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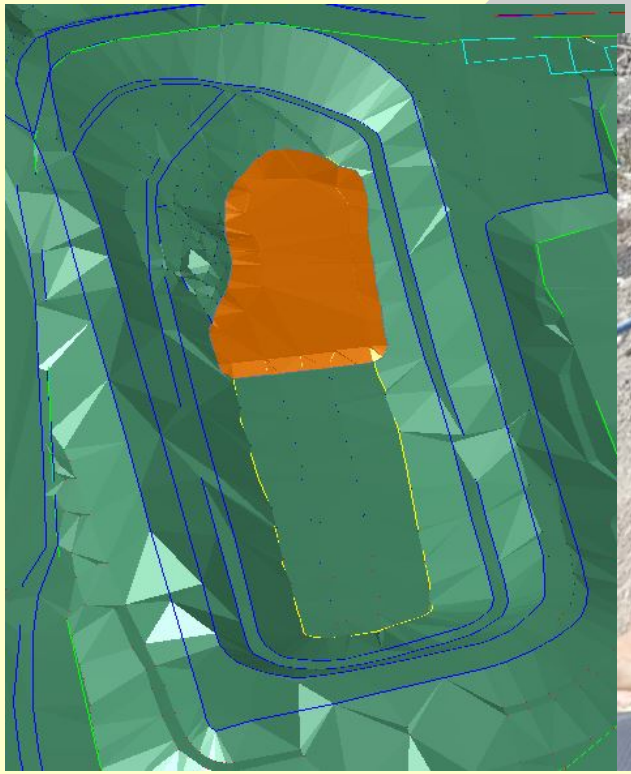

Since more than 25 years active in the matter of landfills

Dr. A. Seyfert,

Germany

Your partner in landfill **issues**

Official German expert in accordance § 29 b Abs. 1 BImSchG, ISA 558

Short introduction Dr. Seyfert

- Dr Seyfert was born in 1962 in Suhl Germany and has 2 children
- 1985 - 1989 graduated engineer (diploma work) – mechanical and Automotive Engineering, University of Applied Sciences, Zwickau, Germany
- 1989 – 1992 Dr.-Ing. (thesis), Mechanical and Automotive Engineering
- 1992 – 1995 research engineer, UNIMOT company Zwickau, Germany
- From 1995 managing director, SEF-Energietechnik GmbH, Germany
- Member of the Technology Committee of IHK-Chemnitz, Saxony
- Member of DIHK Environment and Technology Committee, Berlin
- Official German expert in accordance § 29 b Abs. 1 BImSchG, ISA 558
- Various international projects, studies and landfill gas analyses in diversely countries, like India, Ghana, Pakistan

Start point for the international project development in Turkey was 2004 - from 0 MW(el) to 300 MW(el) in 17 years

- **Start point for international projects was Ankara, Mamak landfill in Turkey with about 3000 tons a day waste mass.**
- **Up to that time no landfills with a working degassing project are existing. It was difficult to organize drilling machines, pipe material and so one.**

- **However, today more than 300 MW(el) are installed!**

Until today more than 50 projects with 300 MW(el) power production realised

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Current project in Izmir, 27 MW(el)

Antakya, 4 MW(el)

Tokat, 3,0 MW(el)

Iskenderun, 4 MW(el)

Mersin, 6 MW(el)

Kayseri, 6 MW(el)

Successful projects in Dubai, Belorussia, Russia, Zypres were also planned and implemented

- **Beside the implemented projects several concepts and studies were created in UAE (Abu Dhabi, RAS, etc.)**
- **Carbon credits more and more important for a long term financial return if no electrical power can be produced**

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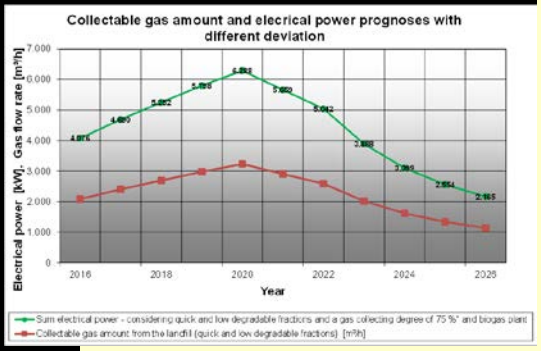
Key point or basis of the whole work is an adjusted landfill gas prognosis considering all feasibilities



