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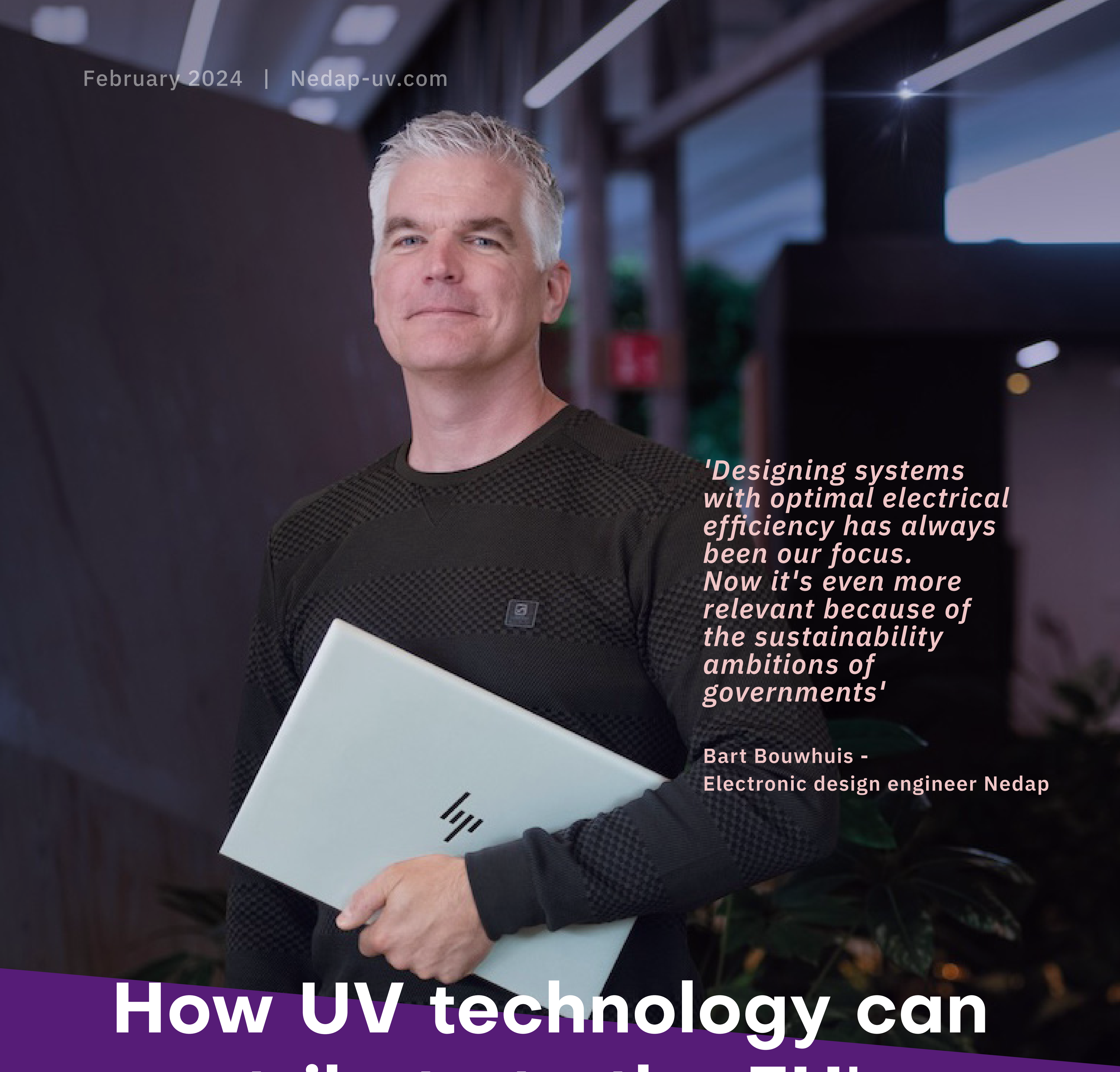


*'Designing systems with optimal electrical efficiency has always been our focus. Now it's even more relevant because of the sustainability ambitions of governments'*

