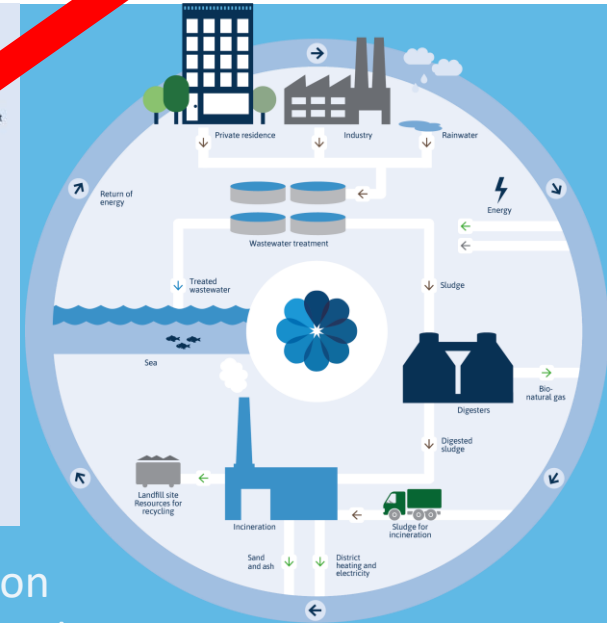


You are here

Energy positive and carbon neutral wastewater treatment in Copenhagen

Carsten Thirring
Senior Process Engineer, project manager
ct@biofos.dk






We treat wastewater for 1,2 million people in the Copenhagen metropolitan area at our 3 wastewater treatment plants

- 15 municipality owners
- 7 utility companies (clients)

BIOFOS treatment plants and energy production



	Lynetten	Avedøre	Damhusåen
			
Person equivalents (design)	1.000.000 PE	400.000 PE	350.000 PE
Biological treatment process	Bio-Denipho	Bio-Denipho	Bio-Denipho
Digesters	+	+	+
Gas engine (CHP)		+	+
Gas boilers (heat)	+	+	+
Sludge incineration	+	+	
Biogas to the grid	Town gas grid	National gas grid	
Electricity to the grid		+	+
District heating to the grid	+	+	+

