-/Aromatengemisch inkl. ca. 20 kg Kondens- 83 wasser	Tank 560 m^3	75.000	
Gasgemisch 5	Gasblase (Speicher) 10 m^3	10 m^3 50	
Summe Output 100		1.000	

Die eigentliche CCC-Anlage arbeitet drucklos, die Outputstoffe sind flüssig und werden in Lagertanks geleitet oder/und zu geringen Teilen gasförmig, diese gelangen in das BHKW zur Verbrennung, so dass als Abgas der gesamten Anlage das Abgas im BHKW entsteht (2 x 13,0 MW Feuerungsleistung).

Das BHKW wird als Containeranlage an der Südseite des Grundstückes aufgestellt und betrieben, das Abgas neben den bauseitigen Schalldämpfern über einen eigene, mit Schalldämpfer ausgerüstete Wärmerückgewinnung auf dem Hallendach abgelassen.

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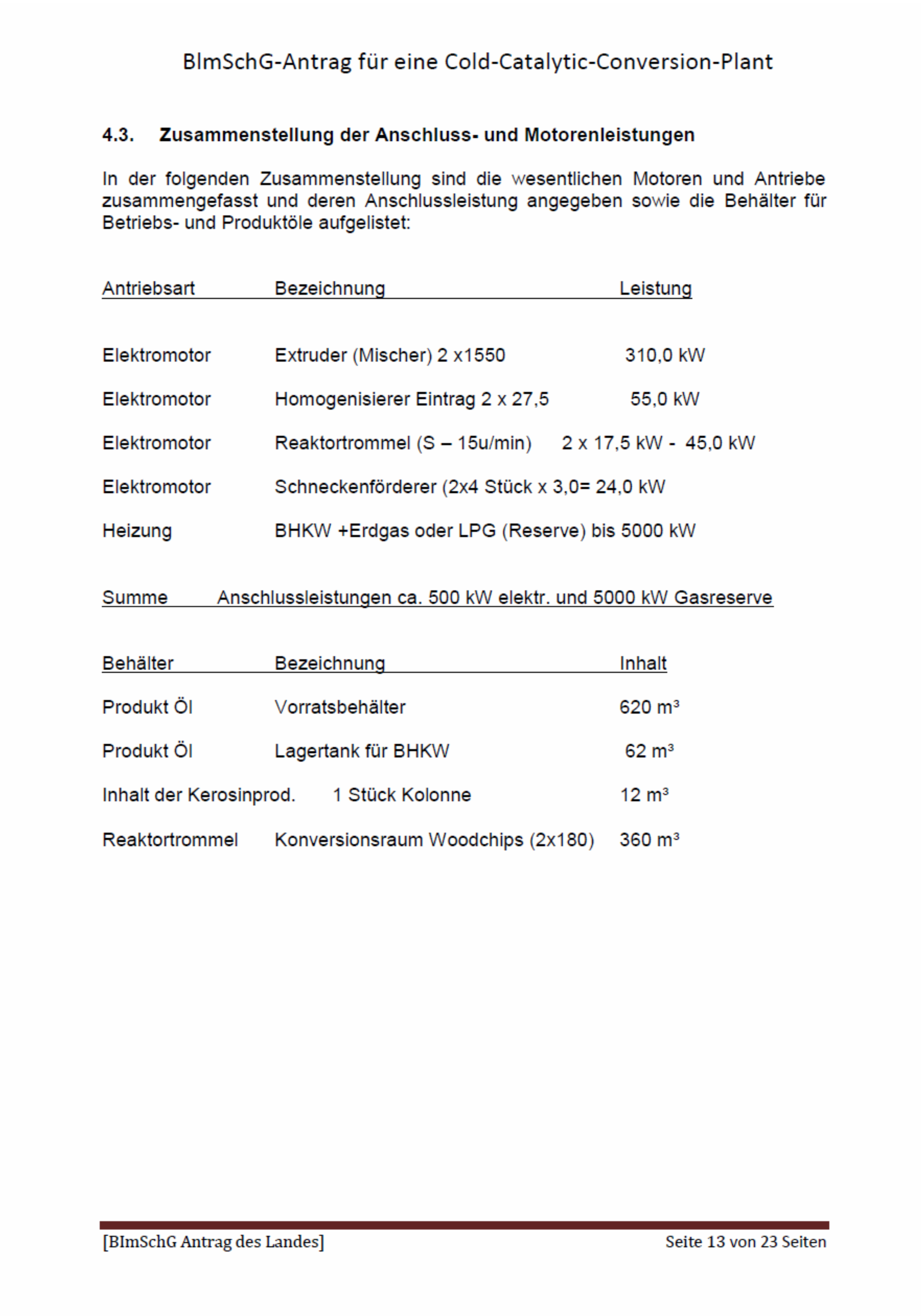
Außerdem wird Kühlwasser (Glykolgemisch) im WEA-Wärme-Kreislauf geführt, die Anlage arbeitet somit völlig abwasserfrei.



