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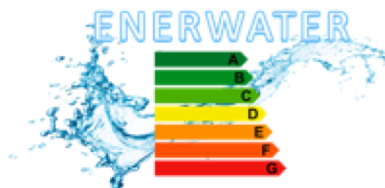
Measuring energy demand and efficiency at WWTPs: an econometric approach

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

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

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What is energy efficiency?

$$\text{Efficiency} = \frac{\text{Input}}{\text{Output}}$$

WWTPs can have different functions

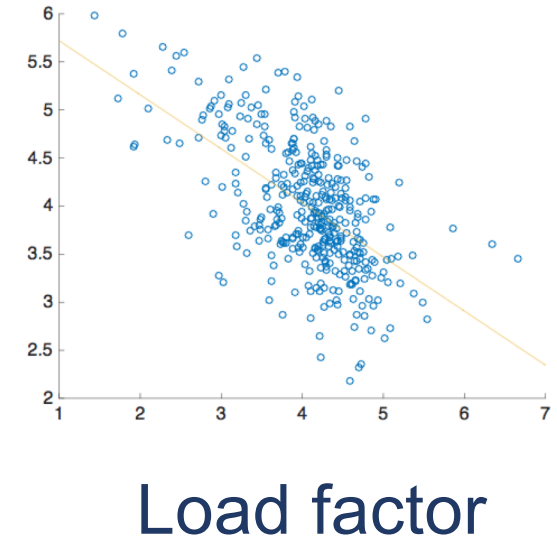
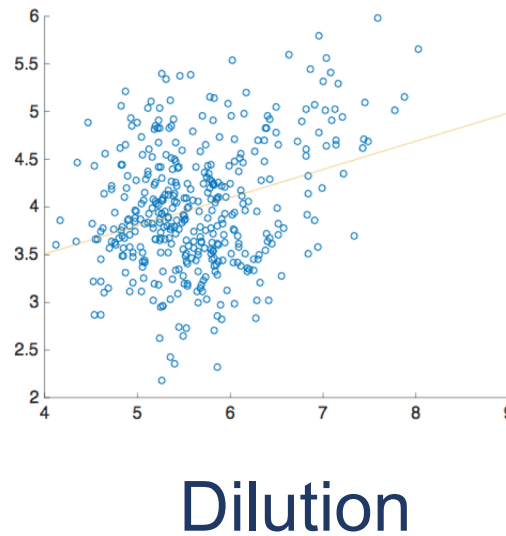
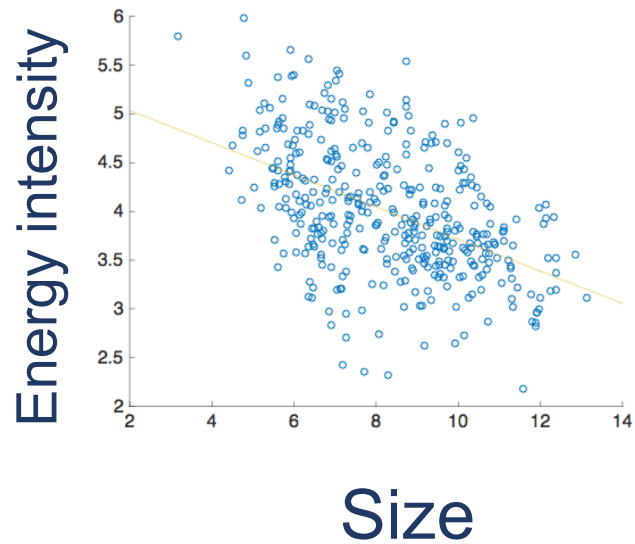
$$\text{Energy efficiency} = \frac{\text{kWh}}{\text{Output}}$$