BIOFOS strategy 2020 to 2025

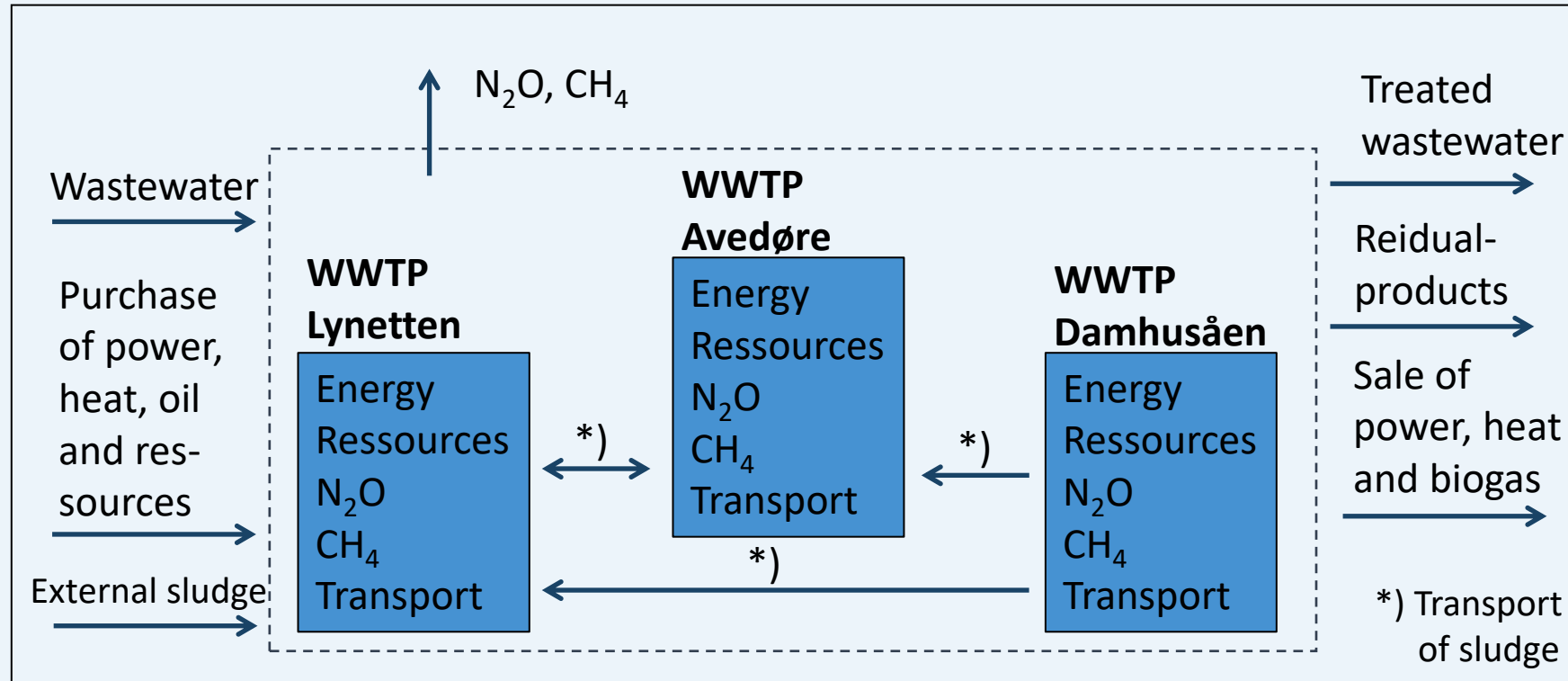


Ambitious benchmarks for 2025 –Approved by BIOFOS board in 2019

- BIOFOS as a whole is not only carbon neutral, but helps to remove carbon by 2025
- BIOFOS will sell more energy to the grid than we buy from the grid
- Reduce the use of resources (i.e. chemicals)
- Reuse (recover or recycle) all residual products from our core processes (i.e. sand, ash from the incineration process)



