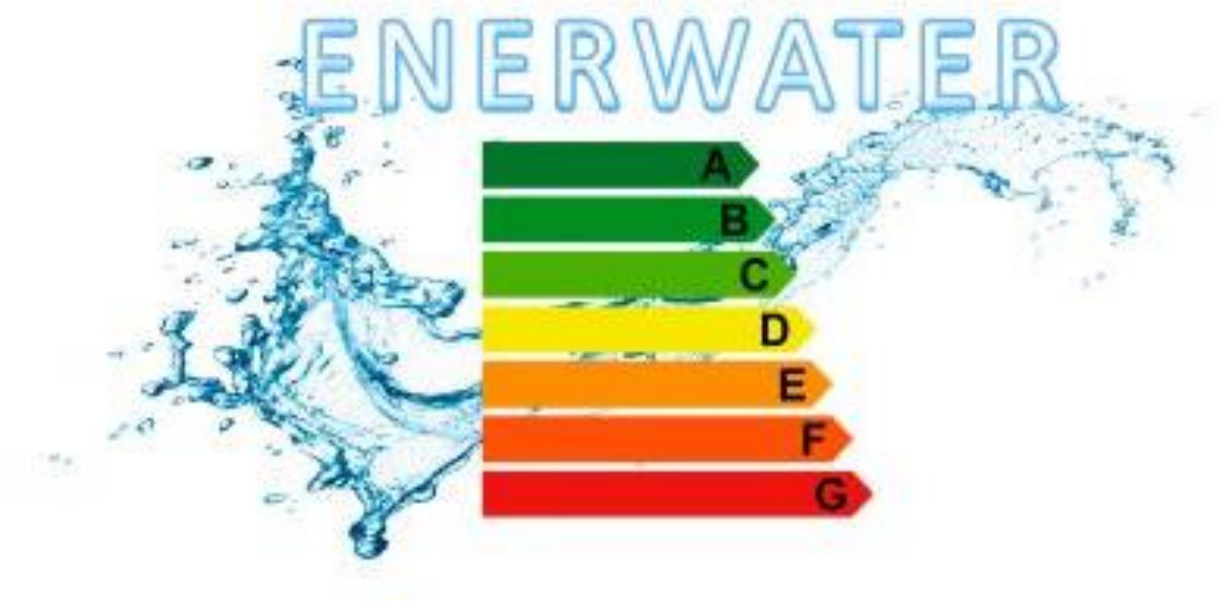

Almudena Hospido (USC – Coordinator)

www.enerwater.eu

www.usc.es/biogroup

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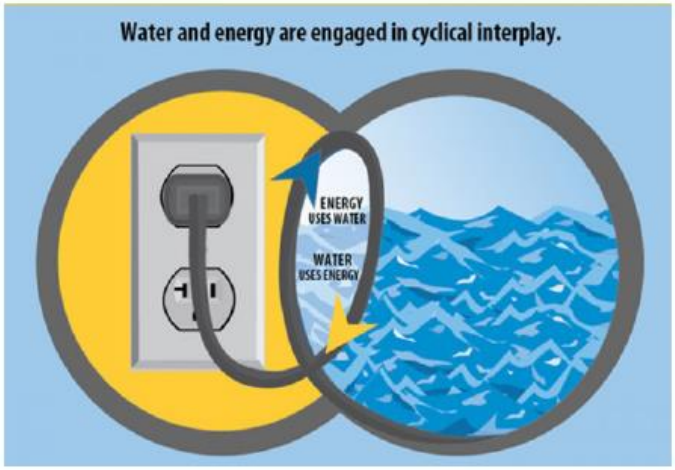
0.33*
m³/kWh

