THE NET ZERO CHALLENGE

The UK water industry has set out its roadmap to achieve net zero carbon emissions by 2030 - https://www.water.org.uk/routemap2030. Key greenhouse gases emitted by the water industry include carbon dioxide, methane and nitrous dioxide. However, not all greenhouse gases (GHG) have the same global warming potential (GWP). Methane has a GWP 27.2-29.8 times that of carbon dioxide, whilst for nitrous oxide the GWP is even higher at 273 times that of carbon dioxide for a 100-year time frame according to the International Panel on Climate Change (IPCC) in 2021. Direct emissions from sludge and wastewater treatment account for the majority (70%) of gross carbon emissions from the water industry, so reducing these scope 1, operational emissions is the main focus of efforts. Sludge treatment is the biggest source of methane emissions, and wastewater treatment is the largest source of nitrous oxide emissions.

Taking United Utilities as an example; in response to the Water UK roadmap UU has pledged to reduce scope 1 and 2 emissions by 42% by 2030 with a 100% reduction by 2050. (Scope 2 emissions are indirect GHG emissions associated with the purchase of energy, so can be addressed by purchasing certified renewable electricity and/or installing renewable energy generation on site.) It makes sense for companies to go first for the big, quick wins: “Currently in our pilots we are targeting nitrous oxide monitoring on the secondary treatment stage as this has the biggest emissions,” explains Richard Bragg, Principal ICA Engineer at United Utilities, “for methane emissions monitoring is focussed predominantly on the sludge process, on secondary digestors and open sludge tanks further down the process”.

Currently the industry uses Carbon Accounting Workbook emissions factors to estimate methane and nitrous oxide release from wastewater and sludge treatment processes. This means there is limited monitoring activity across the sector and a growing recognition that the sector must measure these emissions to develop effective management techniques. A recent review of monitoring activity across the sector by Richard Smith, Wastewater Innovation Architect at Severn Trent Water, is summarised in the figure below. It illustrates where GHG are currently monitored, where leaks are detected and where there is currently no monitoring of GHG and shows there are opportunities for the adoption of new monitoring technologies. A few available technologies that can assist the water industry with reducing GHG emissions are listed in Table 2.

“Nitrous oxide monitoring is currently focused on the aerobic suspended growth process,” admits Richard Bragg, “we don’t yet monitor nitrous oxide emissions upstream or downstream of this, such as monitoring biofilters which serve a large proportion of the population.” For methane monitoring, the focus is currently on leak detection from sealed tanks, using existing technologies such as thermal imaging, using camera systems and optical methods. There are many more technologies that are not being used yet. Richard Bragg has identified various ways that monitoring GHG emissions could be improved, which innovators could address when developing new technology solutions (Table 1).