Bart Bouwhuis -
Electronic design engineer Nedap

# How UV technology can contribute to the EU's wastewater treatment targets

nedap

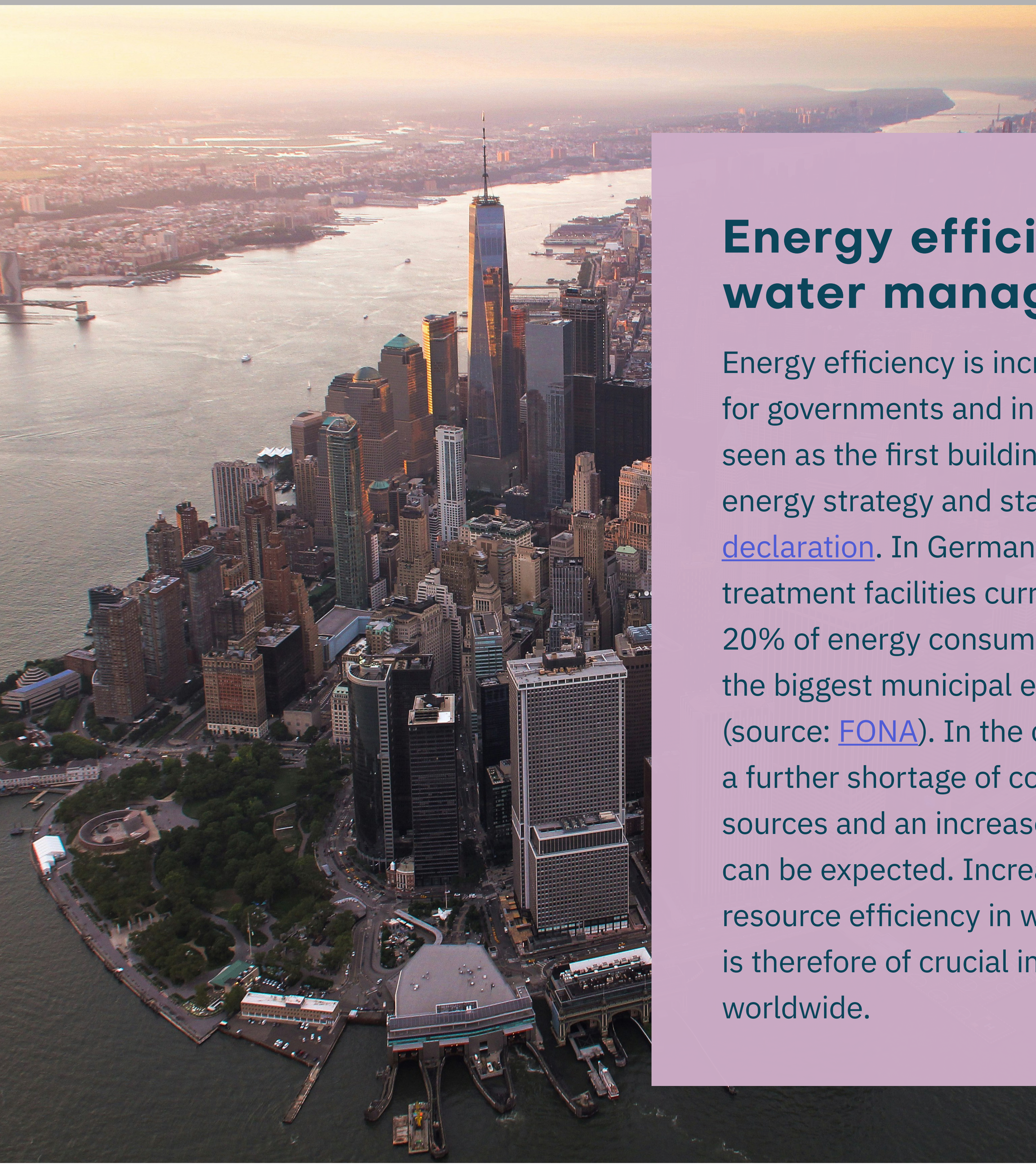
## Agreement on European Urban Wastewater Treatment Directive

On January 29th, the Council and the European Parliament's negotiators reached a provisional political agreement on a proposal to review the urban wastewater treatment directive. The revised directive is one of the key deliverables under the EU's zero-pollution action plan.