WWTPs can have different functions

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

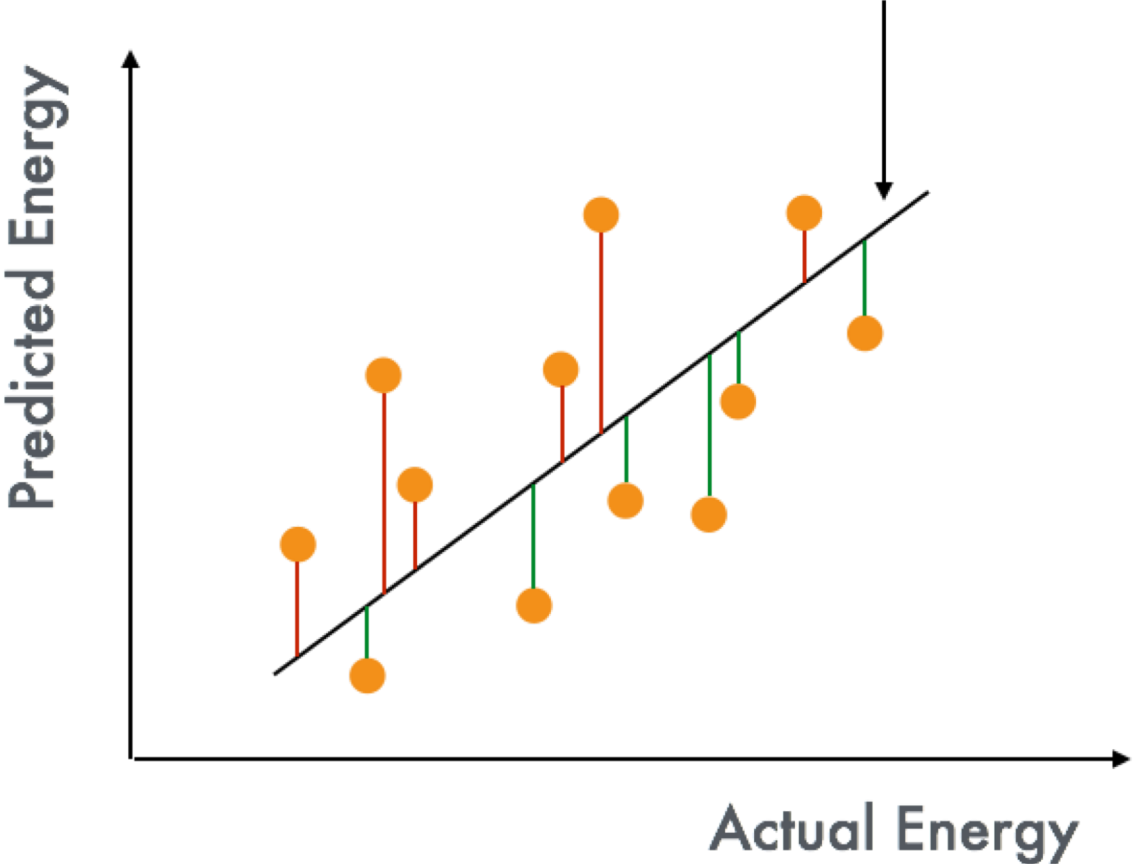
The diagram illustrates the components of 'Output' in the energy efficiency equation. Four arrows point from the word 'Output' to the following units and terms: m³, kgCOD, kgN, and pathogens.

Energy intensity is function of exogenous factors



Ordinary least square (OLS) predicts the expected energy consumption

$$y = f(\text{kgCOD}, \text{kgN}, \text{DIL}, \text{PLF}, \text{TEMP}, \dots)$$

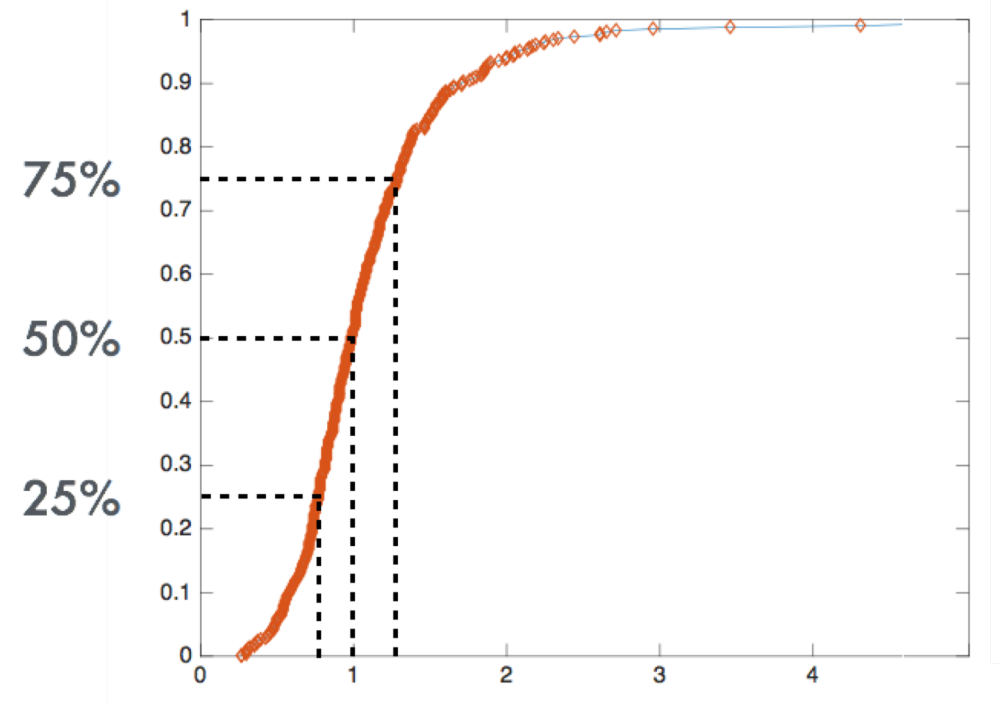


➤ Understanding energy consumption

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
InTemp	0.084***	-0.021	0.174***	-0.043	0.219***	-0.055
InSIZE	0.912***	-0.018	-0.348***	-0.037	-0.438***	-0.047
InPLF	-0.114***	-0.015	-0.237***	-0.031	-0.299***	-0.039
InDIL	0.038**	-0.018	-0.599***	-0.038	0.100**	-0.048
InNout	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.						

➤ Benchmarking energy use

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

To know more: poster n. 35

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Longo S., stefano.longo@usc.es

Thanks!

