

The municipal water utility "Forsyningen" located in Frederikshavn, Denmark has focused on the implementation of methodologies to better estimate and quantify greenhouse gas emissions from a number of different wastewater processes within their municipal wastewater treatment plants (WWTPs).

	Fredrikshavn WWTP
PE	130.000 (split in 2 streams)
Influent	300 m ³ /h
Anoxic Vol	1195 m ³
Aerated Vol	2290 m ³
COD, TKN, TP	2800, 240, 40 Ton/yr

The utility runs both recirculation and biofilm wastewater processes. Due to increasing uncertainty in using emission key numbers, the utility contacted Unisense Environment for assistance in determining the actual N₂O derived CO₂ footprint.

As the foundation for the new initiative, the N₂O emission from a standard recirculation was firstly monitored.

Case: Frederikshavn Water Utility supported by Danish Studies

N₂O Emission Monitoring Made Simple

In order to save energy and increase the N-removal capacity, the aerobic zone was operated with intermittent aeration, allowing denitrification in the aerated zone depending on the ammonium levels in the tank.

Unisense Environment installed two N₂O Wastewater Systems, one placed in the anoxic tank and the other in the aerobic tank. To facilitate the understanding of the N₂O formation, N₂O sensor data was logged with all other plant data through a standard integration with the SCADA system.

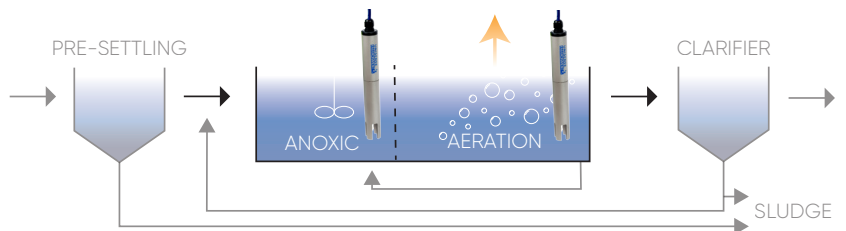


N₂O Wastewater System



Following a quick 2-point calibration procedure, the sensors were left to monitor N₂O levels.

After a 14 day measuring period a full data series extracted from the SCADA system was sent to Unisense Environment for data analysis. Using different data managing tools the overall correlations and in particular the N₂O production were documented.



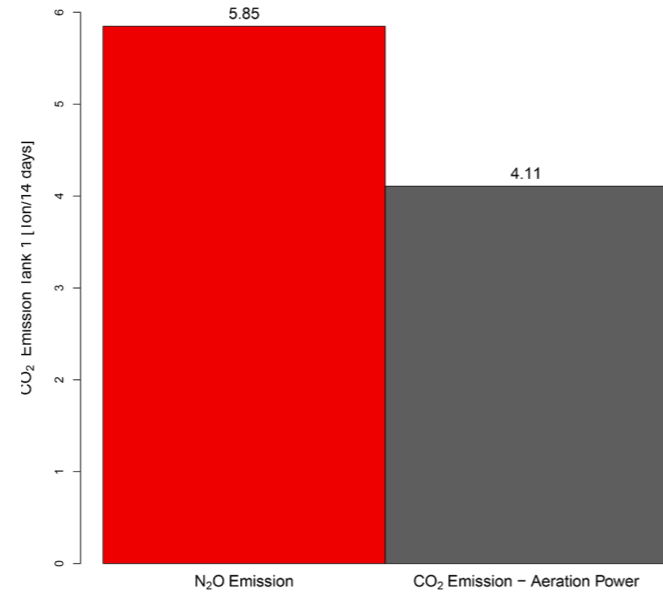
Standard recirculation setup at Frederikshavn WWTP

From the 14-days period it was clear that the variation in N₂O emission is extensive. The main emission over the period was linked to two high load events that led to 53% of the total N₂O emission during 42 hours out of the 14 days. Furthermore, low dissolved oxygen set points in the beginning of the campaign led to a significant increase in the N₂O concentration, clearly stressing the correlation between low oxygen and N₂O formation.

N₂O Emission – in CO₂ Equivalents From Aeration Tank

During the analyzed period the N₂O formation in the anoxic tank was very low and only during a high ammonium period did the N₂O concentration increase to 0.3 N-mg/L for 30 hours. In the aerated part N₂O was mainly produced during the anoxic phases introduced by the intermittent aeration and subsequently stripped to the atmosphere by the aeration.

Finally, emission calculations were performed using peer reviewed and validated models to assess the N₂O emissions and derived CO₂-equivalents. This was compared with the aeration power derived CO₂-equivalents and presented to the management of the water utility as part of a 2-day consultancy service. The total carbon footprint from the period was calculated to be 10 ton CO₂-equivalents with N₂O derived CO₂ accounting for 59% of the total emission.