System borders used in the energy and CO₂-balance



CO₂- emissions are calculated in accordance with a Danish guideline developed by

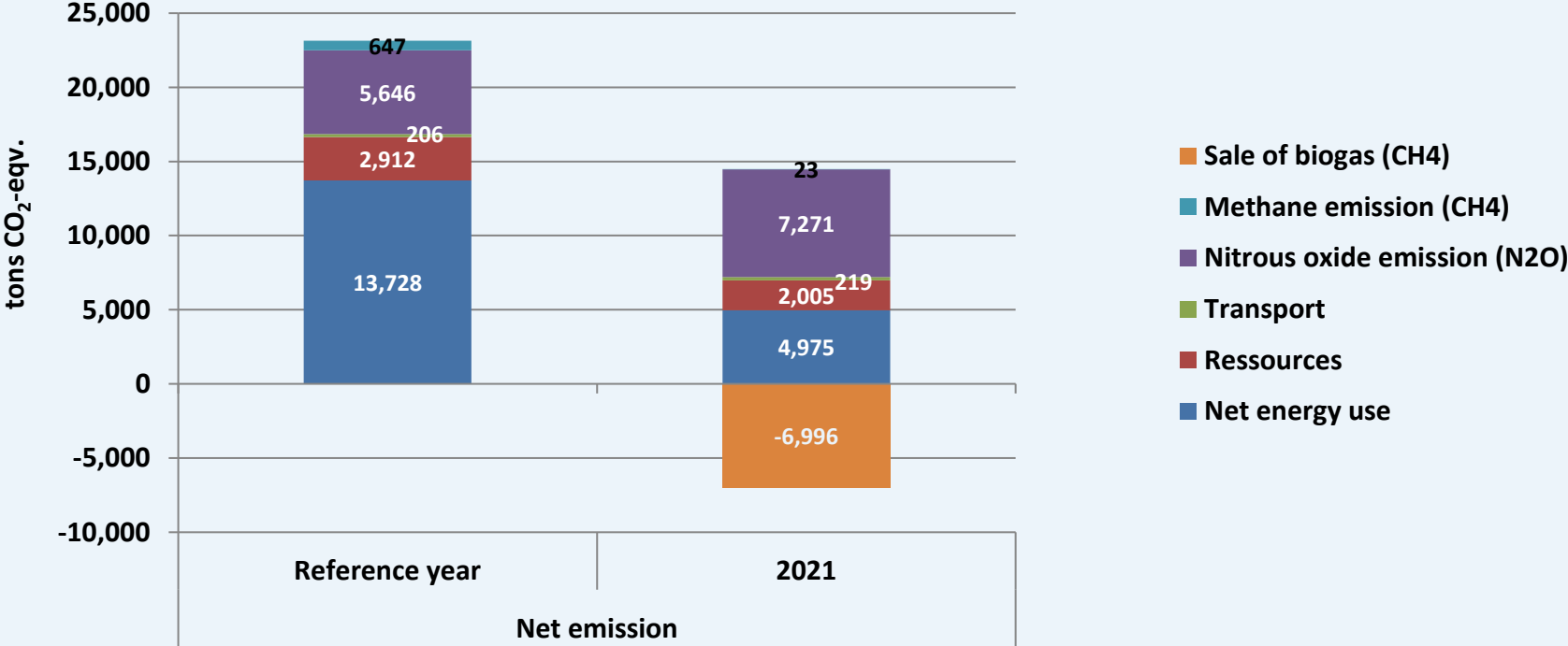


DANVA, Danish Water and Wastewater Association, is a national industry and stakeholder organisation for Denmark's drinking water and wastewater utilities.

BIOFOS net carbon emissions 2021



BIOFOS - net carbon emissions – with energy production and sale of biogas



BIOFOS	Reference year tons CO ₂ -eqv.	2021 tons CO ₂ -eqv.	Reduction in pct.	CO2 emission per capita Kg CO ₂ -eqv.
With energy production and sale of biogas	23.139	7.498	68	7



