SUSTREAT

EU-LIFE + Projekt Layman's Report

STADTENTWÄSSERUNG
EIGENBETRIEB DER STADT KOBLENZ

SWECO

Layman's Report Contents

Project Data

The LIFE+ programme is the European Union's (EU) funding programme for environmental and climate protection measures. (LIFE08 ENV/D/00026)

Project duration: 01/10/2010 -30/09/2021

Project participants: Stadtentwässerung Koblenz

Sweco GmbH (formerly Götzelmann + Partner GmbH)

Investment volume: approx. 17 million euros

The EU has funded this project with more than two million euros under the "LIFE+" programme.

www.sustreat.eu

In recent years, **climate change, rising energy costs and the uncertain disposal situation for sewage sludge in the medium to long term have** presented cities and municipalities with new challenges.

Stadtentwässerung Koblenz has the answer!

1. Introduction: Where does sewage sludge occur?

The used water from houses and commercial enterprises reaches the connected wastewater treatment plant as wastewater through the sewer system. In order to remove pollutants and contaminants from the wastewater, it is treated in mechanical, biological and, if necessary, chemical treatment stages at wastewater treatment plants (WWTP). The treated wastewater is then discharged into water bodies like rivers and lakes. The sewage sludge produced during wastewater treatment remains in the treatment plants.

Figure 1 shows the type of sewage sludge generated depending on the treatment stage. Sewage sludge is very rich in organic substances, a significant proportion of which can be used for energy generation. In addition, sewage sludge serves as a source of important nutrients such as phosphorus. Through sewage sludge digestion, part of the organic matter (approx. 50 %) can be converted into combustible biogas/digester gas and made usable for energy by means of combined heat and power generation. Almost all medium-sized and larger sewage treatment plants in Germany have this type of energetic sewage sludge utilisation. After stabilisation, the sewage sludge is dewatered and mainly disposed of thermally by incineration or, in some cases, utilised agriculturally.

Sewage sludge also represents the pollutant sink in wastewater treatment; pollutants such as heavy metals and pharmaceutical residues as well as microplastics are enriched in it. For this reason, sewage sludge may no longer be spread on fields and arable land in Germany and throughout the EU in the future.

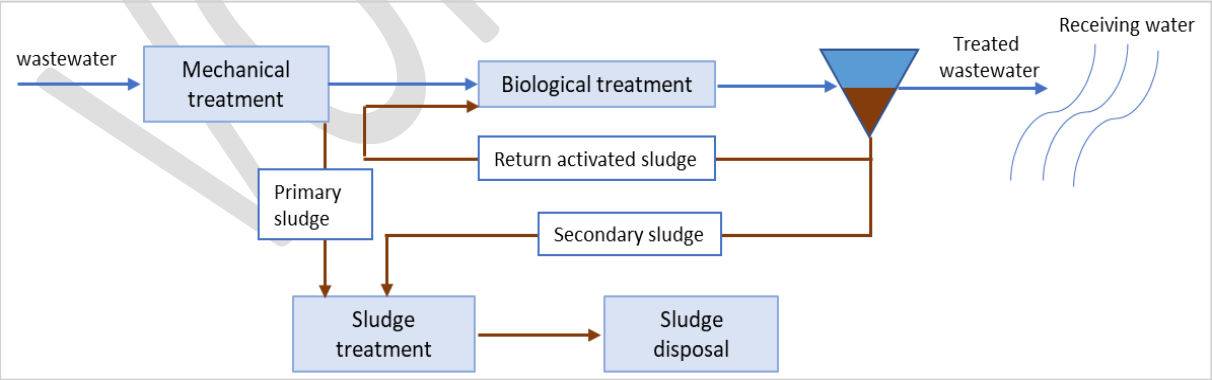


Figure 1: Wastewater treatment and sludge generation at a wastewater treatment plant

2. New challenges in sewage sludge treatment

In 2017, the German Sewage Sludge Ordinance (AbfKlärV) was amended:

> **!** From 2032, sewage sludge from wastewater treatment plants with more than 50,000 inhabitants may no longer be used for agricultural purposes. This means that sewage treatment plant operators are facing new challenges.

➔ Without new solutions, this sewage sludge would have to be **incinerated** (mono-incineration, coal-fired power plants, etc.), but the **capacities required for this currently do not exist.**

➔ Phosphorus must be recovered from the sewage sludge or ash if the phosphorus content in the sewage sludge is at least 20 g/kg dry matter (DM) or at least 2 %.