Sakarya - Landfill gas prognosis in consideration of the biogas production and sorting fractions

Considered waste input and divided in different fractions in according to the handed over data sheed (Calculation only up to the year 2030)

Year	Tons a day delivered to the landfill [t/day]	Additional fractions for biogas treatment [t/day]	Recyling part [t/day]	RDF part [t/day]	Fractions for biogas plant [t/day]	Waste residuals biogas [t/day]	Deposited tons at the landfill in front of the biogas process [t/day]	Deposited tons at the landfill after sorting out all parts [t/day]	Deposited tons plus rest from biogas treatment [t/day]	Input biogas plant [t/year]	Output biogas plant [t/year]	Content liquid fraction biogas [t/year]	Content solid fraction biogas	Deposited tons at the landfill in front of biogas process [t/year]	Deposited tons at the landfill untreated [t/year]	Deposited tons at the landfill at all [t/year]
						5%						65%	35%			
2012/earlier	1.096	0	0	0	0	0	1.096	1.096	1.096	0	0	0	0	400.000	400.000	0
2013	394	0	0	0	0	0	394	394	394	0	0	0	0	143.820	143.820	0
2014	451	0	0	0	0	0	451	451	451	0	0	0	0	168.350	168.350	0
2015	568	0	0	0	0	0	568	568	568	0	0	0	0	207.500	207.500	0
2016	681	0	0	0	0	0	681	681	681	0	0	0	0	248.500	248.500	0
2017	737	0	0	0	0	0	737	737	737	0	0	0	0	268.907	268.907	0
2018	786	0	0	0	0	0	786	786	786	0	0	0	0	286.804	286.804	0
2019	855	0	0	0	0	0	855	855	855	0	0	0	0	312.248	312.248	0
2020	877	0	13	0	0	0	864	864	864	0	0	0	0	315.371	315.371	0
2021	1.000	0	13	0	310	295	0	677	971	113.150	107.493	69.870	37.622	0	247.049	284.672
2022	1.014	0	20	101	395	376	0	497	873	144.300	137.085	89.105	47.980	0	181.400	229.380
2023	1.027	0	25	154	411	390	0	437	827	150.000	142.500	92.625	49.875	0	159.500	209.375
2024	1.041	0	31	156	427	406	0	427	833	155.800	148.010	96.207	51.804	0	155.950	207.754
2025	1.055	0	36	158	432	411	0	428	839	157.850	149.958	97.472	52.485	0	156.100	208.585
2026	1.068	0	42	160	449	426	0	417	844	163.800	155.610	101.147	54.464	0	152.300	206.764
2027	1.082	0	43	162	455	432	0	423	854	165.900	157.605	102.443	55.162	0	154.250	209.412
2028	1.096	0	43	164	460	437	0	428	865	168.000	159.600	103.740	55.860	0	156.200	212.060
2029	1.110	0	44	166	466	443	0	433	876	170.100	161.595	105.037	56.558	0	158.150	214.708
2030	1.123	0	44	168	472	448	0	439	887	172.200	163.590	106.334	57.257	0	160.100	217.357
2031	1.137	0	45	171	478	454	0	444	898	174.300	165.585	107.630	57.955	0	162.050	220.005