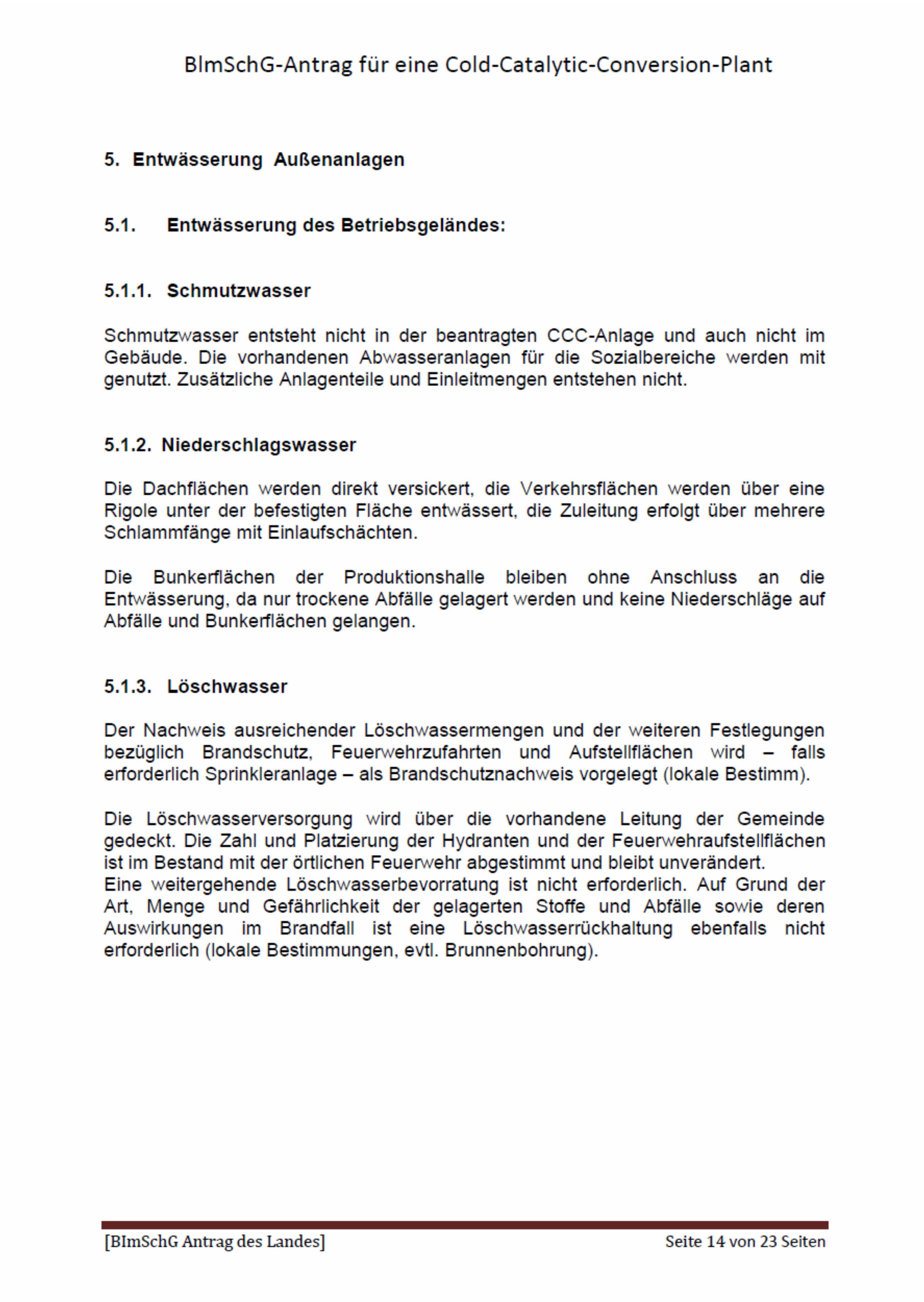
4.3. Zusammenstellung der Anschluss- und Motorenleistungen

In der folgenden Zusammenstellung sind die wesentlichen Motoren und Antriebe zusammengefasst und deren Anschlussleistung angegeben sowie die Behälter für Betriebs- und Produktöle aufgelistet:

Antriebsart	Bezeichnung	Leistung
Elektromotor	Extruder (Mischer) 2 x1550	310,0 kW
Elektromotor	Homogenisierer Eintrag 2 x 27,5	55,0 kW
Elektromotor	Reaktortrommel (S – 15u/min)	2 x 17,5 kW - 45,0 kW
Elektromotor	Schneckenförderer (2x4 Stück x 3,0= 24,0 kW	
Heizung	BHKW +Erdgas oder LPG (Reserve) bis 5000 kW	

Summe Anschlussleistungen ca. 500 kW elektr. und 5000 kW Gasreserve

Behälter	Bezeichnung	Inhalt
Produkt Öl	Vorratsbehälter	620 m³
Produkt Öl	Lagertank für BHKW	62 m³
Inhalt der Kerosinprod.	1 Stück Kolonne	12 m³
Reaktortrommel	Konversionsraum Woodchips (2x180)	360 m³



5. Entwässerung Außenanlagen

5.1. Entwässerung des Betriebsgeländes:

5.1.1. Schmutzwasser

Schmutzwasser entsteht nicht in der beantragten CCC-Anlage und auch nicht im Gebäude. Die vorhandenen Abwasseranlagen für die Sozialbereiche werden mit genutzt. Zusätzliche Anlagenteile und Einleitmengen entstehen nicht.

5.1.2. Niederschlagswasser

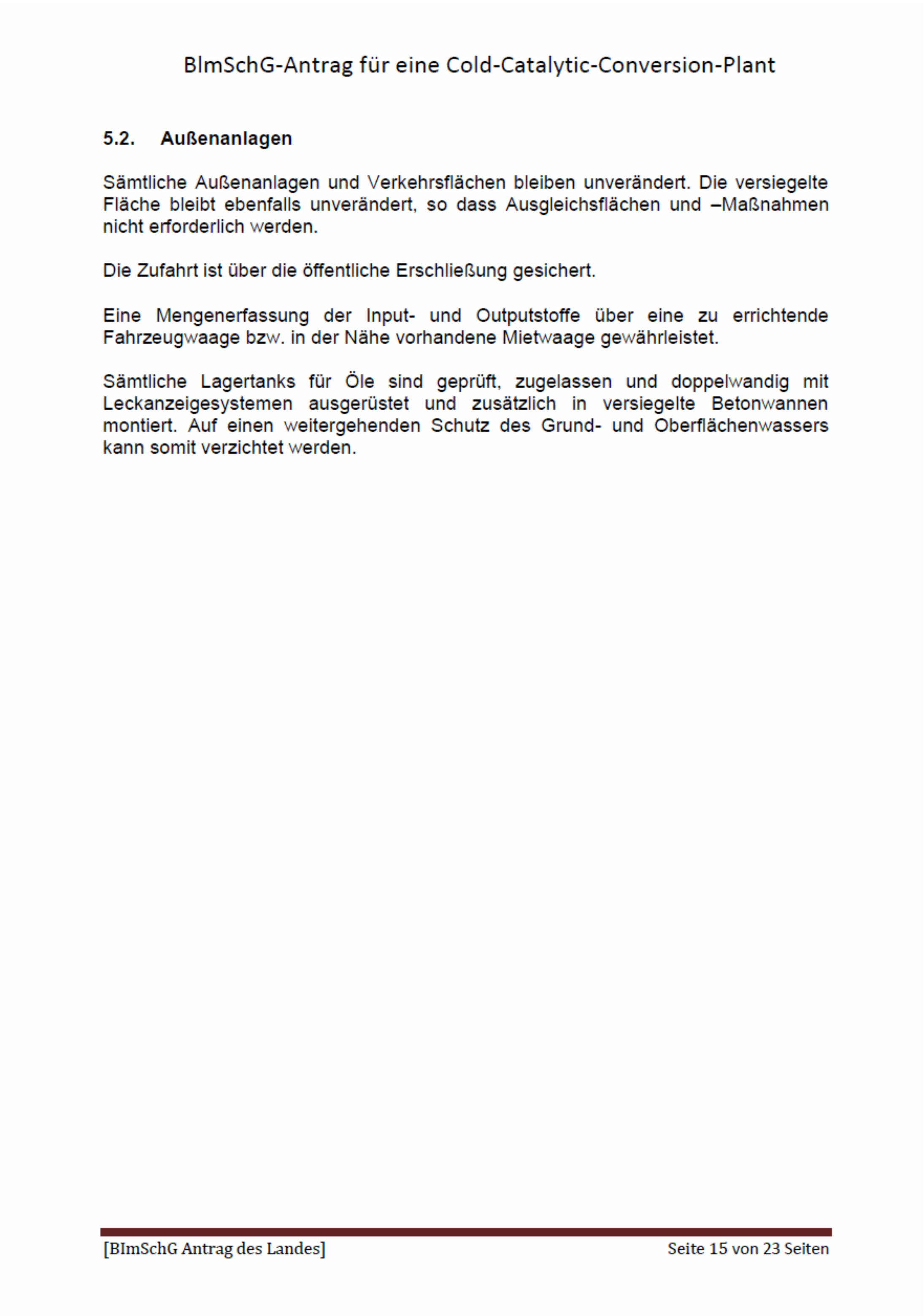
Die Dachflächen werden direkt versickert, die Verkehrsflächen werden über eine Rigole unter der befestigten Fläche entwässert, die Zuleitung erfolgt über mehrere Schlammfänge mit Einlaufschächten.