In the agreement, the co-legislators aligned the thresholds and timelines for quaternary treatment (the removal of a broad spectrum of micropollutants). By 2045, Member states will have to ensure the application of quaternary treatment in larger plants of 150,000 population equivalent and above, with intermediate targets in 2033 and 2039 for quaternary treatment.

## Energy neutrality and renewables

The co-legislators also agreed that the urban wastewater treatment sector could play a significant role in significantly reducing greenhouse gas emissions and helping the EU achieve its climate neutrality objective. They introduced an energy neutrality target, meaning that by 2045 urban wastewater treatment plants will have to produce energy from renewable sources, based on regular energy audits, with progressive intermediate targets. This energy can be produced on or off-site, and up to 35% of non-fossil energy can be purchased from external sources. This percentage only applies to the final target.



## Energy efficiency in water management

Energy efficiency is increasingly important for governments and industries. It is seen as the first building block for any energy strategy and stated in the COP28 declaration. In Germany, wastewater treatment facilities currently account for 20% of energy consumption, making them the biggest municipal energy consumers (source: FONA). In the coming decades, a further shortage of conventional energy sources and an increase in energy costs can be expected. Increasing energy and resource efficiency in water management is therefore of crucial importance worldwide.

## Advancements in oxidation technologies

The opportunity for advanced oxidation processes (AOPs) in water and wastewater treatment is growing concurrently with the increasing drive towards water reuse and stricter regulations for wastewater discharge. Greater understanding of micro-pollutants in waters such as pharmaceuticals and chemicals from industrial production is putting increasing stress on conventional treatment systems that are unable to meet new stringent guidelines. This brings AOPs to the forefront of dealing with new treatment challenges.

Ozon oxidation and UV advanced oxidation have proven to be effective technologies for removal of micro-pollutants in wastewater. Because these technologies use (renewable) electrical energy and produce no waste, they have potential to help water utilities to reach their neutrality target. Several pilots have been conducted to compare the carbon footprint (meanly energy costs) of UV peroxide oxidation and ozonation with other technologies, like activated carbon.

Dutch research conducted by Witteveen + Bos (2023) showed that UV peroxide oxidation technology can have a lower or comparable environmental impact in certain cases compared to activated carbon and ozonation. This is highly dependent on the UV transmission of the wastewater. Higher transmission means lower energy consumption. In case of low transmission, the wastewater can be pretreated with a sand filter and flocculation.

## Leading the way: USA

With more than 16,000 publicly owned wastewater treatment systems, the United States forms a large potential market for UV vendors. The industry is familiar with UV-Hydrogen Peroxide treatment due to several decades of experience. UV treatment coupled with the addition of hydrogen peroxide is the most commonly employed AOP for municipal water and wastewater, either for drinking water or municipal water reuse. This is due to the simple fact that it often comes out as the most cost-effective solution. The UV/hydrogen peroxide combination has been installed in major treatment plants since the early 2000s, with the 2008s Orange County, CA being the first 'toilet-to-tap' treatment plant in the USA.

*Image: Orange County in southern California has built a 500-million-dollar state-of-the-art water treatment plant which turns raw sewage into pure drinking water. The biggest challenge for the authorities is not the technology but selling the public on the process known as from toilet-to-tap.*

# Switzerland's progress

Although not being an EU member state, Switzerland started to invest in quaternary treatment a decade ago. The new Swiss Water Protection Act is in force since January 2016 and has resulted in numerous full scale wastewater treatment plant being upgraded. The so called 'Swiss approach' is praised for tackling the issue in a short period of time. Using mostly ozonation to improve the purification of wastewater, it took just around 15 years for the innovative technology to become practical technology. Early on, care was taken to ensure that potentially toxic oxidation by-products, which can arise during reactions with ozone, were rendered harmless by biological post-treatment (source: eawag).

