DR Z. JASON REN, PROFESSOR

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING. PRINCETON UNIVERSITY

"In order to get to net zero, or carbon neutrality, we have to tackle direct emissions from wastewater treatment as well"

The winner of the 2021 Paul L. Busch Award, Dr Z. Jason Ren, professor in the Department of Civil and Environmental Engineering at Princeton University, intends to use the award's funding to develop an inventory and digital tools to measure greenhouse gas emissions from the wastewater sector.

CRISTINA NOVO PÉREZ

A leading expert on the water-energy nexus, Dr Z. Jason Ren's research focuses on energy and resource recovery during processes such as wastewater treatment, desalination and remediation. He plans to use advanced sensing technologies to quantify direct GHG emissions at the plant level and machine learning tools to understand emissions from the wastewater industry as a whole. In this interview, he explains how his approach to emissions accounting can contribute to the decarbonization of wastewater treatment facilities.

What does it mean for you to receive the Water Research Foundation's Paul L. Busch Award?

It is a tremendous honor and also a big responsibility. The Paul L. Busch Award is many water researchers' dream, and many of the awardees are not only the best in their individual research areas but also leaders in moving the field forward. It's been a humbling experience during the past few weeks, and I am excited to take on this task and contribute to our profession.

What is your research focus and why is it important to quantify direct carbon emissions from wastewater treatment?

I have been working on water energy topics since my graduate school years, and I started by designing energy efficient membrane reactors and then converting wastewater to renewable energy such as hydrogen and electricity.

We know the chemical energy embedded in wastewater can be many times that needed for treatment, so it is possible we get to energy neutral, and in fact quite a few utilities already achieved that goal.

However, in recent years I realized energy neutrality is not enough, because based on studies from UK and other places, direct greenhouse gas (GHG) emissions may account for nearly half of the total emissions. So in order to get to net zero, or carbon neutrality, we have to tackle the direct emissions as well.

What does your approach to emissions accounting involve, and how does it differ from existing methods?

For many years I have been focusing on technology development to reduce energy use and carbon emissions, and I assumed IPCC methods are accurate. But the more I study this area the more I realized there are a lot of knowledge gaps, and the tools for emission estimation can be greatly improved. That's why I was looking for new methods, especially for a plant level prediction. Fortunately, I work with colleagues and think the mobile sensors used in oil/gas fields can be very applicable to wastewater plants because they can't be considered as either a point source or a non-point source, rather somewhere in the middle, and the mobile sensors can be pretty good on estimating emissions at this scale.

Is there a market for emission accounting tools from industrial and municipal wastewater treatment plants?

I believe there is a market for emission accounting tools in the wastewater sector because in many towns and cities such plants are major energy consumers and major non-CO_2 GHG emitters. With the carbon market and other measures coming into place to achieve net zero goals around the globe in the next few decades, it is critical to understand the actual emissions of these facilities to guide emission mitigation programs.

What is the potential for carbon-neutral wastewater treatment technology and what would a utility of the future look like?

I believe there are many opportunities to get to carbon-neutral or even carbon-negative for the utilities of the future. There are three levels of work we need to do to achieve this goal. First, we have to understand the emission baseline and identify the hotspots, so we can develop strategies to reduce emissions and avoid processes that lead to higher emissions. Second, we can optimize the systems and implement technologies to reduce energy and chemical uses, reduce fugitive emissions, and reduce other emissions across all three accounting scopes. Finally, we can even develop new technologies and processes to capture carbon and convert CO_2 or CH_4 into value-added products to not only achieve carbon-negative but possibly revenue-positive. We summarized such strategies in a recent review in Nature Sustainability (Wastewater treatment for carbon capture and utilization, Nature Sustainability, 2018, 1, 750-758).

"Energy neutrality is not enough, because direct greenhouse gas (GHG) emissions may account for nearly half of the total emissions"

"In many towns and cities wastewater treatment plants are major energy consumers and major non-CO_2 greenhouse gas emitters"