Die Bunkerflächen der Produktionshalle bleiben ohne Anschluss an die Entwässerung, da nur trockene Abfälle gelagert werden und keine Niederschläge auf Abfälle und Bunkerflächen gelangen.

5.1.3. Löschwasser

Der Nachweis ausreichender Löschwassermengen und der weiteren Festlegungen bezüglich Brandschutz, Feuerwehrzufahrten und Aufstellflächen wird – falls erforderlich Sprinkleranlage – als Brandschutznachweis vorgelegt (lokale Bestimm).

Die Löschwasserversorgung wird über die vorhandene Leitung der Gemeinde gedeckt. Die Zahl und Platzierung der Hydranten und der Feuerwehraufstellflächen ist im Bestand mit der örtlichen Feuerwehr abgestimmt und bleibt unverändert.
Eine weitergehende Löschwasserbevorratung ist nicht erforderlich. Auf Grund der Art, Menge und Gefährlichkeit der gelagerten Stoffe und Abfälle sowie deren Auswirkungen im Brandfall ist eine Löschwasserrückhaltung ebenfalls nicht erforderlich (lokale Bestimmungen, evtl. Brunnenbohrung).



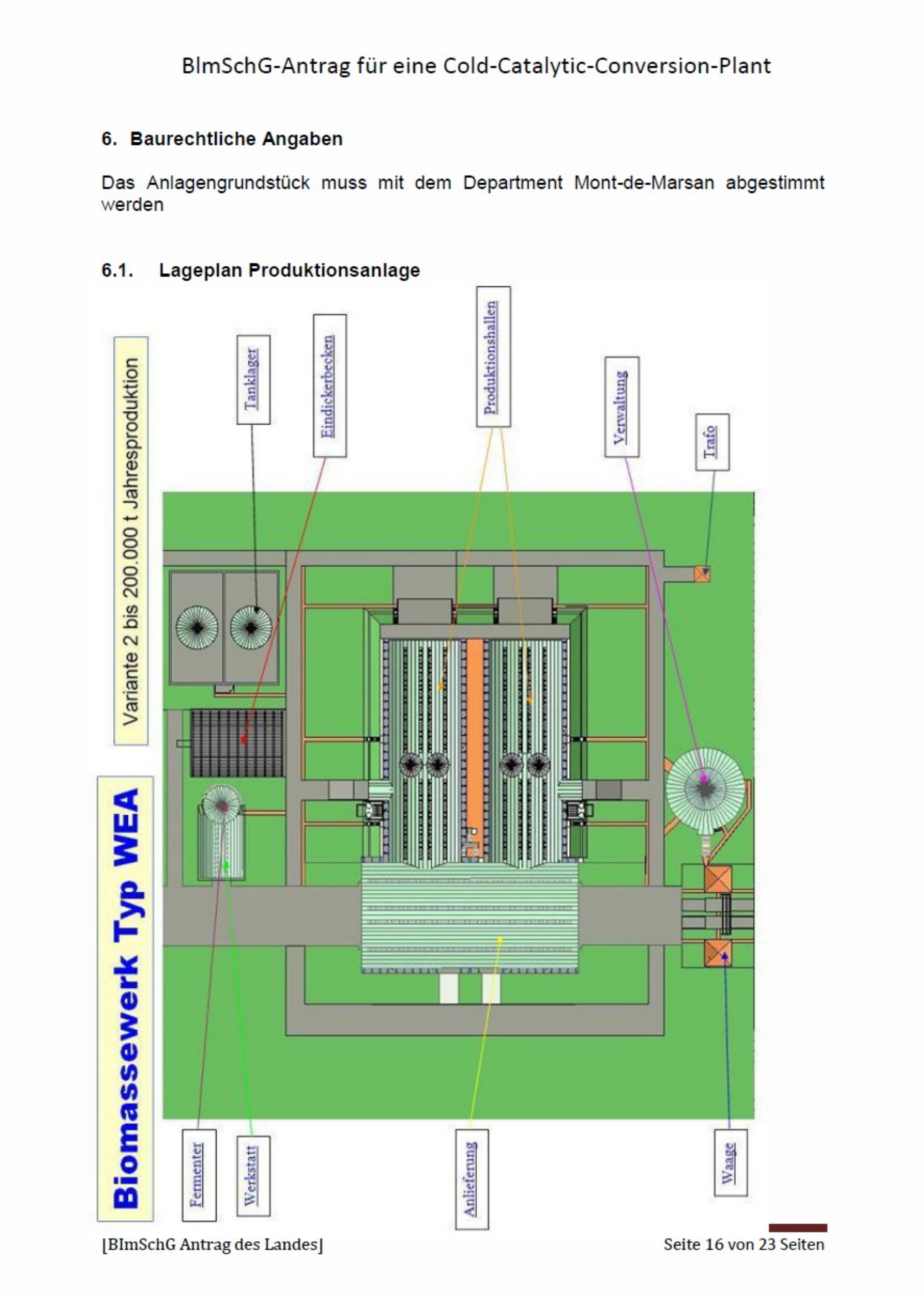
5.2. Außenanlagen

Sämtliche Außenanlagen und Verkehrsflächen bleiben unverändert. Die versiegelte Fläche bleibt ebenfalls unverändert, so dass Ausgleichsflächen und –Maßnahmen nicht erforderlich werden.

Die Zufahrt ist über die öffentliche Erschließung gesichert.

Eine Mengenerfassung der Input- und Outputstoffe über eine zu errichtende Fahrzeugwaage bzw. in der Nähe vorhandene Mietwaage gewährleistet.