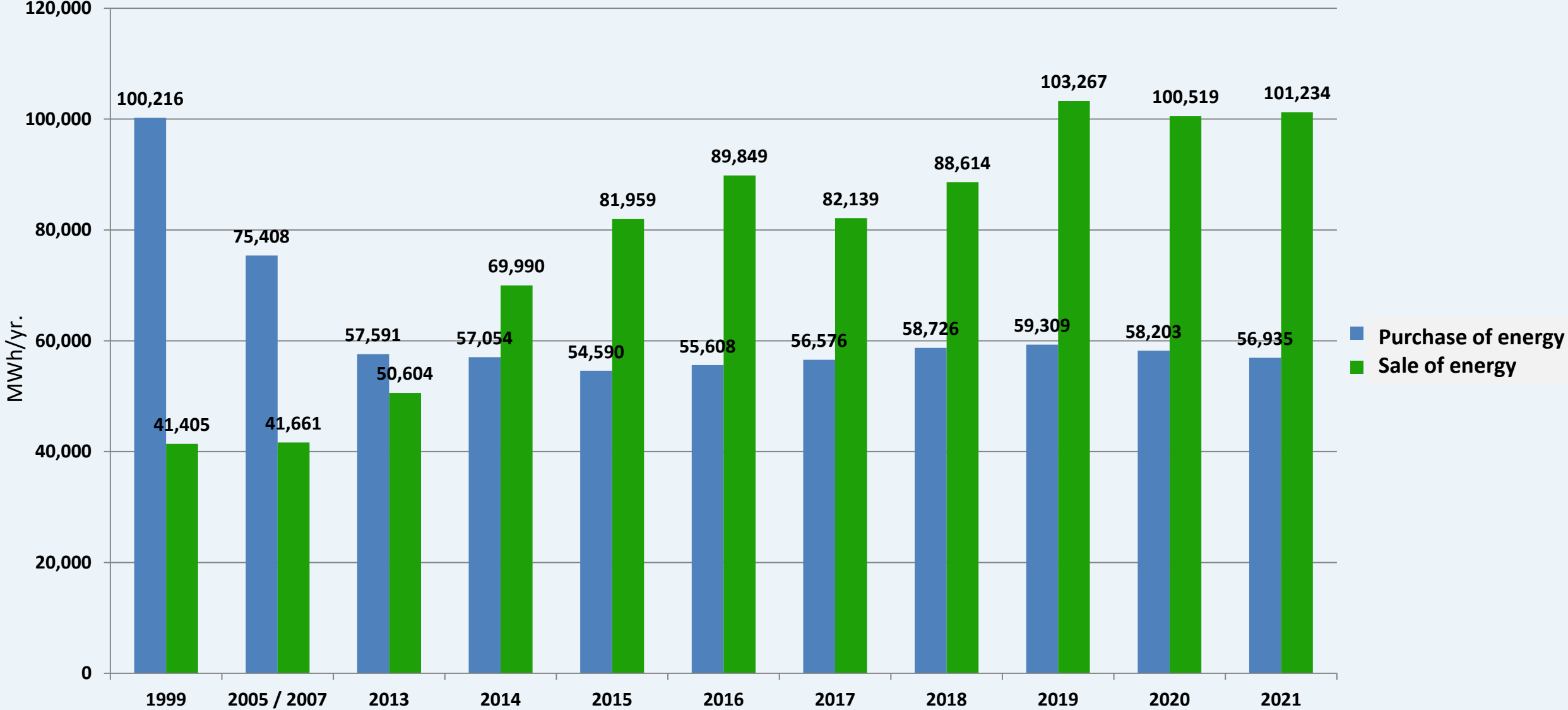
Implemented energy saving and energy producing projects



- Upgrade to new energy saving pumps and mixers
- From surface aeration to diffusor bottom aeration at the Avedøre plant
- Heating, ventilation and air conditioning (HVAC) systems
- Lighting system
- Advanced control of aeration and chemical dosing (STAR) implemented on all treatment plants reducing energy and P precipitation chemicals used in the water treatment line. STAR is currently being upgraded to the new Hubgrade software platform
- Solar panels at the Damhusåen plant (2920 panels)

Rank	Main changes	Plant	Year	Net impact in GWh/yr.
1	Increase digester volume	Lynetten	2017	20,4
2	New incineration plant	Lynetten	2012	20,0
3	From gas engine to upgrading to biomethane	Avedøre	2018	16,8
4	Flue gas heat exchanger af incineration plant	Lynetten	2013	13,4
5	Lowering central heating return temperature	Lynetten	2014	10,1
6	From boiler for district heat to sale to town gas grid	Lynetten	2016	9,6
7	Optimization of HVAC	Lynetten	2018	8,8
Sum	Sum of top 7 changes			99,1