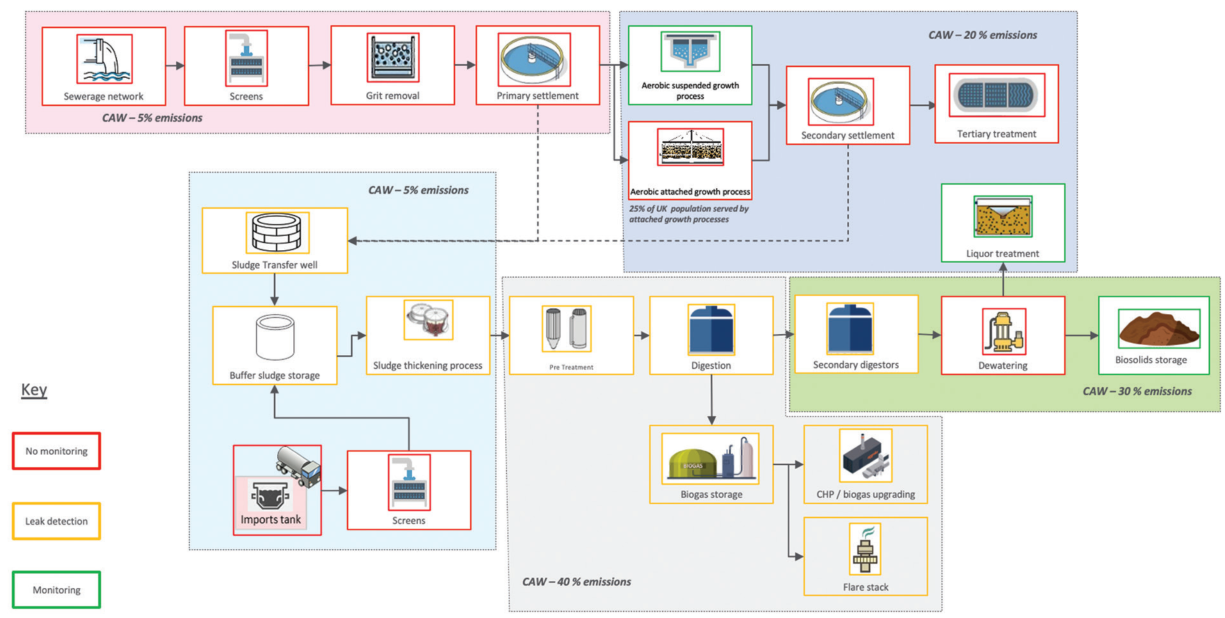

Figure 1: Current monitoring of GHG, leak detection and processes which are not currently monitored for GHG in wastewater treatment © Richard Smith, 2021 Severn Trent Water.

Another opportunity for innovators is to address the level of uncertainty in whether GHG emissions can be reduced in the water sector - estimated to be 30%. There is a need to reduce this uncertainty by better quantification of GHG emissions from the sector. Also the Water UK route map assumes that nitrous oxide emissions can be reduced by 40% by adjusting operational processes, but there is uncertainty around whether this figure can be achieved. In the near future, Richard Bragg predicts that GHG monitoring will be further improved through the use of innovative technologies, novel sensors, non-contact sensors, imagery, AI, machine learning, modelling and applying the data as a service model in the water sector. Most water companies have an innovation team that is happy to engage with innovators. United Utilities has an Innovation Lab which welcomes approaches about new technologies.

Table 1: Opportunities to improve monitoring of GHG emissions in the water sector ©Richard Bragg, 2021

Improvements are needed for monitoring GHG in the water sector in terms of:

- Sensing technologies for GHG
- How to measure GHG in open spaces and in soluble form
- Validation of GHG emissions
- Optimisation of GHG emissions from processes
- Predictive monitoring of GHG (PEMS)
- Relationships between GHGs and known process variables (surrogates)
- Sensor suitability for GHG
- Operational expenditure (OPEX) for GHG sensors
- Future legislation and best practice
- Funding routes
- Scalability of sensor solutions

Table 2: A few technologies on the market that help water companies to cut carbon emissions

Technology	Carbon emissions reduction
Nitrate and nitrite monitoring	• Real time monitoring • Enables optimisation of biological nitrogen removal processes • Reduce energy intensive aeration requirements and related carbon emissions
Nitrous oxide sensor	• Real time, online monitoring of N_2O • Able to monitor where and when N_2O is produced and lost • Enables climate friendly control for oxygen and carbon demand (ammonium turnover and COD/N ratio) • Enables process control to minimise production of N_2O
Bio-electrode sensor	• Real time monitoring of exoelectrogenic microbial activity • Enables quantification of microbial activity to improve understanding • Enables energy optimisation • Operators can turn off Biological Aerated Flooded Filters (BAFF) during periods of low microbial load – can lead to savings of 10-20% per site or £50k - £100k of energy costs (subject to the unit cost of energy).

Rosa Richards is an Environmental Consultant and Programme Manager of SWIG specialising in water policy and monitoring. She is Programme Manager of the Sensors for Water Interest Group (SWIG), and a freelance writer of science and technology. This article is based on a SWIG/KTN Sensor Sprint webinar held on 24 November 2021. www.swig.org.uk

Author Contact Details

Rosa Richards, Environmental Consultant and Programme Manager of SWIG • Bristol • Tel: 01934 830658
• Email: rosapmrichards@gmail.com • **Web: https://www.linkedin.com/in/rosa-richards-7a515936/**