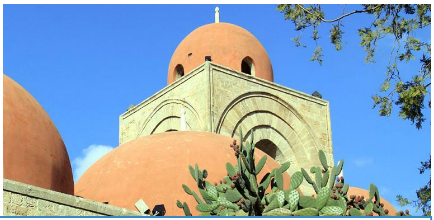
Frontiers International Conference on Wastewater TreatMent
21-24 MAY 2017 | PALERMO – ITALY



Measuring energy demand and efficiency at WWTPs: an econometric approach

Longo S.*, Mauricio-Iglesias M.*, Lema J.M.*, Hospido A.*

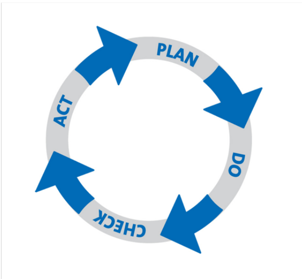
*Department of Chemical Engineering, Institute of Technology, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain

(E-mail: stefano.longo@usc.es)

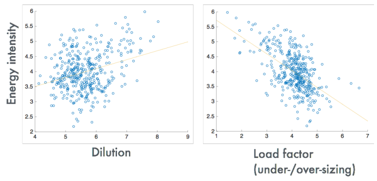
INTRODUCTION

Increasing energy efficiency is a cyclic process based on continually performance measurement (benchmarking). However, measuring energy efficiency at WWTPs is still a challenge.

"If you can't measure it, you can't improve it"



Energy use is affect by exogenous variability



Energy efficiency is typically approximated by energy intensity, which is defined as the amount of energy use per unit of activity (e.g. volume of treated wastewater). Changes in energy intensity are just approximate indicators for changes in energy efficiency since they are affected by external factors such as the influent characteristics, climate, scale effect of plant size and other construction parameters.

Furthermore, considering that WWTPs perform different functions, i.e. removing of COD, removing of N and/or P, resource recovery, producing an effluent free of pathogens, general energy intensity indicators (i.e. kWh/m^3 or kWh/PE) have limited value, as they do not provide enough information of the WWTPs operation.

WWTPs can have different functions

$$\text{Energy efficiency} = \frac{\text{Input}}{\text{Output}}$$

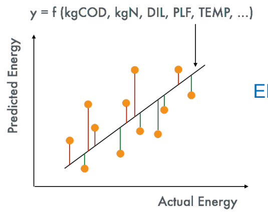
Input → kWh

Output → m^3, kgCOD, kgN, kgP, pathogen

METHODOLOGY

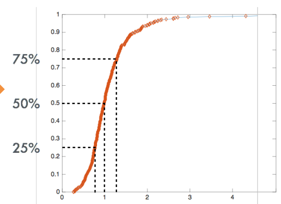
In this study, a linear regression approach is used to control for aspects that systematically influence the energy use at WWTPs. After estimating the log-log model, the β coefficients can be used to determine the impact of independent variables (*X*) on dependent variable (*Y*). Moreover a benchmark table can be build from the ratios between predicted and actual energy consumption.

Ordinary least square (OLS) predicts the expected energy consumption



$$\text{EE Ratio} = \frac{\text{Predicted}}{\text{Expected}}$$

Benchmark table from cumulative distribution of EE ratios



RESULTS AND CONCLUSIONS

OLS for understanding

Estimation results

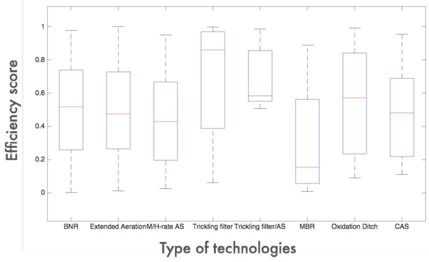
Parameter	M1 (Y=kWh/day)		M2 (Y=kWh/m3)		M3 (Y=kWh/PE)	
Intercept	-0.403***	-0.059	-0.835***	-0.122	-1.051***	-0.153
SecTreat (Trickling filter)						
BNR	0.430***	-0.063	0.893***	-0.131	1.123***	-0.165
Extended Aeration	0.420***	-0.066	0.871***	-0.136	1.096***	-0.172
M/H-rate AS	0.317***	-0.078	0.659***	-0.162	0.829***	-0.204
Trickling filter-AS	0.330***	-0.125	0.684***	-0.259	0.860***	-0.326
MBR	0.548***	-0.112	1.138***	-0.233	1.431***	-0.293
Oxidation Ditch	0.316***	-0.09	0.655***	-0.188	0.824***	-0.236
CAS	0.370***	-0.119	0.768***	-0.247	0.966***	-0.31
TerTreat (NO)						
YES	0.132**	-0.051	0.275**	-0.107	0.346**	-0.135
lnTemp	0.084***	-0.021	0.174***	-0.043	0.219***	-0.055
lnSIZE	0.912***	-0.018	-0.348***	-0.037	-0.438***	-0.047
lnPLF	-0.114***	-0.015	-0.237***	-0.031	-0.299***	-0.039
lnDIL	0.038**	-0.018	-0.599***	-0.038	0.100**	-0.048
lnNout	0.095***	-0.015	-0.197***	-0.032	-0.248***	-0.041
Root Mean Squared Error	0.273		0.565		0.711	
Adjusted R-Squared	0.926		0.681		0.496	

*** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

- Following the previously described procedures three regression models were tested in order to describe the relationship between energy consumption and operational parameters and the results are reported in the following table.

OLS for benchmarking

Are there differences across technologies?



- OLS is a robust technique that can take into account the large heterogeneity which WWTPs are characterized.
- Thanks to the flexibility on the inclusion of different type of variables this technique can be used to test for hypothesis.

Supported by: IWA the international water association; International Environmental Modelling & Software Society

This project is carried out with financial support from the H2020 Coordinated Support Action ENERWATER (grant agreement number 649819): www.enerwater.eu.

ENERWATER · BioGroup · USC Universidade de Santiago de Compostela