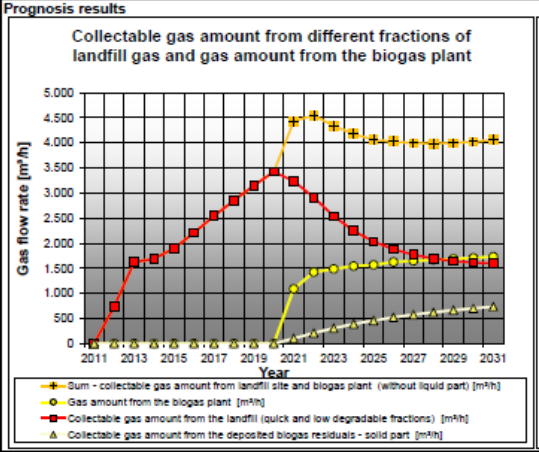
Considered parameter landfill site

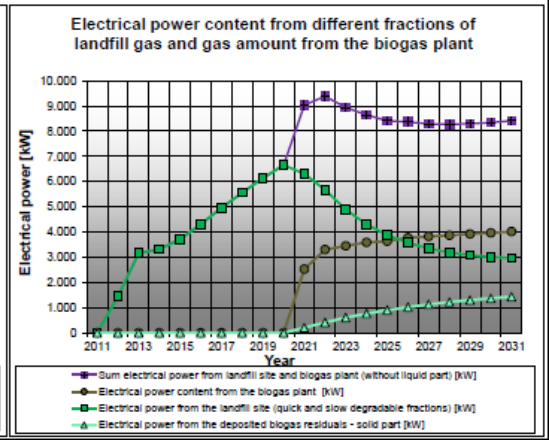
fe norm [°C]	35	k norm	0,35	fen norm	0,95	H_u start value [kWh/m³]	5	BTOC max [%]	5,00
fe max [°C]	37	k max [%]	5	fen max [%]	5	H_u end value [kWh/m³]	0,05	BTOC min [%]	5,00
fe min [°C]	33	k min [%]	5	fen min [%]	5	Collecting degree	75%	fe norm	0,70

Parameter biogas plant (general values, 55 % eff.)

-Liquid fraction not used at the landfill site
-solid residuals biogas plus composting rest complete deposited
-DOC content of the solid biogas residual fractions 64 kg/ton