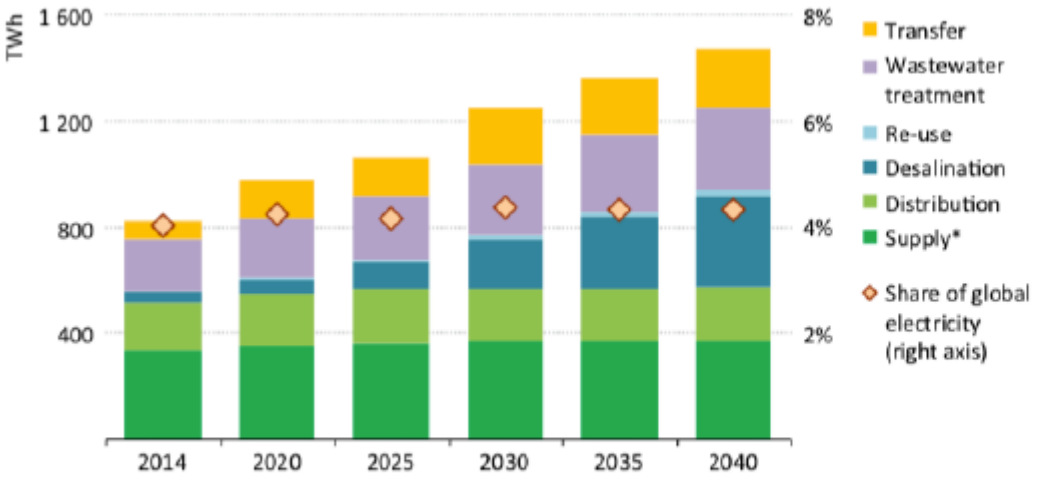
water demand for
energy production



1.78*
kWh/m³

energy demand for
domestic water use

* Including electricity, thermal energy and gas. Data from International Energy Agency (2016), own calculation.



Electricity consumption in the water sector increases by 80% over the next 25 years

International Energy Agency (2016)

- About 800 TWh of electricity are consumed for the water cycle
- Equal to 4% of the global consumption
- 20-30% of electricity consumed in the water cycle is for wastewater treatment
- Electricity consumption is set to increase due to:
  - increasing number of people who have access to water
  - increasing effluent requirements

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ENERWATER: Standard method and online tool for assessing and improving the energy efficiency of wastewater treatment plants

was a 44 months CSA within the H2020 Programme.

CALL: H2020-EE-2014-3-MarketUptake.

Scope: Activities should focus on removing market barriers, in particular the lack of expertise and information on energy management. Proposals should primarily address the uptake of cross-cutting innovative technologies, such as energy efficient electric motor driven systems and steam/hot water generation, because these represent 75% of the potential savings in industry[3]. They should also consider total-site energy management schemes and system optimization methodologies to identify saving potentials, monitor progress, and design energy recovery and energy storage solutions. Proposals should put in place mechanisms to secure funding for energy efficiency investments and facilitate the continuation of the activities beyond the project lifetime. The use of renewable energies and waste heat recovery should be encouraged where it is cost-effective. Energy-intensive industries should be prioritised as they account for 70% of industrial energy use. Processes (e.g. drying) which represent a relatively high share of energy consumption in industry should also be considered where appropriate.

The following areas or their combination are also eligible for funding:

- *Industrial systems efficiency benchmarking*: Devise methods and tools including ICT to compare and benchmark the energy performance of industrial systems and processes, and develop guidelines for tailored measures, in particular in energy-intensive industries. Such methods and tools should be based on existing standards where applicable.

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Who? How? When?

Universities

University of Santiago de Compostela (ES)

Marche Polytechnic University (IT)

– *Before University of Verona*

University of Cranfield (UK)

Technical University of Cologne (DE)

Water Utilities

Espina y Delfín (ES)

ETRA (IT)

Aggerverband (DE)

Standardisation Body

UNE (ES)

SME

Wellness Smart Cities (ES)

Budget: 1 731 087 € **Duration: March 2015 – October 2018**

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What?

ENERWATER has developed, validated and disseminated **a standardized methodology** *(also implemented as an online tool)* for continuously assessing, labelling and improving the **overall energy performance of Wastewater Treatment Plants.**

The ENERWATER, which has been tested in 50 plants in 3 countries, is:

- **Standardized**: to allow sound comparisons between different plants and operators
- **Generic**: Adapted to different typologies of WWTPs
- **Open**: Anyone must be capable of using it and understand how the results are obtained.

A collaboration network in the wastewater treatment sector, including research groups, SMEs, utilities, city councils, authorities and industry has been set up *(check D5.1 an D5.3 for further information)*

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The beginning is the most important part of the work.

Plato (Greek Philosopher 427 BC - 347 BC)

Applied Energy 179 (2016) 1251–1268

Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy

Monitoring and diagnosis of energy consumption in wastewater treatment plants. A state of the art and proposals for improvement

Stefano Longo [a], Benedetto Mirko d'Antoni [b], Michael Bongards [c], Antonio Chaparro [d], Andreas Cronrath [c], Francesco Fatone [b], Juan M. Lema [a], Miguel Mauricio-Iglesias [a], Ana Soares [e], Almudena Hospido [a,*]

[a] Department of Chemical Engineering, Institute of Technology, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain
[b] Department of Biotechnology, University of Verona, Strada Le Grazie 15, 37134 Verona, Italy
[c] Cologne University of Applied Sciences, Research group GECO-C, Steinmüllerallee 1, 51643 Gummersbach, Germany
[d] Wellness Smart Cities, Calle Charles Darwin, 41092 Sevilla, Spain
[e] Cranfield Water Science Institute, Cranfield University, Cranfield, Bedfordshire MK43 0AL, UK

HIGHLIGHTS

- A review of WWTP energy-use and benchmarking systems is performed.
- Energy data from more than 600 WWTPs were inventoried.
- Energy KPIs found are often not representative of the overall energy consumption.
- Benchmarking method selection is linked to data availability and purpose of study.
- Further research is required on the field of energy efficiency at WWTPs.