Sämtliche Lagertanks für Öle sind geprüft, zugelassen und doppelwandig mit Leckanzeigesystemen ausgerüstet und zusätzlich in versiegelte Betonwannen montiert. Auf einen weitergehenden Schutz des Grund- und Oberflächenwassers kann somit verzichtet werden.



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6. Baurechtliche Angaben

Das Anlagengrundstück muss mit dem Department Mont-de-Marsan abgestimmt werden

6.1. Lageplan Produktionsanlage

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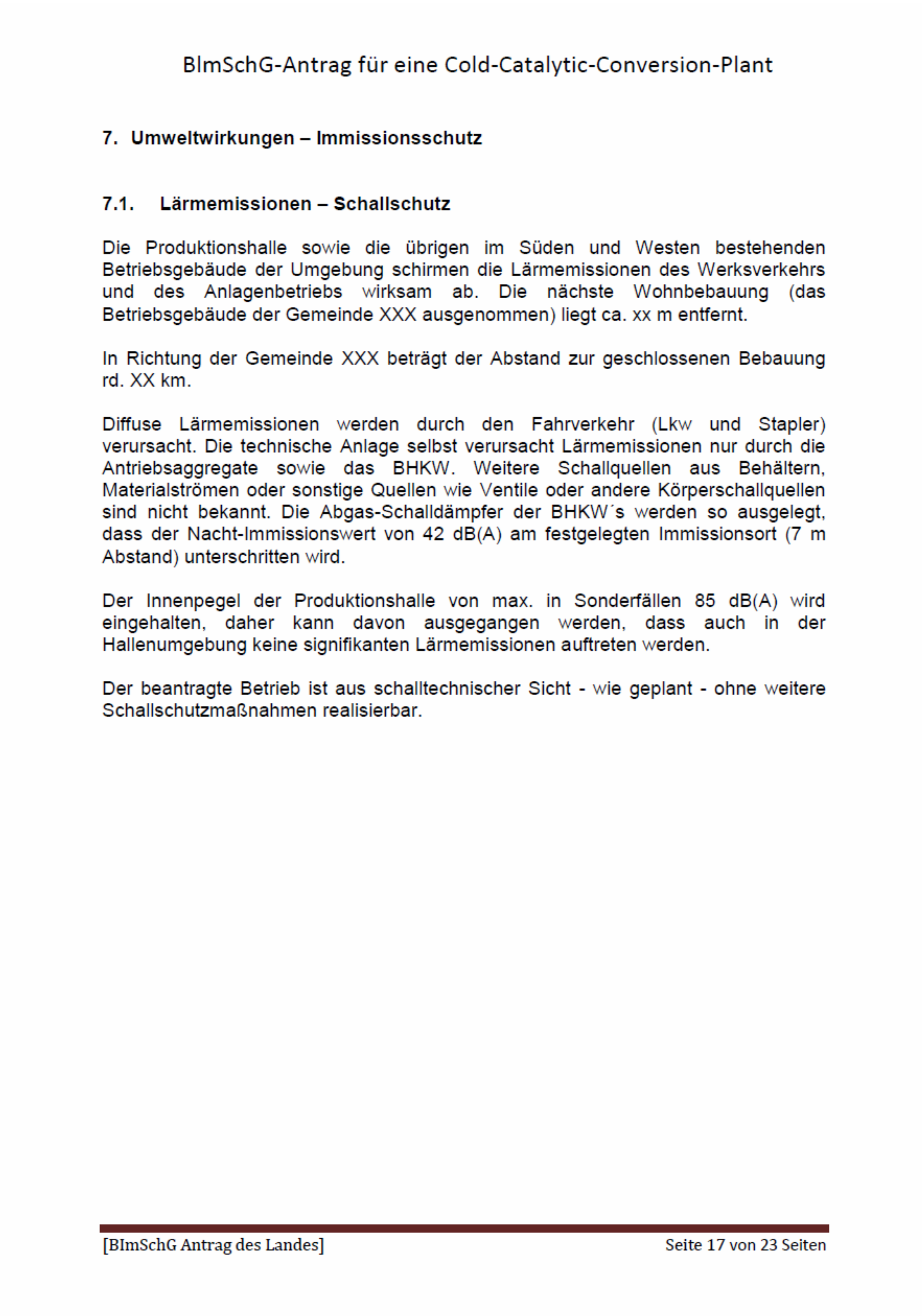


7. Umweltwirkungen – Immissionsschutz

7.1. Lärmemissionen – Schallschutz

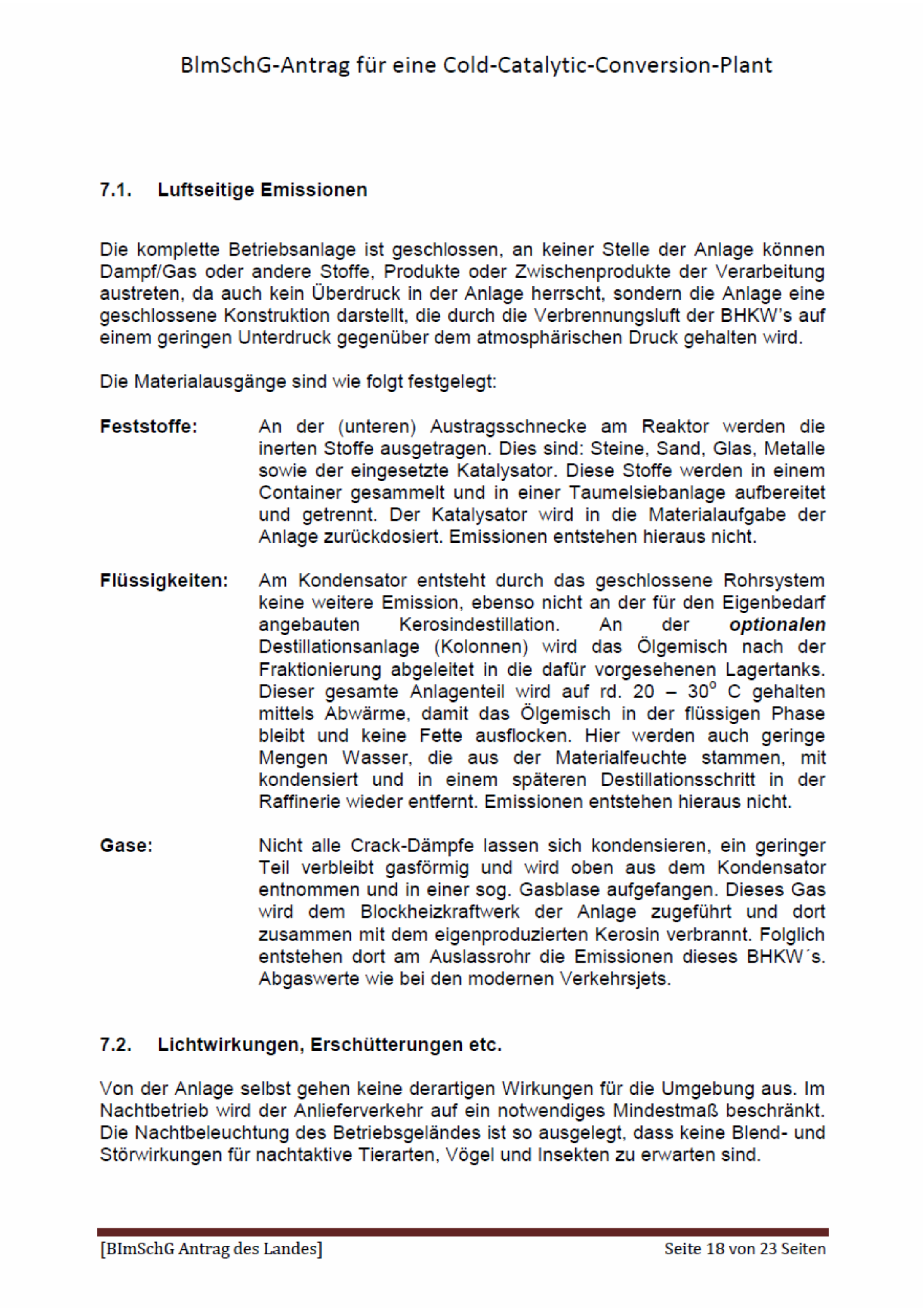
Die Produktionshalle sowie die übrigen im Süden und Westen bestehenden Betriebsgebäude der Umgebung schirmen die Lärmemissionen des Werksverkehrs und des Anlagenbetriebs wirksam ab. Die nächste Wohnbebauung (das Betriebsgebäude der Gemeinde XXX ausgenommen) liegt ca. xx m entfernt.

