



# Standardizing energy consumption calculations for wastewater treatment systems

## The new ISO 21939 offers engineers and facility owners a universal means to evaluate process energy use

In today's environment, energy consumption is an increasingly important consideration for efficient wastewater treatment plant design. The energy consumed by biological treatment processes significantly impacts their operational costs and environmental footprint.

Traditionally, measuring the energy consumption efficiency of a given treatment process is based on either:

- 1 Volumetric calculations [kWh/m<sup>3</sup> treated], or
- 2 The extent of pollutants removed [kWh/kg of COD/BOD/other].

However, these methods generate inconsistent and often misleading results that vary depending upon location, wastewater characteristics, and the nature of pollutants involved. For example, Plant A can report higher energy consumption than Plant B when calculated on a volumetric basis, yet demonstrate lower energy consumption based on the mass of BOD removed.

**The new international Standard ISO 21939-1:2019** introduces a standardized means to express energy consumption for biological wastewater treatment processes. This method accounts for all pollutants and normalizes the calculation of energy consumed to allow meaningful comparisons among different facilities and technologies.

### NEC = kWh/kg NOR

**Normalized Energy Consumption (NEC)** expresses the full energy consumption of the biological treatment process, accounting for the net oxidation work performed on all pollutants and normalized to energy per unit mass measurement (kWh/kg NOR).

**Net Oxidizable Mass Removed (NOR)** is the mass of the pollutants removed by a biological treatment process per unit of time (kg/day). NOR consists of the Chemical Oxygen Demand (COD) plus Total Kjeldahl Nitrogen (TKN) plus nitrate created (or minus the nitrate removed).

The formula calculates energy consumption using average values of pollutant concentrations and daily flow rates derived from representative samples under steady-state conditions.



For clarity, ISO 21939 directs that NEC accounts for the energy consumed by equipment serving the biological treatment, namely:

- Aeration, mixing, and agitation
- Solid-liquid separation processes
- Settled sludge, recirculation, and other pumping requirements.

Likewise, ISO 21939 states that the NEC does NOT include the energy consumed by:

- Wastewater feed pumping
- Pre-treatment systems (such as screening, sedimentation, dissolved air flotation, chemical oxidation, and oil separation)
- Post-treatment systems (such as disinfection, desalination, ion exchange, and sludge treatment/handling)
- Site lighting or offices
- Energy recovery from anaerobic reactors producing biogas and other processes.

The widespread adoption of ISO 21939 by consultants and utility owners will standardize energy consumption performance evaluations and facilitate more accurate comparisons among different biological treatment process alternatives.

Fluence supports this development by including Normalized Energy Consumption calculations in accordance with ISO 21939 in its technology offerings and specifications which will allow for a more accurate evaluation of process energy use.