Energy efficiency of wastewater treatment plants. Overview of the literature and critical discussion of energy data

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the international water association

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CHALLENGE

Wastewater treatment plants (WWTPs) are one of the most expensive public industries in terms of energy requirements, accounting for more than 1% of the consumption of electricity in Europe. Although there is a large improving potential, **energy efficiency measures are sometimes not adopted due to the impossibility to properly assess the energy performance of WWTPs**.

Since the 2012 Energy Efficiency Directive was introduced energy audit has become a legal requirement also for water utilities.

However, in the absence of fundamental and globally recognized approach evaluating WWTP energy performance, these policies could be economically wasteful.

OBJECTIVES

By assessing the literature, this study represents the first step in the development of a systematic methodology for evaluation and improvement of energy performance in WWTPs operation (Longo et al., 2016). Such a methodology is the main aim of the ENERWATER project, which objectives are:

- **DEFINE** a performance index adapted to the plant function.
- **MEASURE** by online detailed monitoring, including seasonal variation.
- **ANALYZE** and development of a methodology that can be used for normalization (standard).
- **IMPROVE** by correlation of measured variables with plant performance
- **TRAINING** and guidance of WWTP auditors.

HOW ARE ENERGY DATA REPORTED IN THE LITERATURE?

KPI	Overall	Prelim. treat.	Primary treat.	Sec. treat.	Tert. treat.	Sludge treat.	Comments	Frequency
kWh/m³	✗	✓✓	✗	✗	✓	✗	Does not take into account influent dilution; Does not represent the removal of pollutants	59%
kWh/PE year	✗	✗	✗	✗	✗	✗	Does not represent the removal of pollutants	26%
kWh/kg $COD_{rem.}$	✓	✗	✓	✓	✗	✗	Limited to plants with same function	13%
kWh/kg $TSS_{rem.}$	✗	✗	✓✓	✗	✗	✓✓	Limited to primary and/or sludge treatment	0.5%
kWh/kg $N_{rem.}$	✓	✗	✗	✓	✗	✗	Limited to WWTPs where N removal is implemented	1%
kWh/kg $TPUs_{rem.}$	✓✓	✗	✗	✓✓	✓✓	✗	Allow the comparison of WWTPs regardless of treatment intensity	0.4%

Energy KPIs found are often not representative of the overall energy consumption: it is assumed that pollutants concentrations or effluent quality do not vary significantly among WWTPs.

WHICH ARE THE VARIABLES THAT HAVE THE LARGEST EFFECT ON ENERGY CONSUMPTION?

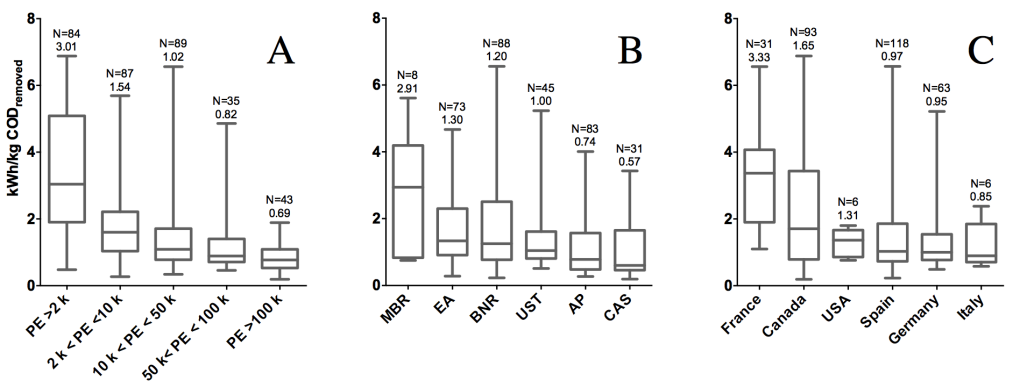

Fig. 1 Variables that have a largest effect on energy consumption

THERE IS A CLEAR NEED TO ESTABLISH SUITABLE KPIs THAT ALLOW A COMPARABLE, REALISTIC AND UNIVERSAL FORM OF REPORTING ENERGY DATA

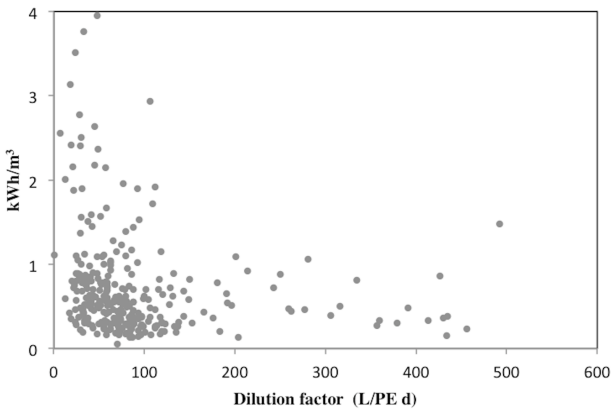

Fig. 3 Variation of energy consumption for different influent wastewater dilution factors

Plants treating wastewater from combined sewer overflows often show higher energy efficiency, which is caused by the higher dilution of the pollutants in the influent (Gallego et al., 2008).