In Richtung der Gemeinde XXX beträgt der Abstand zur geschlossenen Bebauung rd. XX km.

Diffuse Lärmemissionen werden durch den Fahrverkehr (Lkw und Stapler) verursacht. Die technische Anlage selbst verursacht Lärmemissionen nur durch die Antriebsaggregate sowie das BHKW. Weitere Schallquellen aus Behältern, Materialströmen oder sonstige Quellen wie Ventile oder andere Körperschallquellen sind nicht bekannt. Die Abgas-Schalldämpfer der BHKW´s werden so ausgelegt, dass der Nacht-Immissionswert von 42 dB(A) am festgelegten Immissionsort (7 m Abstand) unterschritten wird.

Der Innenpegel der Produktionshalle von max. in Sonderfällen 85 dB(A) wird eingehalten, daher kann davon ausgegangen werden, dass auch in der Hallenumgebung keine signifikanten Lärmemissionen auftreten werden.

Der beantragte Betrieb ist aus schalltechnischer Sicht - wie geplant - ohne weitere Schallschutzmaßnahmen realisierbar.



7.1. Luftseitige Emissionen

Die komplette Betriebsanlage ist geschlossen, an keiner Stelle der Anlage können Dampf/Gas oder andere Stoffe, Produkte oder Zwischenprodukte der Verarbeitung austreten, da auch kein Überdruck in der Anlage herrscht, sondern die Anlage eine geschlossene Konstruktion darstellt, die durch die Verbrennungsluft der BHKW's auf einem geringen Unterdruck gegenüber dem atmosphärischen Druck gehalten wird.

Die Materialausgänge sind wie folgt festgelegt:

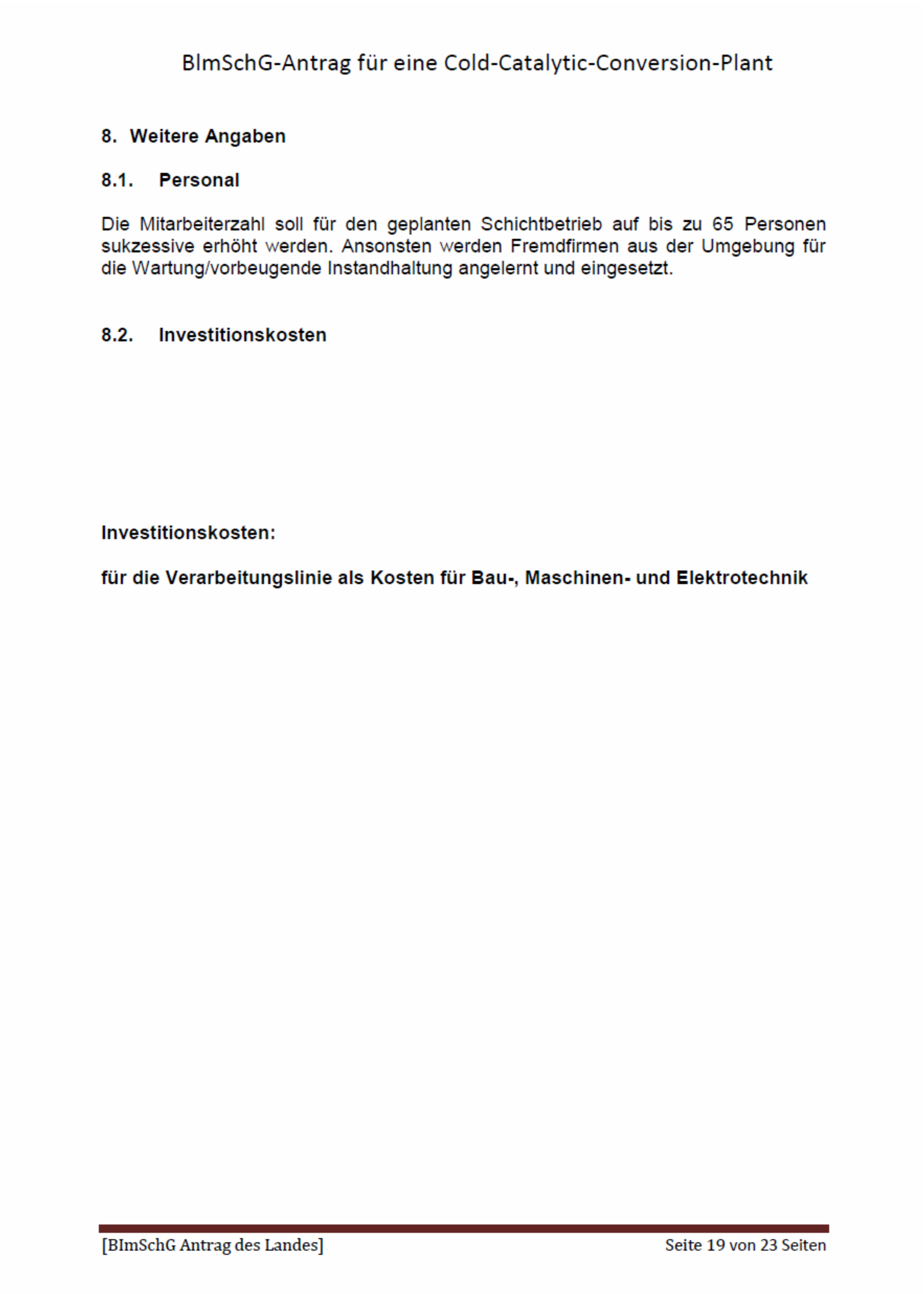
Feststoffe: An der (unteren) Austragsschnecke am Reaktor werden die inerten Stoffe ausgetragen. Dies sind: Steine, Sand, Glas, Metalle sowie der eingesetzte Katalysator. Diese Stoffe werden in einem Container gesammelt und in einer Taumelsiebanlage aufbereitet und getrennt. Der Katalysator wird in die Materialaufgabe der Anlage zurückdosiert. Emissionen entstehen hieraus nicht.