3. Koblenz wastewater treatment plant

With a capacity of 320,000 population equivalents, the Koblenz WWTP is the second largest municipal sewage treatment plant in Rhineland-Palatinate. The wastewater from over 100,000 inhabitants as well as from trade and industry is treated in a mechanical and biological treatment stage (trickling filter with aeration tank) and then discharged into the Rhine. The remaining sewage sludge has been anaerobically stabilised in the digestion towers for 40 years and biogas is produced in the process. This biogas is converted into electricity and heat, enabling the WWTP to cover up to 54 % of its own energy requirements.

Koblenz wastewater treatment plant

from waste management company to innovation leader

Since 1970, Stadtentwässerung Koblenz has been reliably making its contribution to a clean, liveable and lovable Koblenz. Now more than 40 years later due to

- climate change,
- the rising energy costs and
- the uncertain disposal situation for sewage sludge in the medium to long term

cities and municipalities face new challenges.

Stadtentwässerung Koblenz has the answer:

SusTreat*

- this is the working title for the conversion of the wastewater treatment plant into an energy self-sufficient wastewater treatment plant

*Use *of immanent energy in self-sustaining sludge treatment - a central step towards self-sustaining wastewater treatment plants*

SusTreat represents a complex system solution that harnesses and bundles these energy potentials.

4. Project „SusTreat“

The Koblenz WWTP already had three digestion towers and following mechanical dewatering. In the past, the sewage sludge was used for agricultural purposes after dewatering by spreading it on arable land. This has not been possible since 2010. From 2032, phosphorus is also to be recovered from the sewage sludge.

With the **SusTreat** project, new plant components for sewage sludge drying and gasification are connected to the existing plant. With these plants, the following will be achieved:

- Reduction of the amount of sewage sludge,
- Production of combustible synthesis gas,
- Creation of the conditions for recovery of phosphorus from the final product.

The central aspect of SusTreat is the reduction in volume of the sewage sludge produced by 85 %. This corresponds to a reduction in disposal and transport volumes of approx. 11,000 Mg of sewage sludge per year.

In this project, the WWTP was considered holistically and optimisation measures for energy efficiency were sought. The following measures were defined:

- Optimisation of the digestion process,
- Renewal of the combined heat and power plants,
- Electricity production from renewable energies within the Koblenz sewage treatment plant by photovoltaic systems,
- Energetic sewage sludge exploitation (digestion, drying, gasification).

The WWTP was first expanded with a sewage sludge dryer. This enables the drying of the dewatered sewage sludge from approx. 25 % DM to around 90 % DM by means of a belt dryer. The residual organic matter in the dried sewage sludge is then almost completely converted to synthesis gas in a gasification plant, which is burned in a combined heat and power plant (CHP). Thereby, the amount of residual waste to be disposed of is reduced and the energy potential of the sewage sludge is made completely usable. The resulting energy (heat and electricity) is utilised at the Koblenz sewage treatment plant. The final product is ash, which can be used for phosphorus recovery. In the future, direct use of this ash as a fertiliser is also planned.