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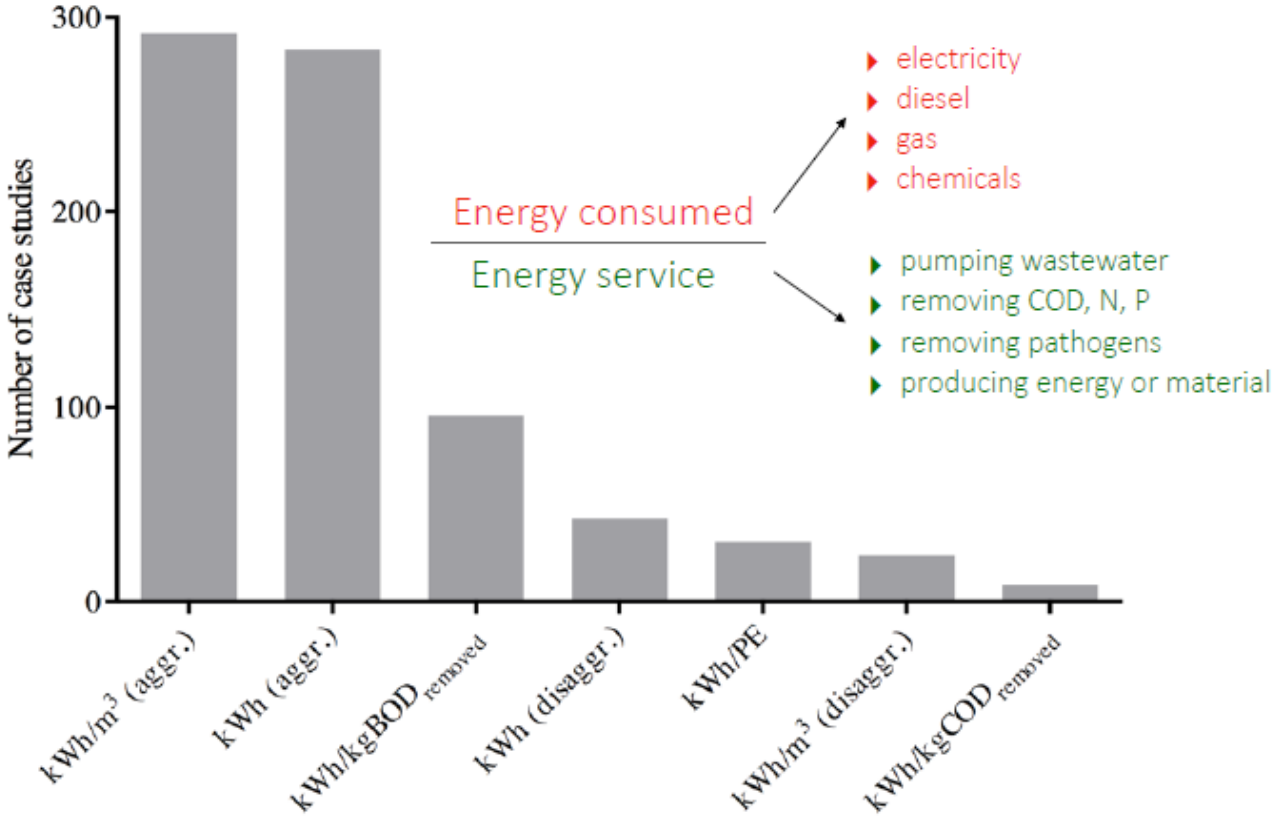
Energy efficiency =
relationship between the production of a service or good and the consumption of energy