Flüssigkeiten: Am Kondensator entsteht durch das geschlossene Rohrsystem keine weitere Emission, ebenso nicht an der für den Eigenbedarf angebauten Kerosindestillation. An der ***optionalen*** Destillationsanlage (Kolonnen) wird das Ölgemisch nach der Fraktionierung abgeleitet in die dafür vorgesehenen Lagertanks. Dieser gesamte Anlagenteil wird auf rd. 20 – 30° C gehalten mittels Abwärme, damit das Ölgemisch in der flüssigen Phase bleibt und keine Fette ausflocken. Hier werden auch geringe Mengen Wasser, die aus der Materialfeuchte stammen, mit kondensiert und in einem späteren Destillationsschritt in der Raffinerie wieder entfernt. Emissionen entstehen hieraus nicht.

Gase: Nicht alle Crack-Dämpfe lassen sich kondensieren, ein geringer Teil verbleibt gasförmig und wird oben aus dem Kondensator entnommen und in einer sog. Gasblase aufgefangen. Dieses Gas wird dem Blockheizkraftwerk der Anlage zugeführt und dort zusammen mit dem eigenproduzierten Kerosin verbrannt. Folglich entstehen dort am Auslassrohr die Emissionen dieses BHKW´s. Abgaswerte wie bei den modernen Verkehrsjets.

7.2. Lichtwirkungen, Erschütterungen etc.

Von der Anlage selbst gehen keine derartigen Wirkungen für die Umgebung aus. Im Nachtbetrieb wird der Anlieferverkehr auf ein notwendiges Mindestmaß beschränkt. Die Nachtbeleuchtung des Betriebsgeländes ist so ausgelegt, dass keine Blend- und Störwirkungen für nachtaktive Tierarten, Vögel und Insekten zu erwarten sind.



8. Weitere Angaben

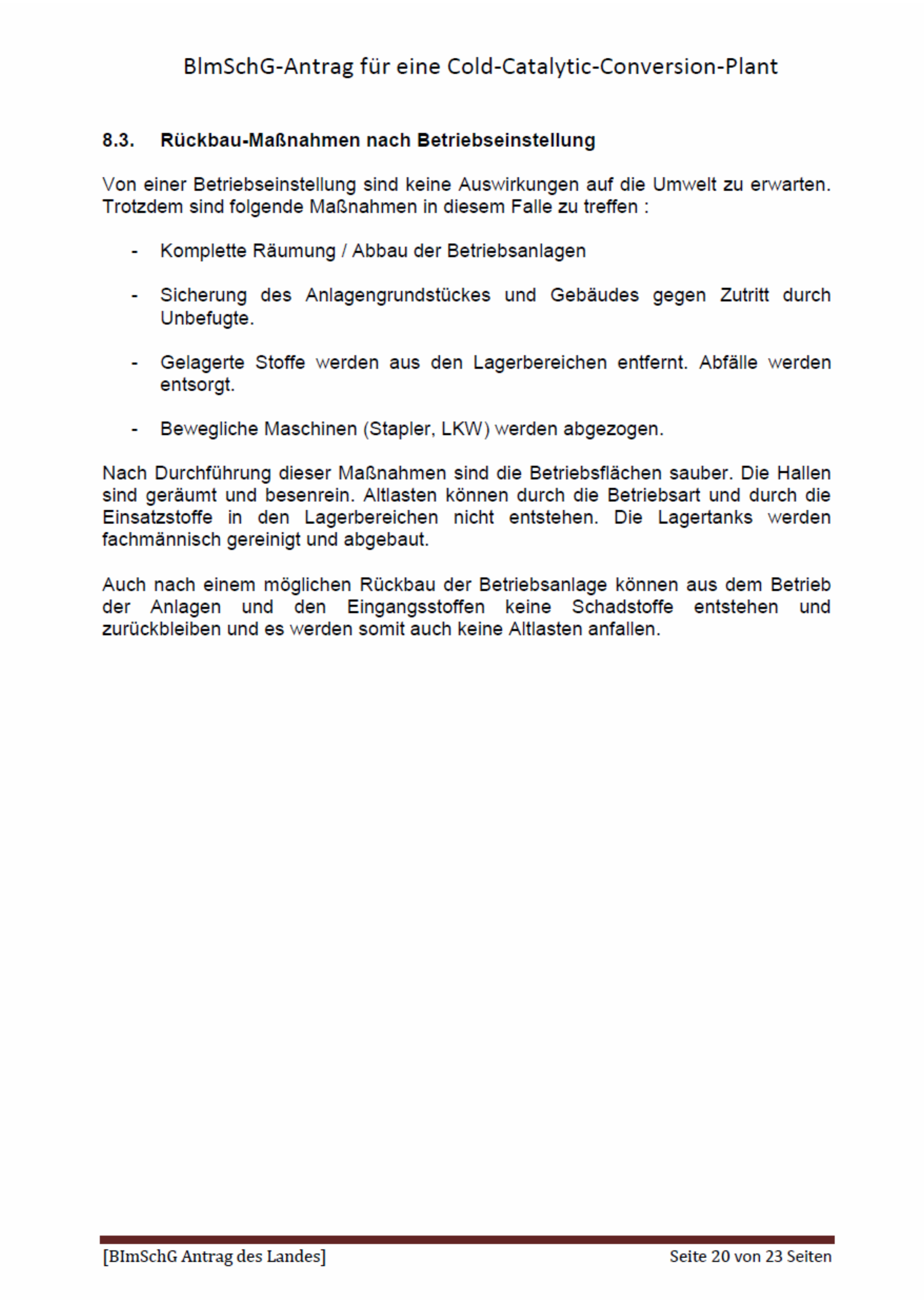
8.1. Personal

Die Mitarbeiterzahl soll für den geplanten Schichtbetrieb auf bis zu 65 Personen sukzessive erhöht werden. Ansonsten werden Fremdfirmen aus der Umgebung für die Wartung/vorbeugende Instandhaltung angelernt und eingesetzt.