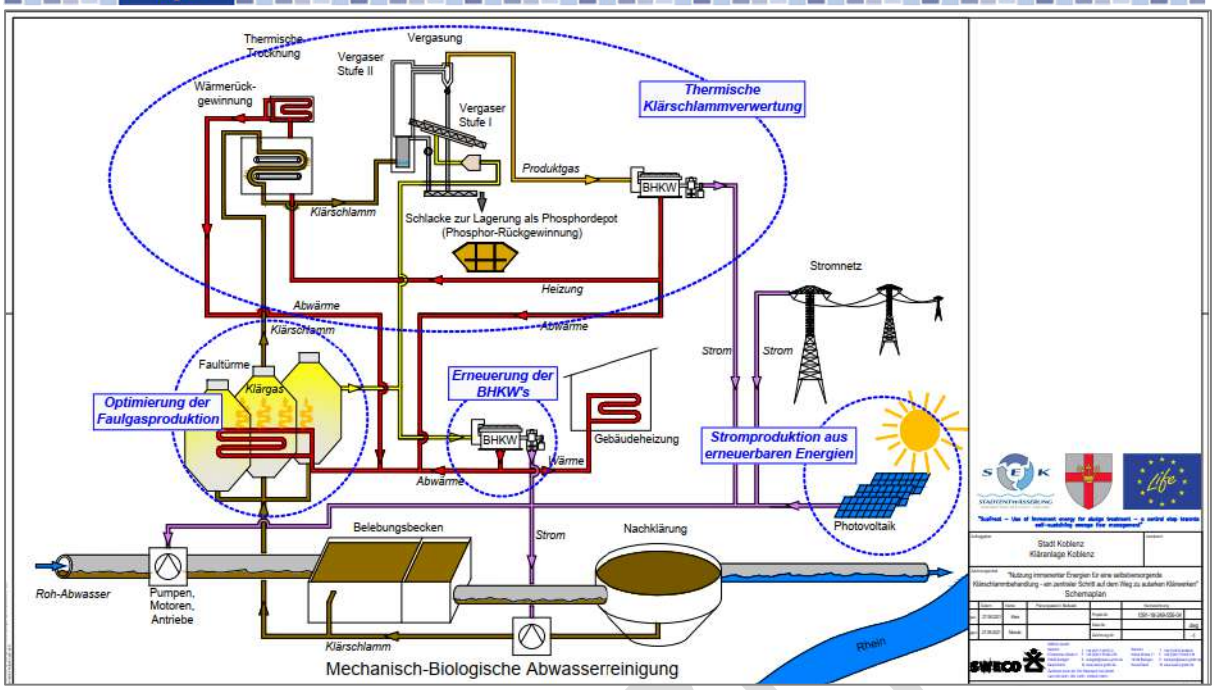
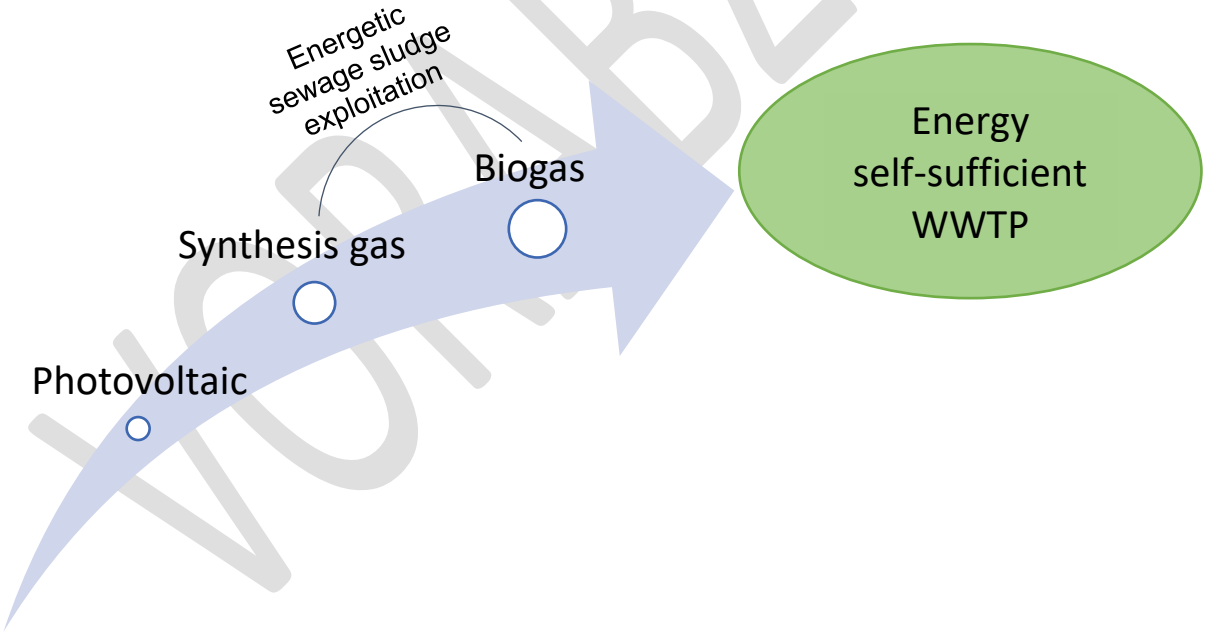


Figure 2: Flow diagram of Koblenz wastewater treatment plant with energetic sewage sludge exploitation