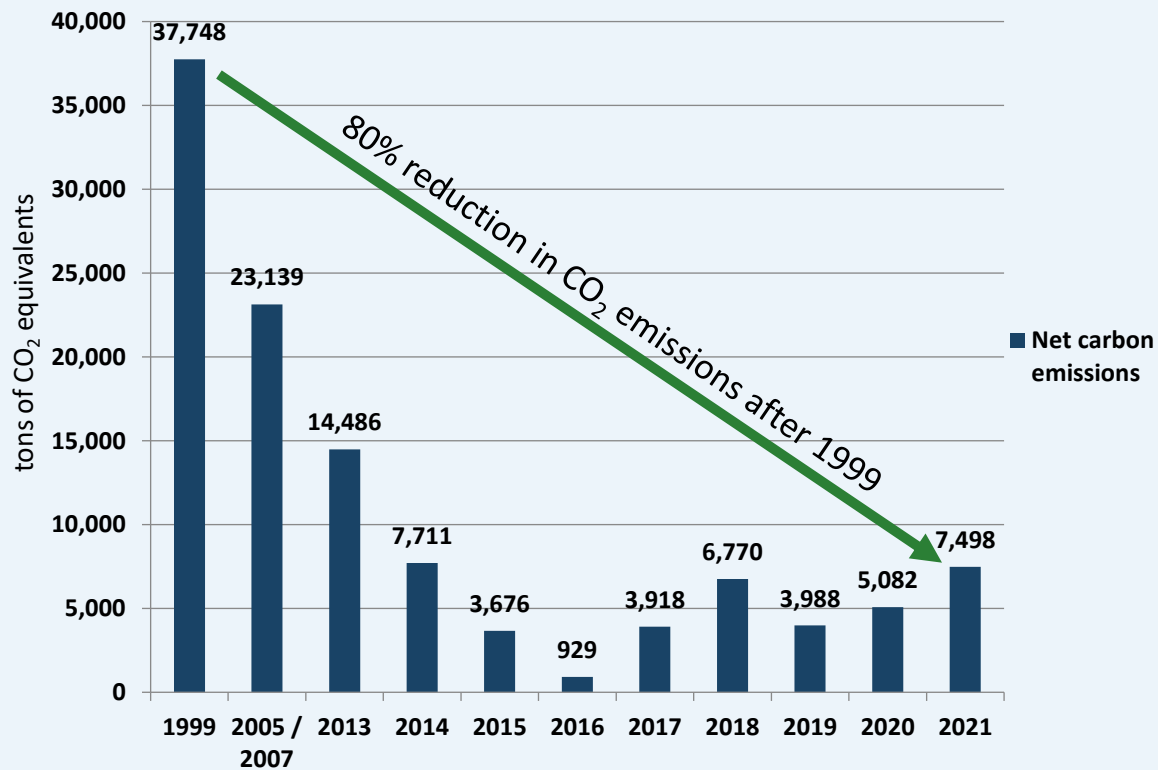
BIOFOS energy balance