8.2. Investitionskosten

Investitionskosten:

für die Verarbeitungslinie als Kosten für Bau-, Maschinen- und Elektrotechnik



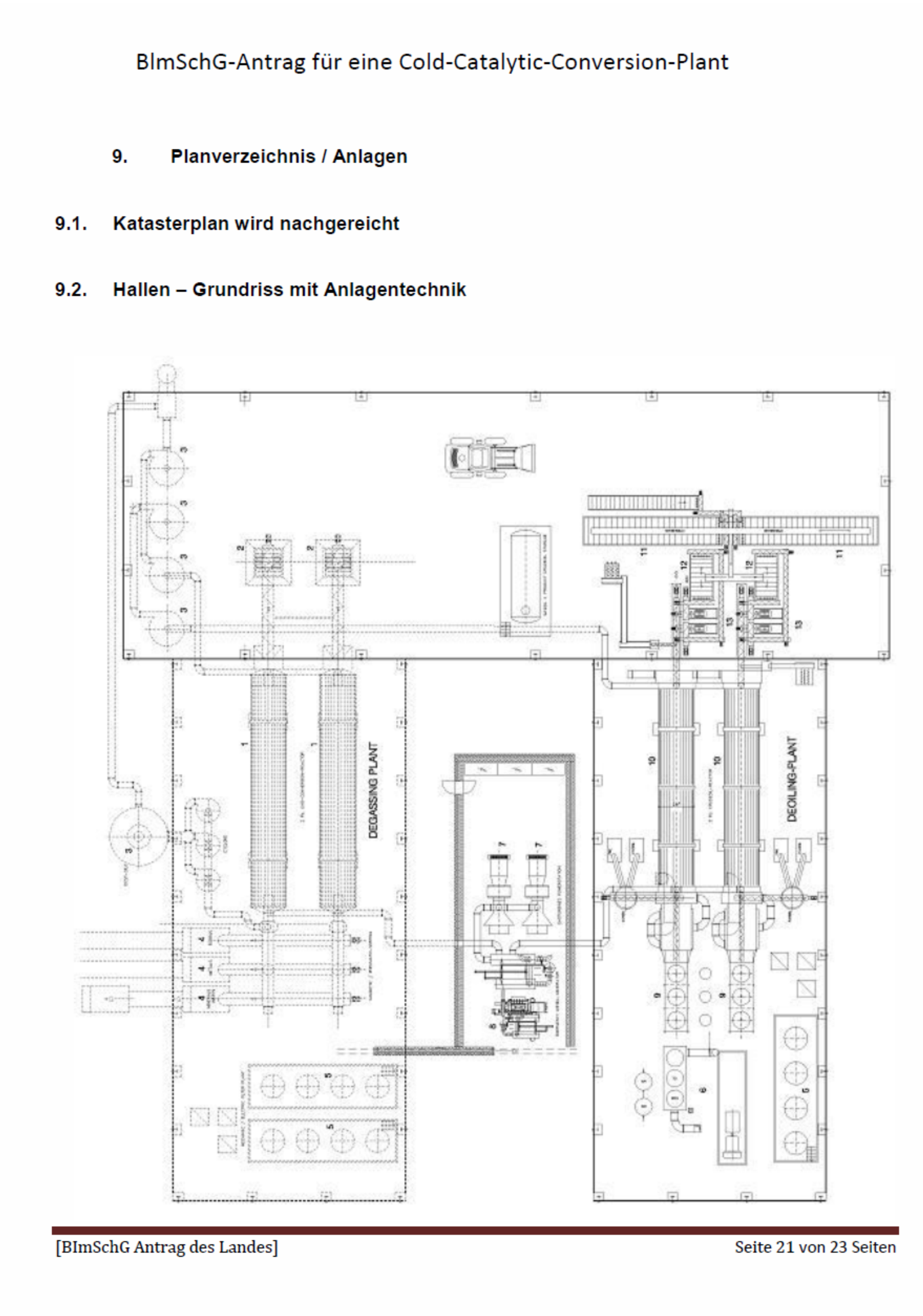
8.3. Rückbau-Maßnahmen nach Betriebseinstellung

Von einer Betriebseinstellung sind keine Auswirkungen auf die Umwelt zu erwarten. Trotzdem sind folgende Maßnahmen in diesem Falle zu treffen :

- Komplette Räumung / Abbau der Betriebsanlagen
- Sicherung des Anlagengrundstückes und Gebäudes gegen Zutritt durch Unbefugte.
- Gelagerte Stoffe werden aus den Lagerbereichen entfernt. Abfälle werden entsorgt.
- Bewegliche Maschinen (Stapler, LKW) werden abgezogen.

Nach Durchführung dieser Maßnahmen sind die Betriebsflächen sauber. Die Hallen sind geräumt und besenrein. Altlasten können durch die Betriebsart und durch die Einsatzstoffe in den Lagerbereichen nicht entstehen. Die Lagertanks werden fachmännisch gereinigt und abgebaut.

Auch nach einem möglichen Rückbau der Betriebsanlage können aus dem Betrieb der Anlagen und den Eingangsstoffen keine Schadstoffe entstehen und zurückbleiben und es werden somit auch keine Altlasten anfallen.



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9. Planverzeichnis / Anlagen