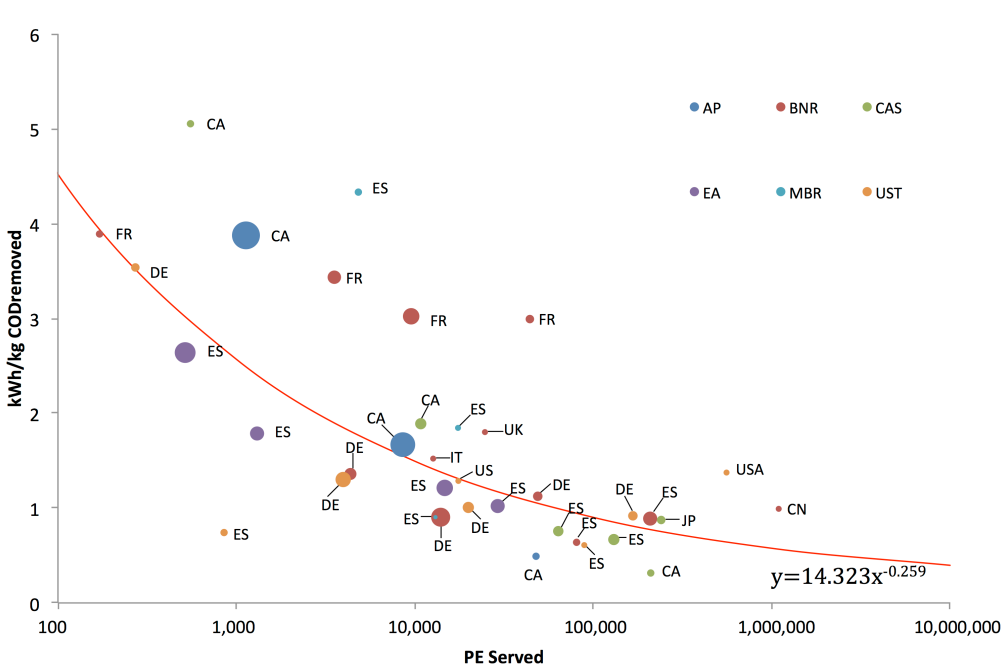

Fig. 2 Specific energy consumption per country and type of treatment

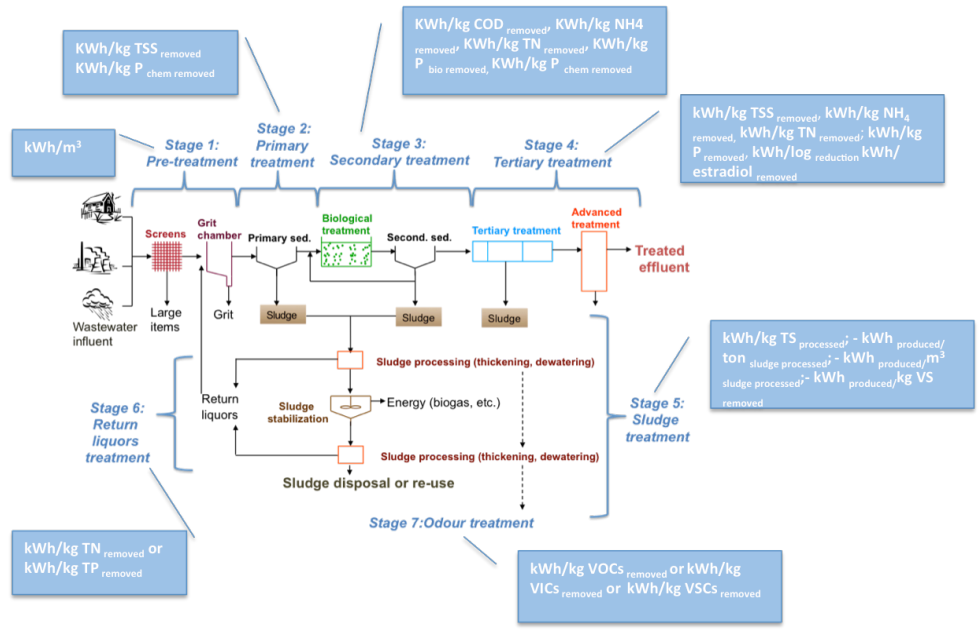

Fig. 4 Suggested KPIs per treatment stage(s)

CONCLUSIONS

- **This study represents the first step in the development of a systematic methodology for evaluation and improvement of energy performance in WWTPs operation.**
- **The large dispersion of the results shows that there is considerable room for improving the efficiency of WWTP operation.**
- **To achieve this aim, detailed monitoring of the WWTP operation is crucial and is expected to be more frequently carried out in the upcoming years.**

References

Gallego et al. (2008). Environmental performance of wastewater treatment plants for small populations. *Resources, Conservation and Recycling, 52*(6), 931-940.

Longo et al. (2016). Monitoring and diagnosis of energy consumption in wastewater treatment plants. A state of the art and proposals for improvement (submitted to Applied Energy)

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