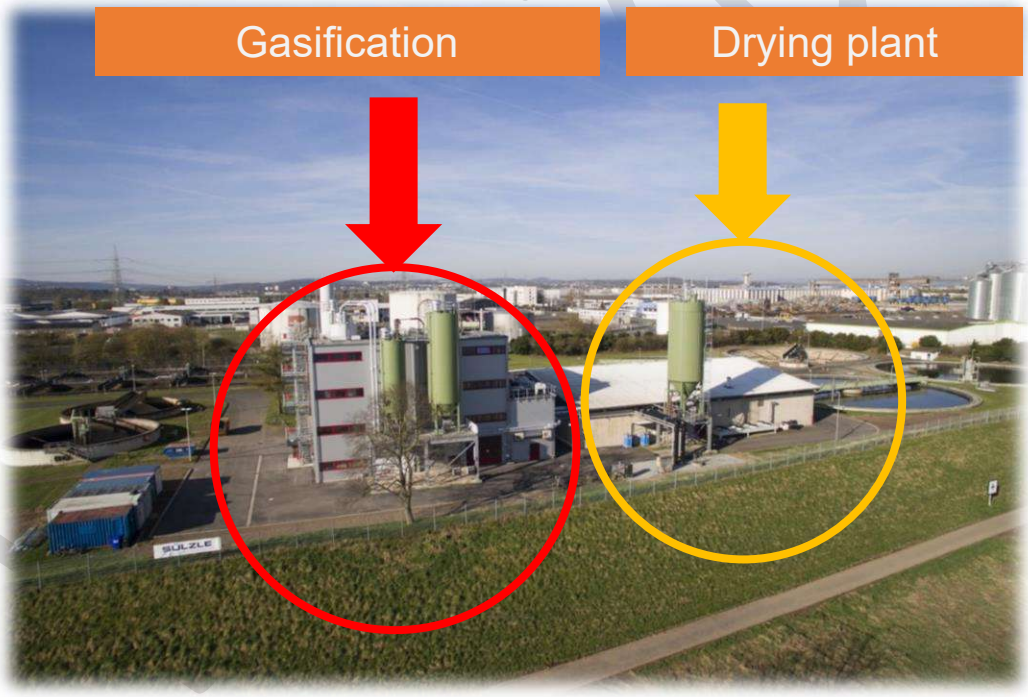
With the implementation of SusTreat, the aim is to achieve complete energy self-sufficiency in the medium to long term.

SusTreat is not just an incinerator - it is a sustainable energy producer!

As a rule, only heat can be recovered in conventional sewage sludge incineration. In the summer months, this heat must be dissipated by emergency coolers, as there are no consumers for it.

In the **SusTreat** project, individual module solutions were combined in such a way that complete heat recovery from drying and gasification takes place. The synthesis gas from the gasification increases the Koblenz sewage treatment plant's own energy production. The overall concept is designed to maximize the plant's own power generation.
Compared to combustion, gasification has the following advantages:

- Gasification produces synthesis gas, which is converted into electricity and heat by a CHP unit,
- The heat demand of the consumers and producers are adapted to each other. The heat demand of the sewage treatment plant is covered up to 100 %. No excess heat is generated during optimal operation.



The individual module solutions were intelligently combined. Sewage sludge and digester gas are fully tapped for use as CO_2-neutral energy sources.

SusTreat is a source of phosphorus!

After gasification, a mineral product (ash) remains. This ash can be used either directly as phosphate fertiliser or as a source for phosphorus recovery.
The resulting ash meets the requirements of the German Fertiliser Ordinance (DüMV).

Analysis results of the ash

Nutrient content (% DM)

P_2O_5	>10%
K_2O	0,3%
CaO	28%
MgO	1,1%

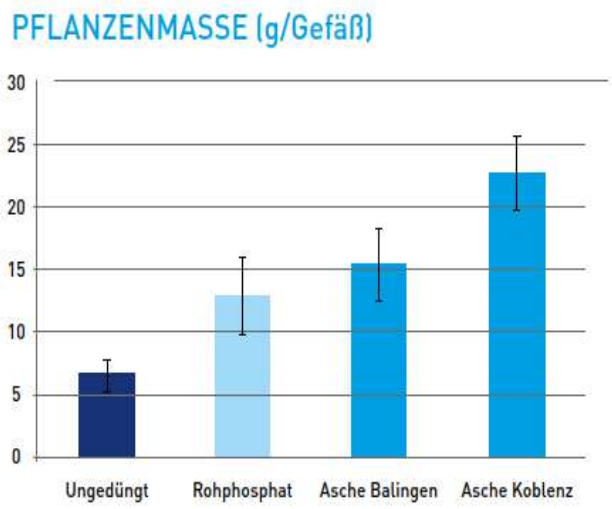
Pollutant content (mg/kg DM)

	Ash	*Limit values DüMV*
Cd	<0,2	1,5
Cr (VI)	<0,5	2
Hg	<0,05	1
Ni	<40	80
Tl	<0,01	1
Pb	37	150
As	18	40
AOX	<0,05	-
PAK 16	<0,4	-
PFT	<0,01	-

Phosphorus plant availability

Plant experiments with untreated ash from the Koblenz WWTP showed:

➔ The fertilizing effect of the ash lay:
- above the unfertilised control,
- even above rock phosphates.