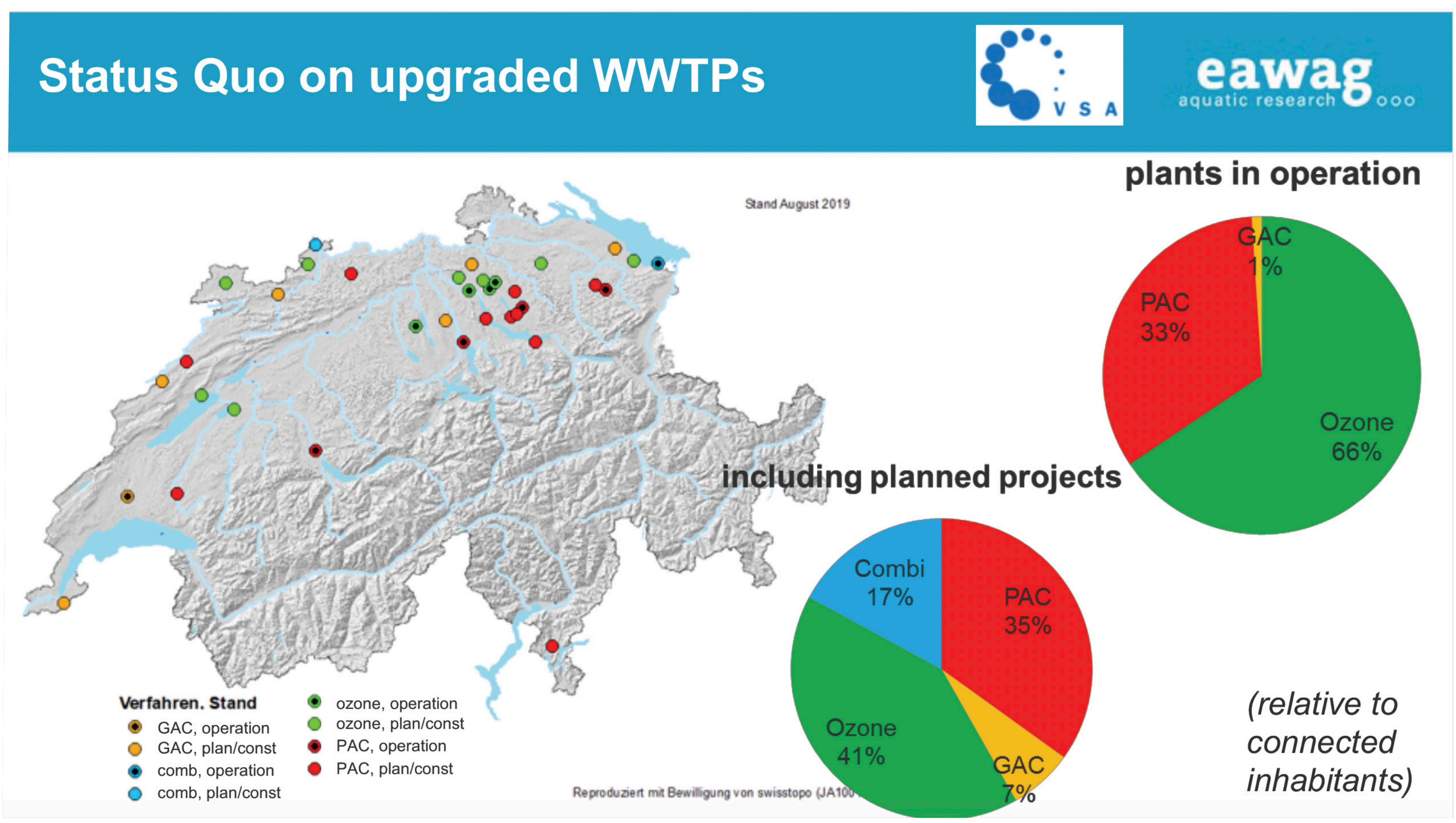



*Image: Status Quo September 2019, source: Aquastrategy*

## Combining technology increases effectiveness and efficiency

Following Switzerland, the 'Dutch approach' was also based on 'learning by implementation' in close cooperation with all parties involved. The aim of Innovation Program for Micro-Pollutants from Wastewater Treatment Plant Effluent (IPMV) was to quickly pave the way for promising new techniques, improvements of existing techniques or innovative combinations of promising and existing techniques.