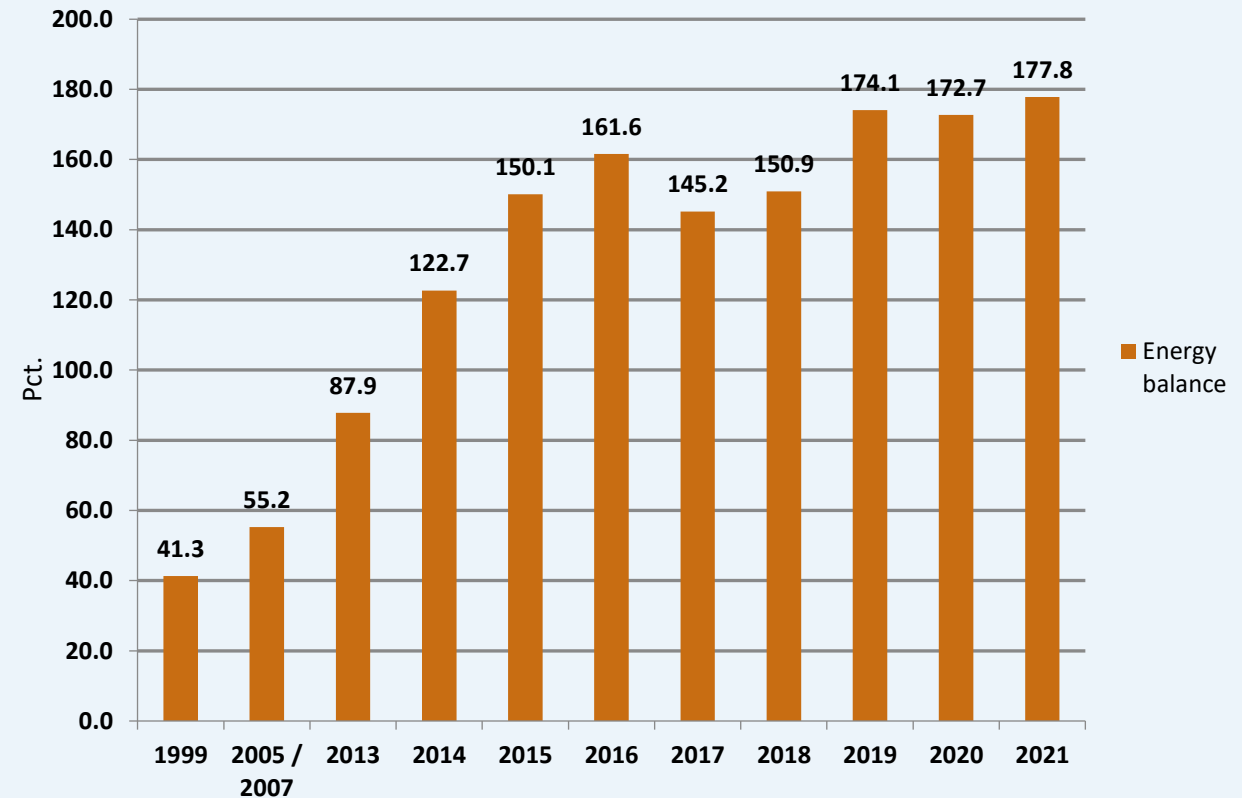
From a energy using WWTP to a energy producing WWTP