9.1. Katasterplan wird nachgereicht

9.2. Hallen – Grundriss mit Anlagentechnik

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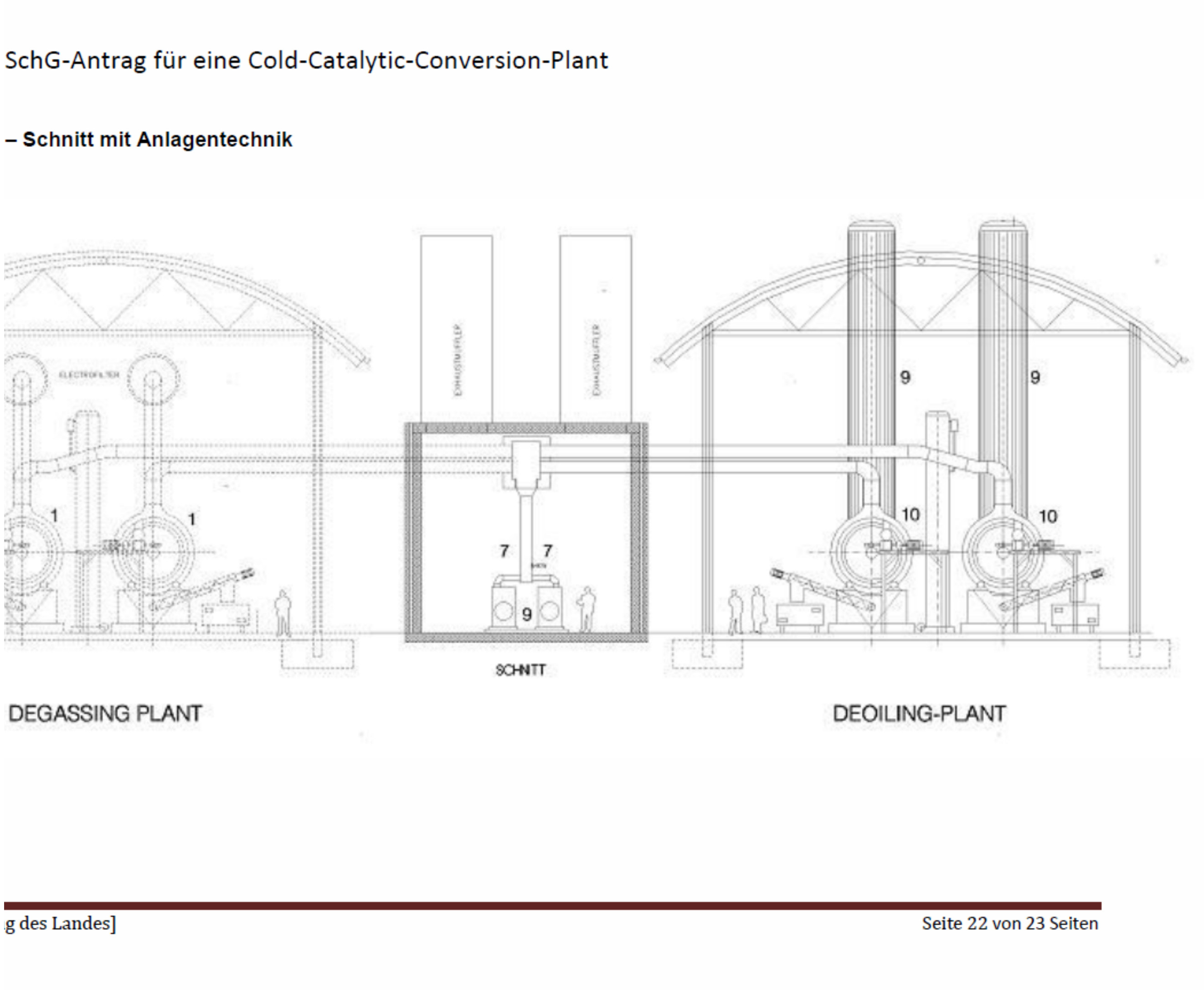

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– Schnitt mit Anlagentechnik

g des Landes]

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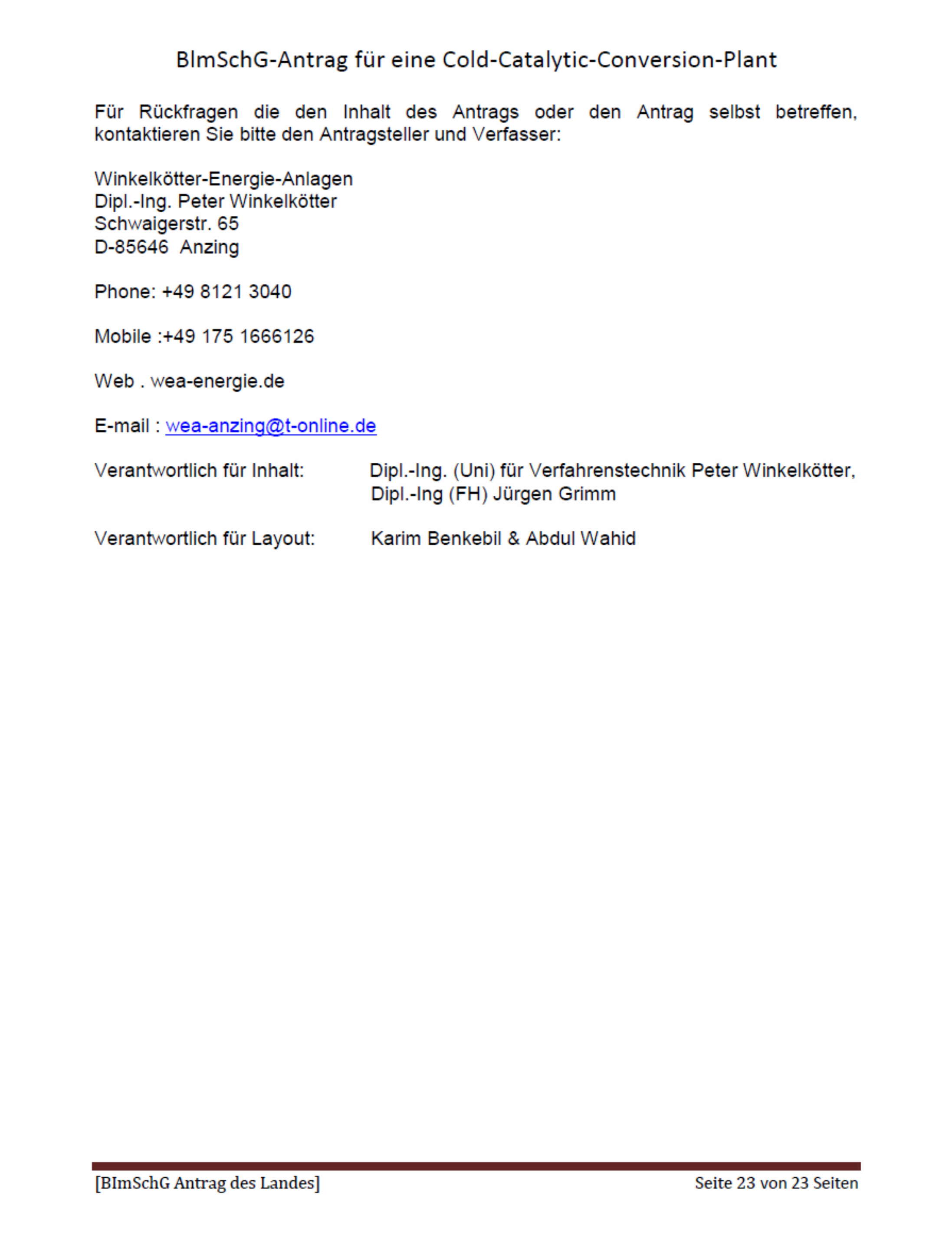

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Für Rückfragen die den Inhalt des Antrags oder den Antrag selbst betreffen, kontaktieren Sie bitte den Antragsteller und Verfasser:

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