## Ozonation and biological oxidation

In one of the pilot studies, ozonation and biological oxidation were combined to remove organic micro-pollutants. By combining these, the best of both worlds is brought together, namely the strong oxidizing properties of ozone and the sustainable nature of biological filtration. The combination requires about 40% less ozone compared to a stand-alone ozonation process. This research (2023) revealed that the lower ozone dosage resulted in lower energy and resource consumption reducing CO2 footprint of approximately 50% compared to the reference technology (Ozone + Sand filtration). In this study it was also demonstrated that no quantifiable concentrations of bromate were formed.

**OVERVIEW CRITERIA MICROFORCE++**

| | Unit | PACAS | GAC | Ozone + SF | MicroForce++ |
|---|---|---|---|---|---|
| CO2-footprint* | g CO2/m³ | 122 | 325 | 130 | **66** |
| Costs** | €/m³ | 0,05 | 0,26 | 0,17 | **0,10** |
| Romoval Efficiency Guide substances | % | 70-75 | 80-85 | 80-85 | **80** |

* Grams CO2 per m³ treated sewage water
**Removal Efficiency method for at least 7 of the 11 guide substances determined by the Dutch Ministry of Infrastructure and Water Management. Here, the efficiency is determined based on the total effluent (after extra technology) compared to the influent of the Wastewater Treatment Plant.

*Image: The MicroForce++ technology combines ozonation and biological oxidation and has a removal efficiency of 80%, low carbon footprint and low cost per m3 treated water.*

***DEFINITIONS:***
***Pacas:*** *Powdered Activated Carbon in Activated Sludge*
***GAC:*** *Granular Activated Carbon*
***Ozone + SF*** *Ozone and Sandfiltration*

# Customization being the standard

CO2 FOOTPRINT MICROFORCE++ COMPARED TO STANDARD WASTEWATER-TREATMENT PLANT WITHOUT POST-TREATMENT (REFERENCE), WITH ALTERNATIVE SEQUENCED TECHNOLOGIES (PACAS, GAC, OZONE + SF) AND WITH MICROFORCE++

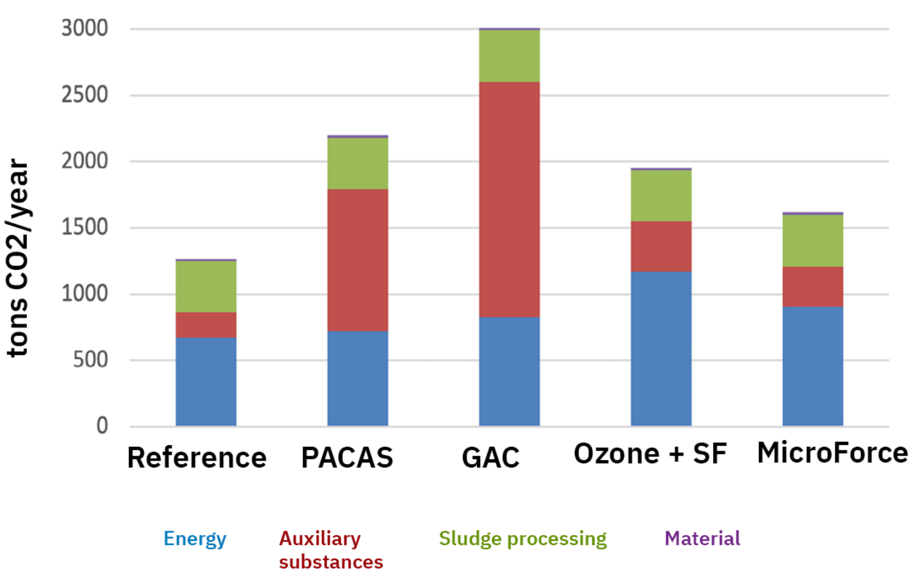
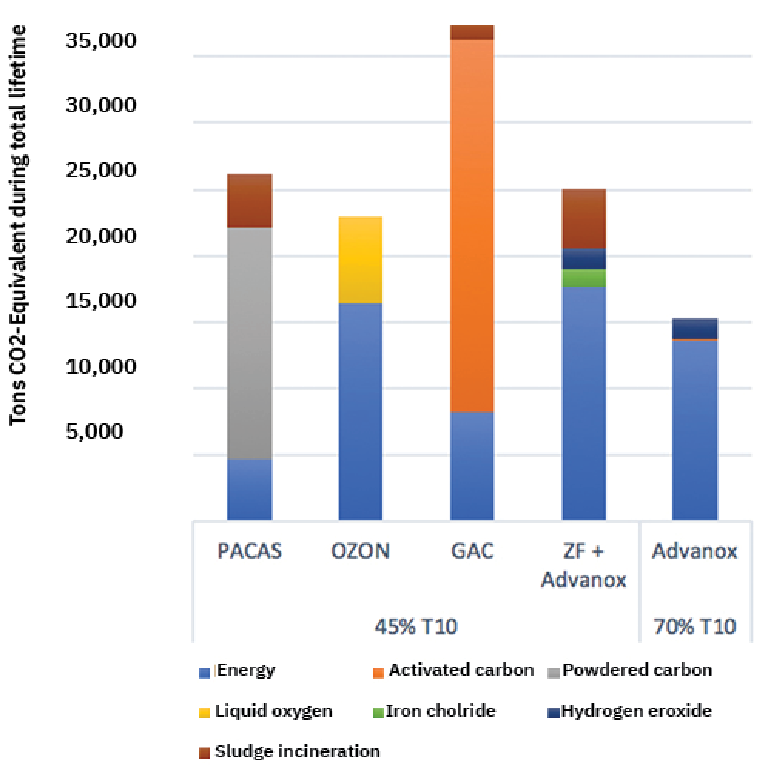