Prognosis results

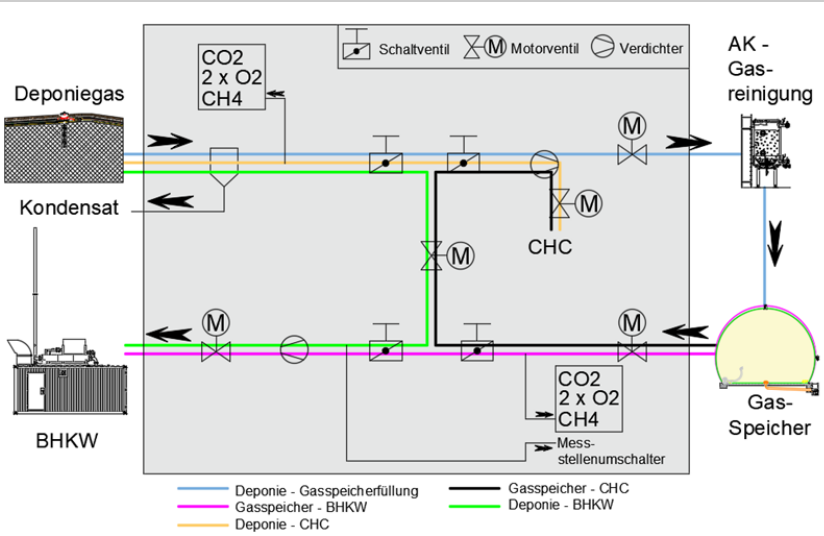


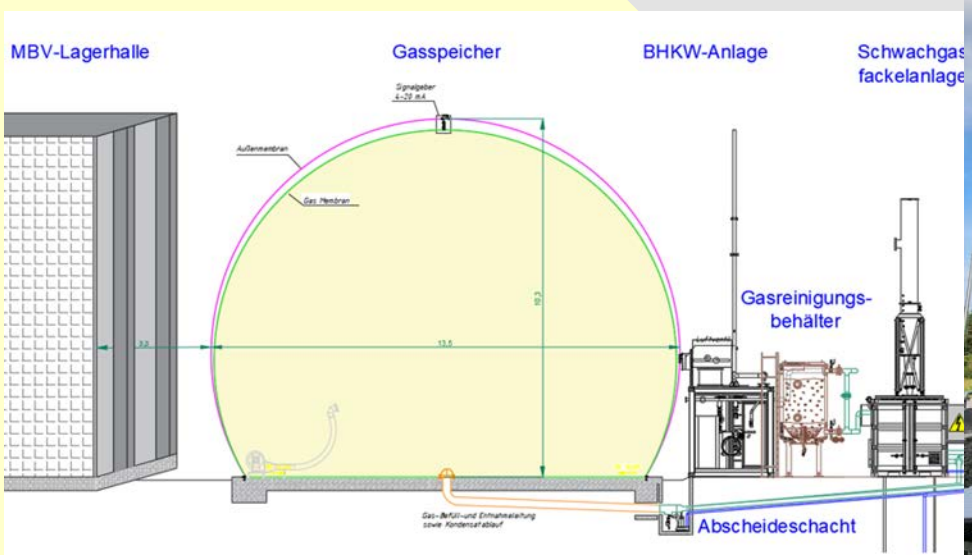


Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Collectable gas amount from the landfill (quick and low degradable fractions) [m³/h]	3152	3423	3242	2914	2542	2245	2034	1882	1769	1694	1644	1614	1596
Collectable gas amount from the deposited biogas residuals - solid part [m³/h]	0	0	102	212	307	390	460	523	577	624	666	702	735
Gas amount from the biogas plant [m³/h]	0	0	1090	1423	1488	1546	1567	1625	1647	1668	1689	1710	1730
Sum - collectable gas amount from landfill site and biogas plant (without liquid part) [m³/h]	3152	3423	4433	4549	4337	4181	4061	4030	3993	3986	3999	4026	4062
Electrical power from the landfill site (quick and slow degradable fractions) [kW]	6137	6657	6309	5673	4891	4302	3880	3575	3345	3188	3082	3011	2965
Electrical power from the deposited biogas residuals - solid part [kW]	0	0	198	414	599	761	897	1020	1126	1218	1298	1370	1433
Electrical power content from the biogas plant [kW]	0	0	2528	3301	3451	3586	3635	3770	3821	3869	3918	3966	4015
Sum electrical power from landfill site and biogas plant (without liquid part) [kW]	6137	6657	9036	9388	8941	8648	8412	8365	8291	8275	8298	8347	8413

The handed over data have been identified and carefully analysed but no guarantee for the accuracy can be given!

German projects – week gas removing or rest gas utilisation





International modern landfilling – integrated energy projects, waste to energy!

- Waste sorting is the key point for an integrated waste concept to separate the organic rich and high caloric fraction as well as the valuable sorting fraction

- Organic rich fractions mostly will be traded in semi wet flow fermenter with huge capacity. Liquid fermenter are more problematic for mixed landfill fractions

- High caloric fractions mostly going to the cement industry and the payment for this fraction is very different depending on the quality and special utilisation