BIOFOS - Net carbon emissions



BIOFOS - Energy balance



Future projects



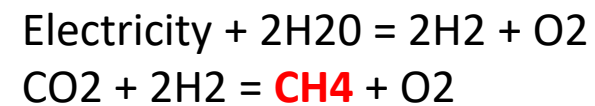
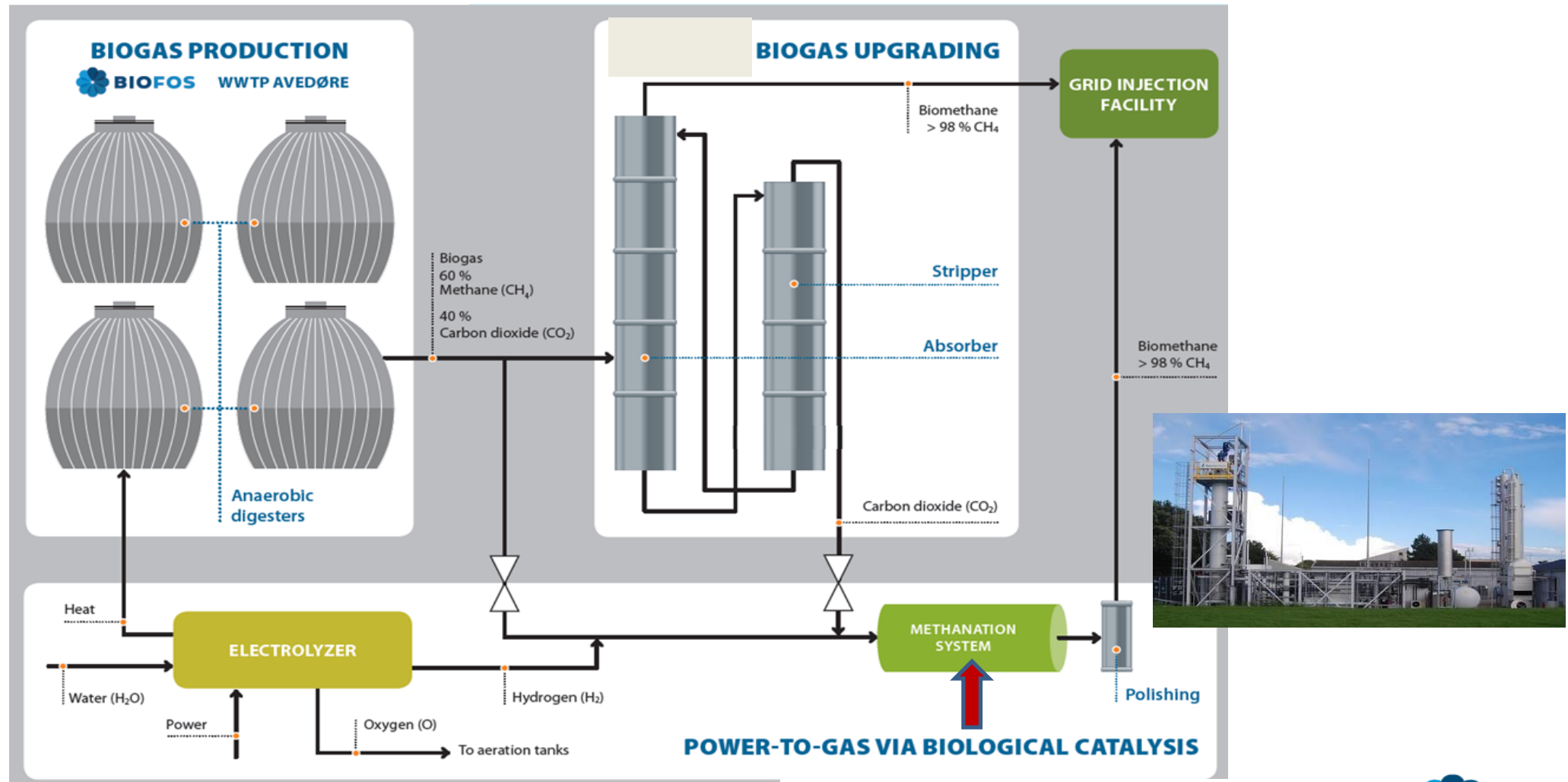
- Heat pumps in effluent, potential 850 GWh/yr. *
- Increased biogas production by utilizing an external carbon source 42,3 GWh/yr. *
- Utilization of the flue gas condensation heat at Avedøre for production of district heating 10 GWh/yr
- Provide flexibility services i.e., peak shaving of district heating demand
- Provide flexibility services for balancing the demand in the electricity network to support efficient use
- Carbon capture utilization (CCS) and power to X (PtX) of the CO₂ emission from the 2 incineration plants
- Smart lighting (LED and 'follow me' lighting in underground hallways)

* Not supported by the Danish regulation of the water sector

Rank	Main changes	Plant	tons CO ₂ -eqv.	Net impact in GWh/yr.
1	Sale of biogas to the grid	Damhusåen	-3.350	14,9
2	Bottom aeration	Lynetten + Damhusåen	-1.168	8,4
3	Ventilation systems (heating)	All 3 WWTP's	311	6,3
4	Increased biogas production and sal	Lynetten	-804	3,6
5	Internal heating systems	Lynetten	-125	2,5
6	Standby - low load	Lynetten	-167	1,2
7	Ventilation systems (electricity)	Lynetten + Damhusåen	-129	0,9
Sum	Sum of top 7 changes		6.054	37,7