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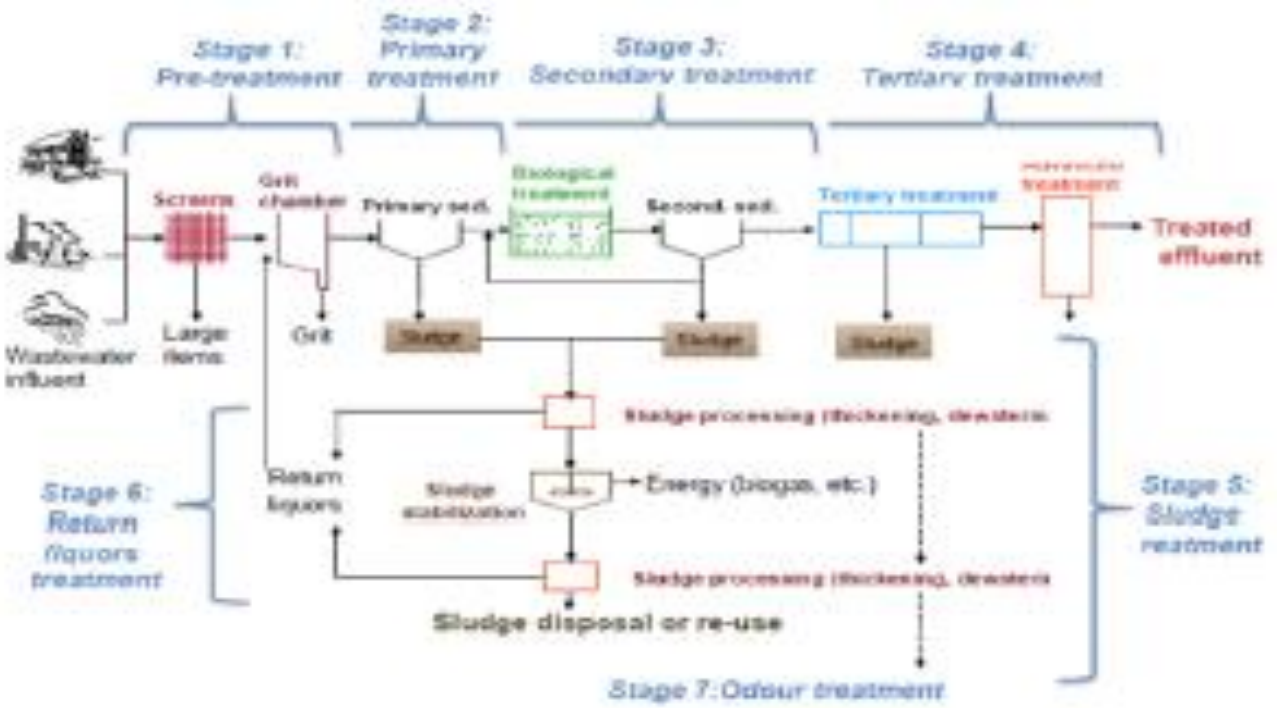

STAGE	FUNCTION	KPI
STAGE 1	Pumping	kWh/m^3
STAGE 2	Solid removal	$kWh/kg\ TSS_{removed}$
STAGE 3	Pollutants removal	$kWh/kg\ TPE_{removed}$ *
STAGE 4	Pathogens removal	$kWh/Log_{reduction} * m^3$
STAGE 5	Sludge handling	$kWh/kg\ TS_{processed}$

* kgTPE (total pollution equivalent) = kgCOD+20 kgTN+100 kgTP
Benedetti et al. 2008

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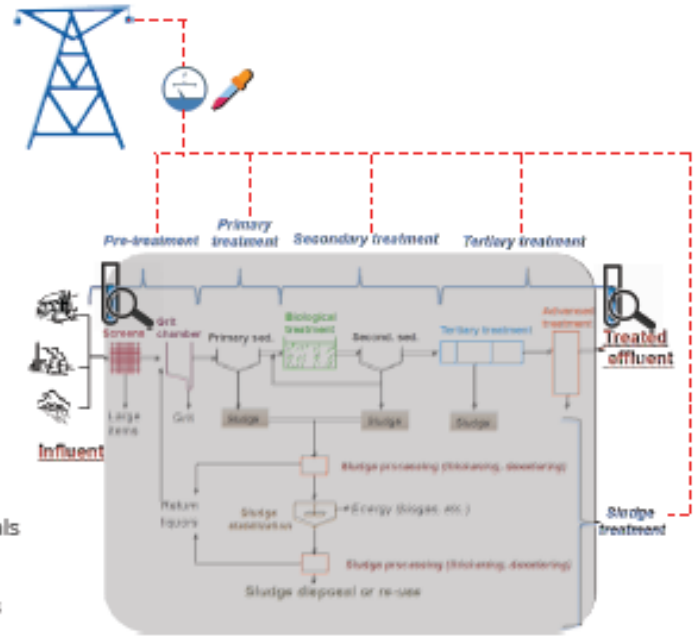
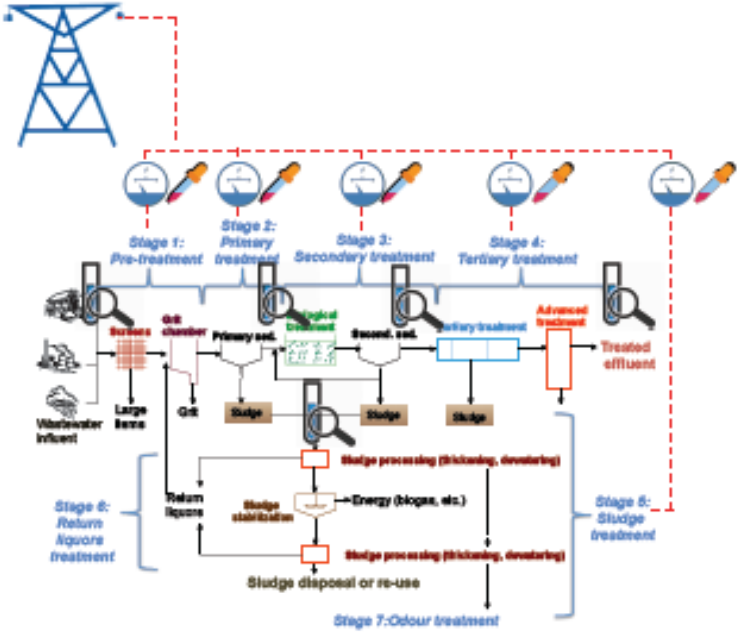
Rapid Audit