Source: Sülzle Kopf SynGas

5. Medium and long-term benefits

SusTreat: environmental protection - cost reduction - disposal safety

With this project, the goal of being the first WWTP in Rhineland-Palatinate to be largely independent of external energy suppliers and to use the energy contained in the wastewater almost completely can be achieved.

Added value expected in the medium term:

- Disposal reliability resulting in stable disposal costs,
- Sewage sludge exploitation within the frame of the Closed Substance Cycle Waste Management Act,
- Cost reduction,
- Reduction of CO2 emissions by more than 40 %,
- Reduction of the externally purchased electricity volume by up to 50 %,
- Closing the heat demand gap.

Added value expected long-term:

- Extensive energy self-sufficiency,
- Disposal facility for other wastewater treatment plants,
- Additional heating of adjacent industrial buildings via district heating systems,
- Possible added value through phosphorus recovery from sewage sludge ash.

6. Energy key figures

Koblenz WWTP

Electricity consumption and generation

Designation	EU application 2008	Commissioning 2020	Unit
Total power consumption	4,670	6,131	MWh/a
- thereof purchased from third parties	2,140	1,088	MWh/a
- of which self-generated electricity (incl. PV)	2,530	5,043	MWh/a
- Share of self-generated electricity	53	82	%
Specifically:			
Dryer			
Electricity demand of dryer (3,350 Mg DM/a, 29 % DM)		698	MWh/a
Gasification			
Electricity demand of the gasification		653	MWh/a
Self-generated electricity with the syngas-CHP		2,501	MWh/a
Wastewater treatment plant			
Electricity demand of WWTP without dryer and gasification		4,780	MWh/a
Self-generated electricity with biogas-CHP		2,457	MWh/a
Self-generated electricity through photovoltaics		85	MWh/a
Heat balance of the existing heat grids			
Total heat consumption	6,400	10,542	MWh/a
- of which purchased from third parties (heating oil 2008) (natural gas 2018)	150	501	MWh/a
- thereof own production	6,250	11,039	MWh/a
- share of self-generation	97	95	MWh/a
Specifically:			
Dryer			
Heat consumption dryer (3,350 Mg DM/a, 29 % DM)		6,142	MWh/a
- of which on the 85 °C rail		3,648	MWh/a
- of which on the 140 °C rail		2,494	MWh/a
Heat recovery 60 °C rail dryer (3,350 Mg DM/a)		up to 3,482	MWh/a
Gasification			
Biogas consumption of gasification (1st stage with biogas)		3,261	MWh/a
Heat production of the syngas-CHP		4,281	MWh/a
- of which on the 85 °C rail		1,289	MWh/a
- of which on the 140 °C rail		2,992	MWh/a
Wastewater treatment plant			
Heat requirement of the WWTP without dryer and gasification		4,400	MWh/a
Heat generation through biogas-CHP		2,895	MWh/a

Other data

Designation	EU application 2008	Commissioning 2020	Unit
Dryer			
Dewatered sewage sludge quantity (3,350 Mg DM/a, 29 % DM)		11,550	Mg FiKu/a
Water content in the filter cake		8,200	Mg H_2O/a
Dried sewage sludge volume (90 % DM)		3,800	Mg DM/a
Volume reduction through drying		68	%
Amount of water to be evaporated		7,745	Mg H_2O/a
Maximum evaporation capacity dryer		1,250	kg H_2O/h
Spec. heat requirement dryer		790	kWh/Mg H_2O
Spec. power consumption dryer		90	kWh/Mg H_2O
Heat recovery potential		up to 57	%
Gasification			
Maximum throughput gasification plant		4,000	Mg DM/a
according to a DM content of 90 %		4,440	Mg DM/a
respectively		592	kg DM/h
Residues from gasification		1,870	Mg/a
- Slag/ash		600	Mg/a
- Fly ash/filter dust		1,270	Mg/a
Volume reduction through gasification		57	%
Volume reduction through drying and gasification		84	%
General			
CO_2 emission	1,270	735	Mg CO_2/a
CO_2 reduction		42	%