To day: Biogas upgrading

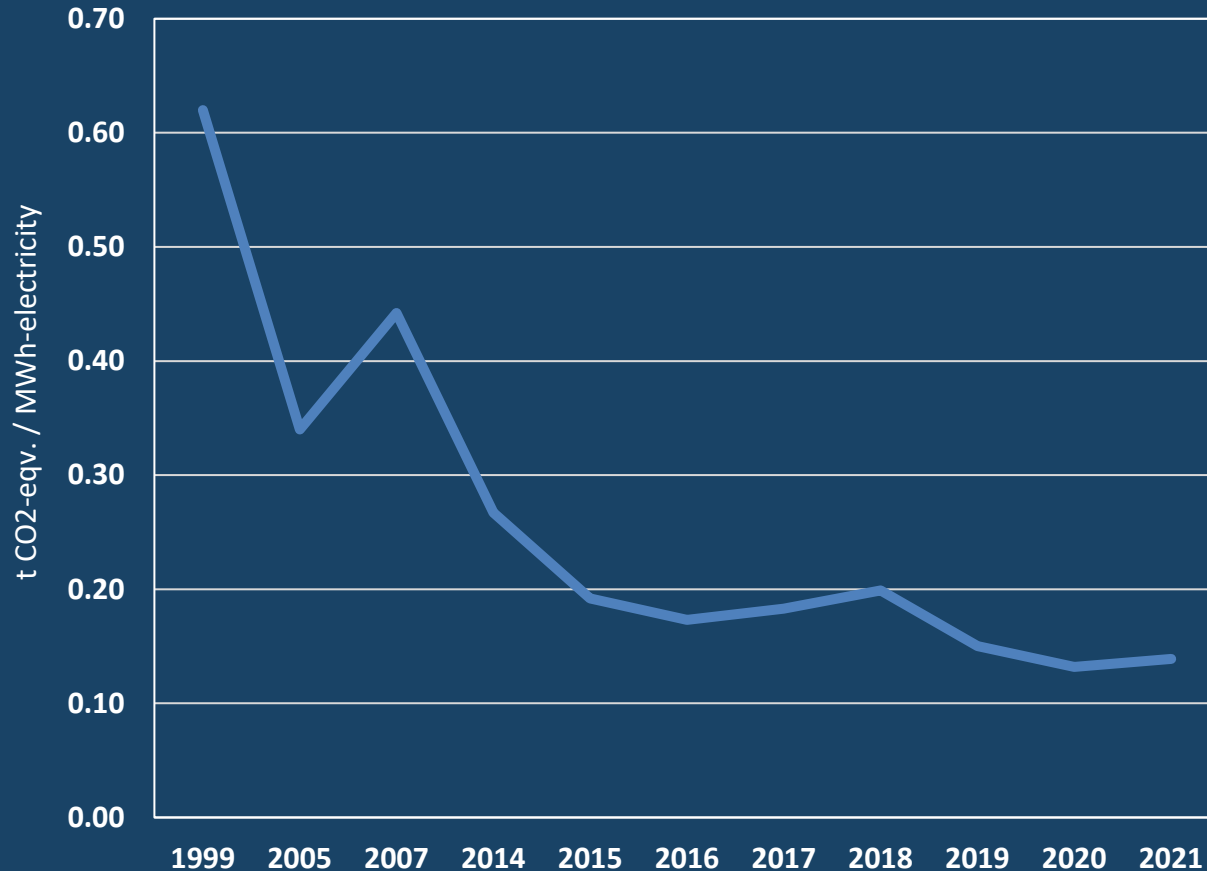
Probably full-scale tomorrow: Power-to-Gas



Development in Danish emission factor for electricity



Electricity – emission factor
ton CO₂-eqv. / MWh-electricity



The more green energy there is in the Danish electricity grid (solar, wind and water based) , BIOFOS green energy production will reduce less fossil-based electricity every year

The same complies for heat and biogas production at our WWTP's

This is a challenge for BIOFOS and our goal to have carbon neutral wastewater treatment by 2025

Conclusions



- Transformation of a Wastewater Treatment Plant to become a Water Resource Recovery Facility is possible:
 - Obtaining a positive energy balance (since 2014)
 - Significantly reducing the CO₂-emissions (80 % in 2021)
 - Reducing N₂O emissions from the biological nitrogen removal will have a big effect on the future CO₂ – emissions, this is a focus point for us now
 - We have several ongoing projects with the aim of reducing the N₂O emissions from the water treatment line with N₂O sensors and advanced online control



Residential housing, house boats near the incineration plant at WWTP Lynetten

BIOFOS forecast	Year 2025	Year 2035	unit
Energy balance	+ 200	+250	%
CO ₂ - emissions	- 2.000	- 5.000	tons CO ₂ eqv/yr.