*Image: The Ozone treatment technology of MicroForce shows that the total CO2 footprint only slightly increases compared to the reference situation without post-treatment, and that this increase is almost entirely due to the energy required to generate and introduce the ozone.*




**The figure shows the environmental impact of different technologies based on a transmission of 45%. A transmission of 70% T10 means that at least 70% of UV C-light remains after it has traveled through 10 mm of water. The higher the percentage, the higher the transmission. 70% T10 is comparable to that of a wastewater treatment plant with high natural transmission or of an effluent stream that has been treated with sand filtration and coagulation.**

The pilots and full-scale applications have set a clear rule: there is no one size fits all approach. The make-up of streams that require treatment varies wildly from industry to industry (and sometimes between streams in one facility) and technology application requires large amounts of customization. Full scale pilot studies do show that when combining filtration technologies with ozonization or an AOP step with UV and hydrogen peroxide, the removal efficiencies greatly increase. This results in high quality water that for example can be reused in the industrial processes.

*< Image: The Advanox AOP system combines UV-C light with hydrogen peroxide to effectively break down micro-pollutants. The CO2- footprint primarily consists of the required electronic energy. This consumption is the smallest when the water has high transmission values (70% T10); then the technology works most efficiently, and the CO2 footprint is lower compared to other technologies.*
*If renewable energy is also utilized, the impact decreases even further.*
*Source: H2OWaternetwerk.nl (Sept. 2023)*

**DEFINITIONS:**

| | |
|---|---|
| Pacas: | *Powdered Activated Carbon in Activated Sludge* |
| GAC: | *Granular Activated Carbon* |
| SF + Advanox | *Sandfiltration combined with UV AOP system* |

# How Nedap UV driver technology helps to reduce energy consumption

We partner with UV professionals globally to create energy efficient UV systems at the lowest total costs of ownership. We help our partners to:

- Reduce operational costs and carbon footprint by integrating energy efficient UV drivers.
- Build robust systems with drivers that have a lifetime of >10 years.*
- Create smart systems that provide users with data insights.

* The expected lifetime is partly determined by situational circumstances, for example the average ambient temperature profile.


*Image: St Anthony Village is the 35th public water system in North America to specifically treat 1,4 Dioxane using Advanced Oxidation with UV-Peroxide. The six (6) Trojan UVPhox Reactors each contain 144 low-pressure high-output UV lamps. The overall system can remove more than 99% of 1,4 Dioxane at Peak Flow Conditions of 3,000 GPM. Source: www.health.state.mn.us (August 2017)*

## Contact us

Nedap is dedicated to reducing our environmental footprint through smart driver technology that meets current regulations and anticipates future trends. Get in touch to discover how our team can support your business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