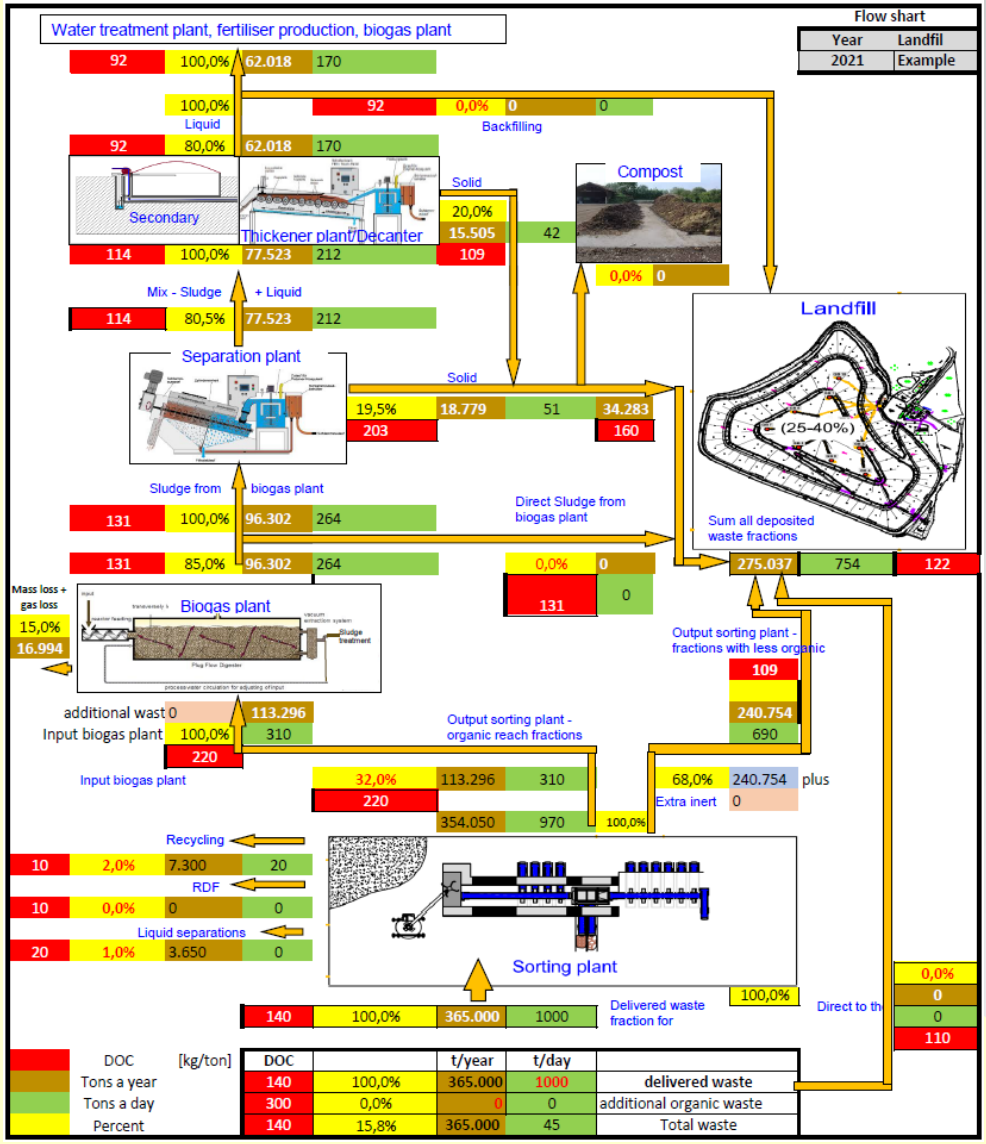
Integrated energy projects

- Valuable fractions are PET and metal and in some places and sometimes paper, but the price is very volatile

- In Malatya-Turkey a new small burning plant with about 2 MW(el) was implemented and is running since 1 year with the sorted high caloric fraction

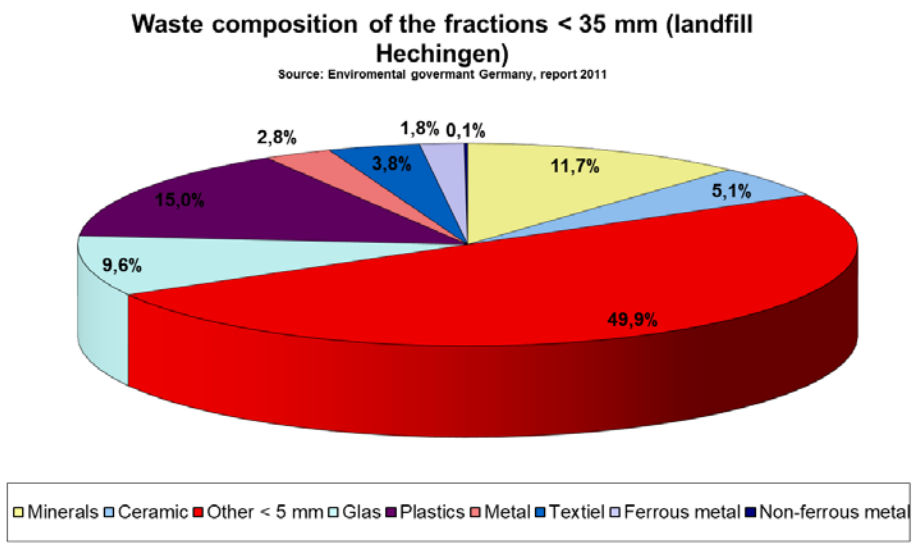
- A pyrolyses test plant was implemented in Ankara and was shut down after 5 years test run

Integrated waste concepts needs an comprehensive substance analyses



- How many organic rich fraction can be used?
- What is the high caloric content?

Landfill mining, there are a lot of intensiv analyzed projects



- There are a lot of intensive realized landfill mining projects in Austria and Germany (Hechingen, Reiskirchen) with detailed analyzing of the available substances
- However, the value of the removed and sorted waste is mostly not sufficient

Landfill mining needs a comprehensive study of the condition of the waste fraction

- The gas building process in Turkey landfills is mostly terminated before the more difficult dissociated fractions (wood) can be organic converted. Hence, there are good conditions to generate substitute fuel

Process for landfill mining

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- **Please Dr. Seyfert, there is no time for recreation !**