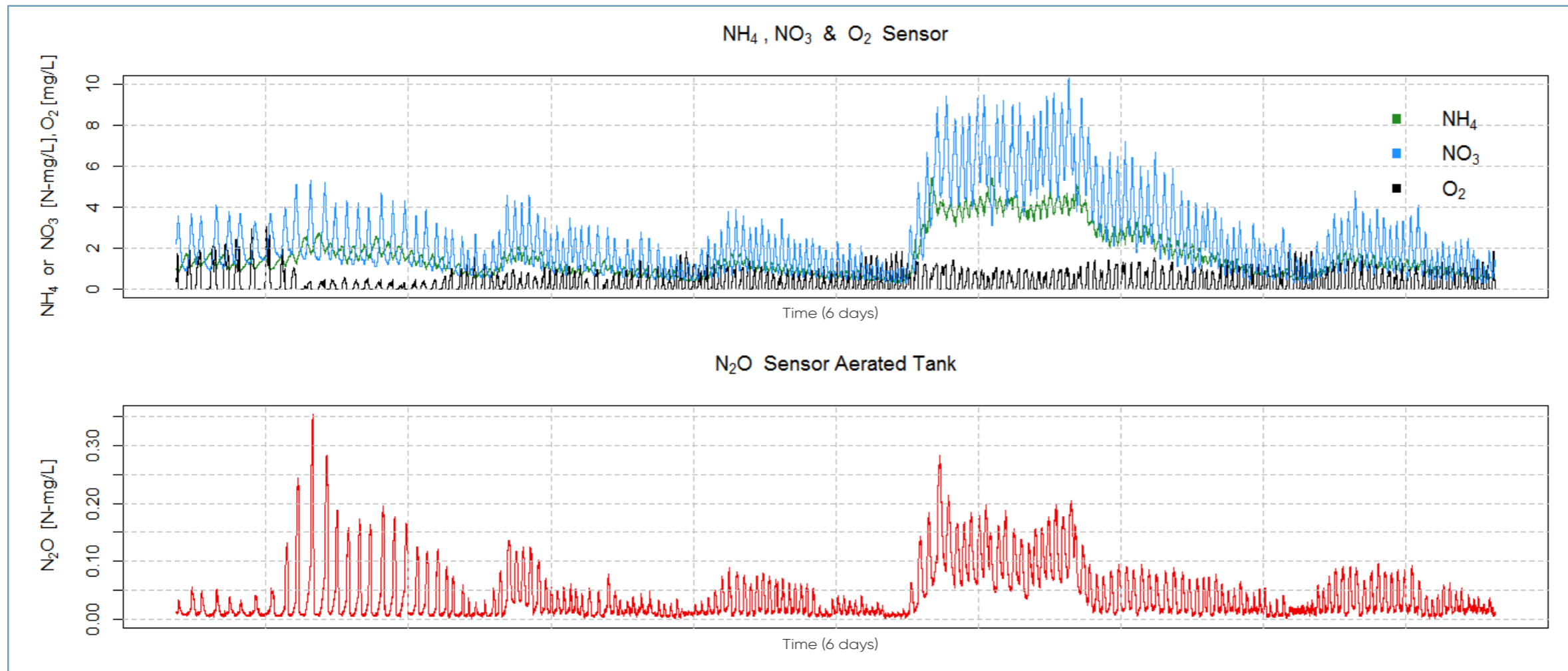


Cumulated CO₂ emission over 14 days derived from the calculated N₂O emission and from the kWh used for aeration. CO₂ equivalent factors used: 296 kg CO₂ /kg N₂O and 0.418 kg CO₂ / kWh used.

From the short monitoring and data analysis campaign a short list of problems and possible solutions was derived.

- The N₂O concentration and emission is highly variable.
- Dissolved oxygen control is important to avoid elevated N₂O production and emission.
- Short periods of high ammonium loads should be avoided by balancing the influent load.
- Control strategies with COD enhanced denitrification can potentially diminish the N₂O emission.
- Energy optimization using pause-aeration strategies must be coupled with N₂O monitoring to avoid excessive N₂O emissions.
- With a small investment the utility has gained a real insight into the source and causes of their N₂O derived emissions and can now act towards minimizing their climate impact from N₂O.

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A 6 day section of the 14 day measuring period. NH₄, NO₃, O₂, and N₂O data series are plotted and include the low O₂ set point and one of two high load periods.

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Nitrous Oxide process sensor for online
wastewater treatment optimization,
low-cost greenhouse gas reduction,
and reliable sustainability accounting

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