Legend:

- Energy sources
- Addition of chemicals
- Sampling + analysis

Decision Support



	Rapid Audit	Decision Support
Energy consumption data	- Aggregated energy consumption from energy bills	- Disaggregated online data from energy meters on site
Operational data	- Routine influent/effluent analyses	- Per section influent/effluent analyses
Objective of the analysis	- Energy benchmarking	- Energy benchmarking - Diagnosis

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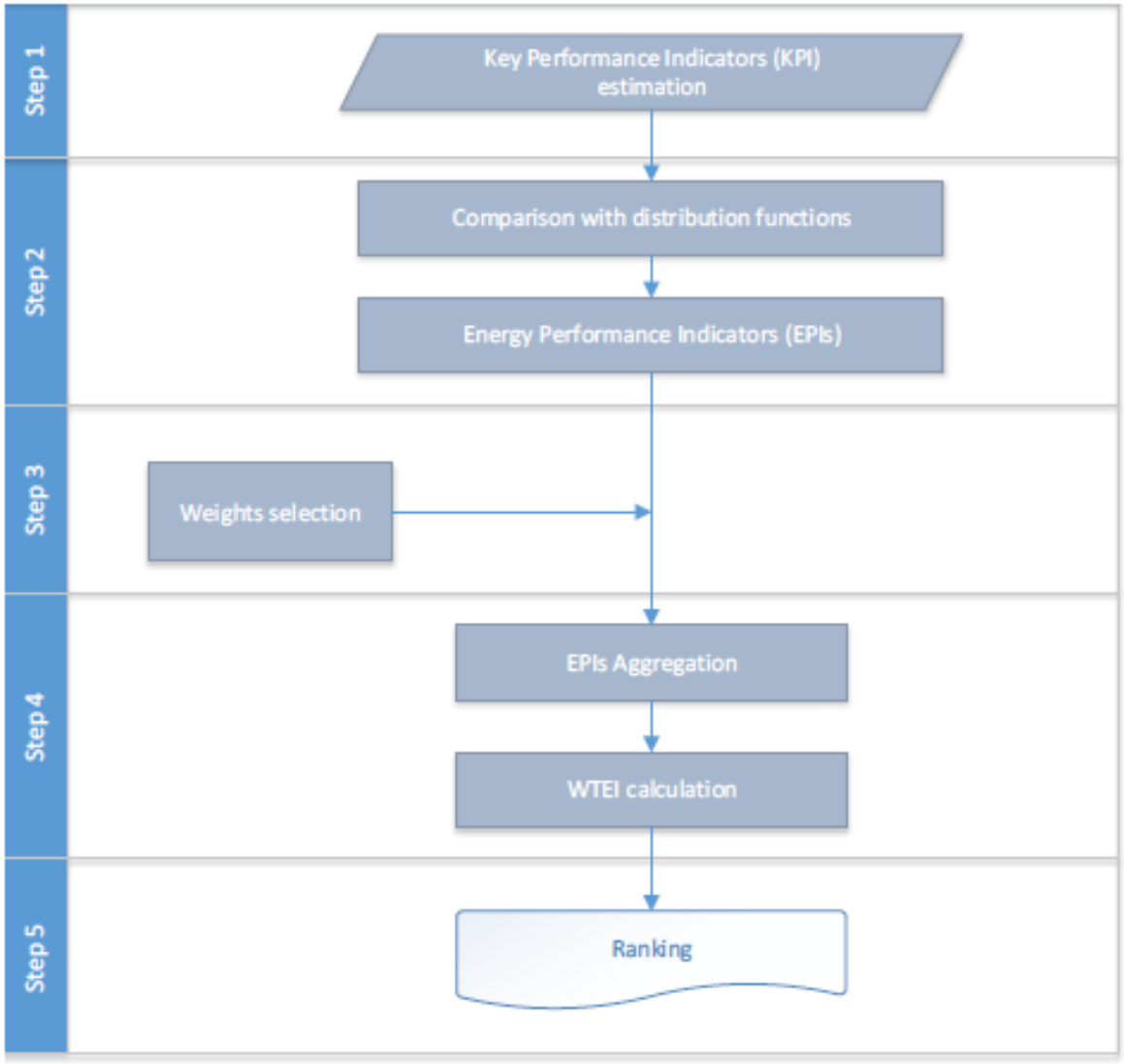

Data collection and KPIs calculation

Compare the value of the KPIs with distribution functions and obtain percentile of each KPIs (EPIs)

Choose the weights for the selected KPIs from database of WWTPs energy consumption data

Aggregate the EPIs into a single WTEI through a weighted sum

Assign label corresponding to the value of the WTEI

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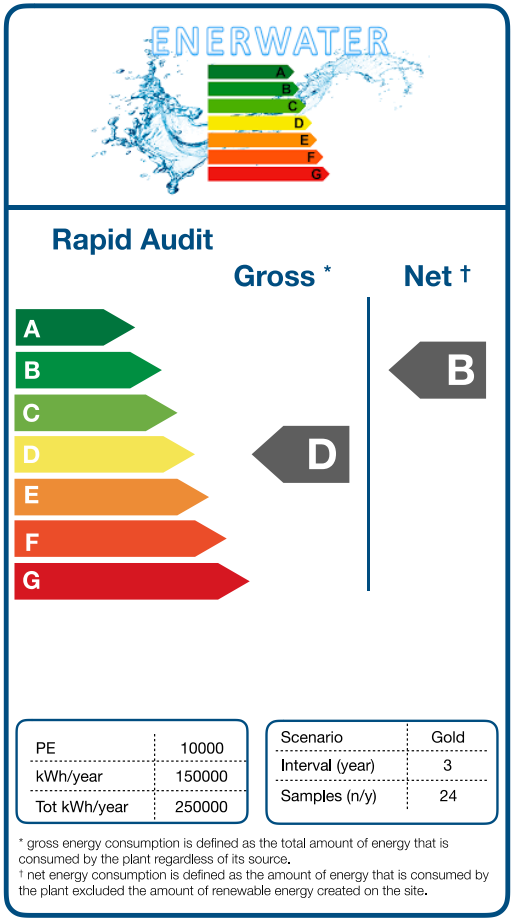
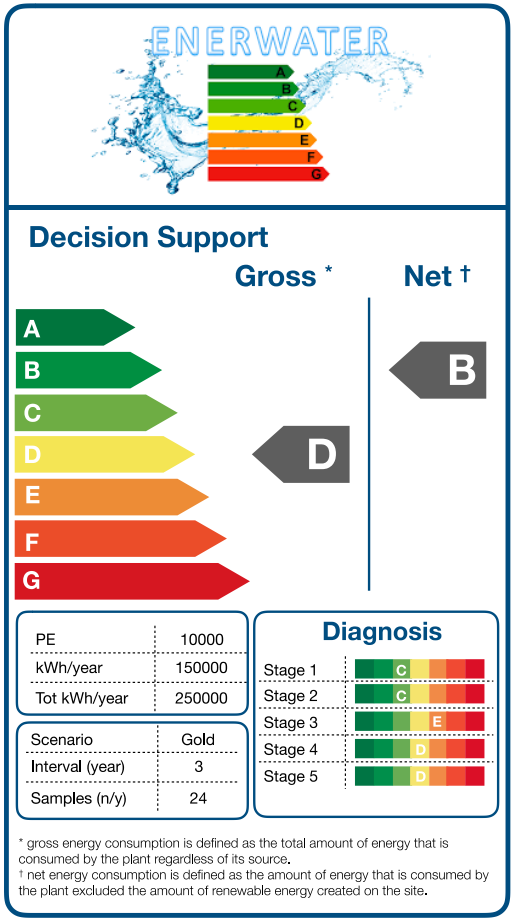
The boundaries between labels have been decided according to the following criterion, common in EU efficiency labelling standards: the median performance index is the upper boundary of class D. This labelling strategy allows good discrimination power at high efficiency, serving as an incentive for innovation.

Label	WTEI
A	<0.11
B	0.11≤WTEI<0.22
C	0.22≤WTEI<0.33
D	0.33≤WTEI<0.44
E	0.44≤WTEI<0.55
F	0.55≤WTEI<0.75
G	<0.75





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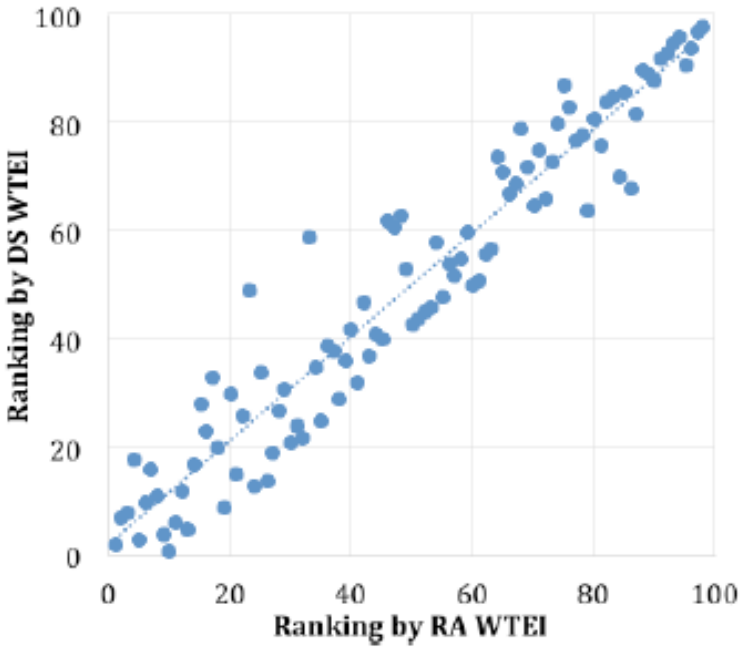
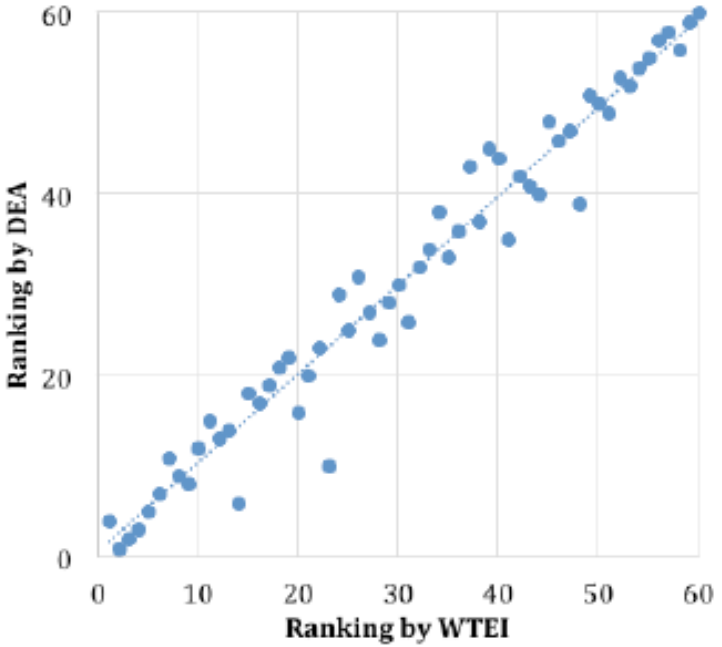
Internal validation: RA vs DS



External validation: ENERWATER vs DEA



SOURCE: Longo S. et al. (2019). ENERWATER - A standard method for assessing and improving the energy efficiency of wastewater treatment plants. Applied Energy (Under Review).

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ENERWATER methodology can help you

- to compare and estimate the energy efficiency of most types of WWTPs, based on available data
- to diagnose and support decision-making for plant upgrade and retrofitting
- easily by using the online application

Validation of ENERWATER methodology (1/3)

- (Easy) installation and operation of the real-time meters

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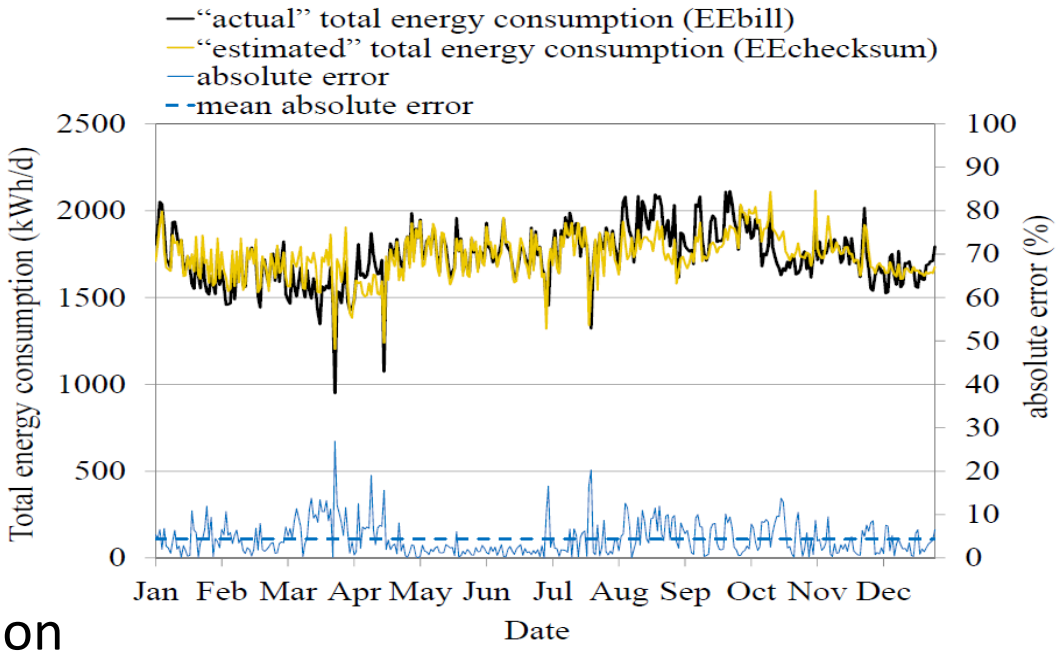
Validation of ENERWATER methodology (2/3)

- Data reliability testing



- Validation of weights selection

  What many do NOT know/expect: impact of chemical energy demand on the rest of energy consumption

- Interaction and reaction of external utilities and auditors

  Training of auditors workshop held in Rubano (Italy) on July 2016 (D4.1)

  D3.4 - Annex C. ENERWATER Methodology versus the Standard DWA-A 216 E and the Italian Guidelines for Energy Audit of WWTPs (D3.4)

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Validation of ENERWATER methodology (3/3)

1st ENERWATER STAKEHOLDER EVENT - ECOMONDO 2015 (ITALY), a major international fair and exhibition event on green and sustainable solutions and was visited by more 105 000 people and had more than 1200 exhibitors

2nd ENERWATER STAKEHOLDER EVENT - 3rd IWA Specialized International Conference Eco-technologies for Wastewater Treatment 2016 (UK) and the final meeting of the COST ACTION WATER 2020.

3rd ENERWATER STAKEHOLDER EVENT – 2017 (GERMANY)

4th ENERWATER STAKEHOLDER EVENT – 2018 (SPAIN) co-organised with the Spanish network of wastewater treatment NOVEDAR (www.novedar.com)

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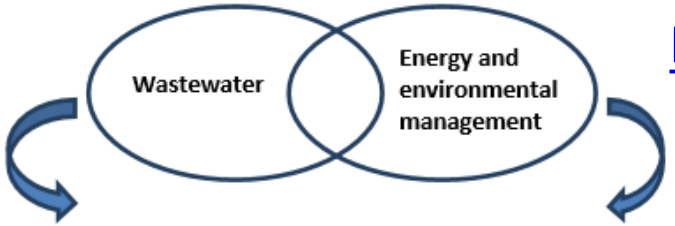
- To provide the partners with information about the state of the art in standardization, including published standards and standards under development which can be interesting for the project objectives
- To identify the standardization technical committees (TCs) which could be useful for the project

D5.2



Wastewater systems
Wastewater treatment
Water re-use

Energy audit
Energy savings
Energy efficiency
Life cycle assessment
Greenhouse gases
Energy performance

NOTE: Some other keywords like sewage, labelling, etc. were also used to make the search but no satisfactory results for the project have been found.

Conclusions:

✓Significant horizontal standards on energy efficiency and energy savings were identified: EN 16212, EN ISO 50001, ISO 50015, EN 16247 (series)...

✓**CEN/TC 165** develops standards for performance and installation in the field of waste water engineering for systems and components: EN 12255 (series) – WWTPs > 50 PT (WG 40)

✓Other documents of interest:

- Manual Energy in WWTP. BFE&VSA. Switzerland
- Energy check and energy analysis. Measures for energy optimisation of WWTPs. DWA-M216 *(Energiecheck und Energieanalyse – Instrumente zur Energieoptimierung von Abwasseranlagen*. Germany (English translation expected soon)
- Sewage Treatment Plants – Economic Evaluation of Innovative Technologies for Energy Efficiency (IWA Publishing)

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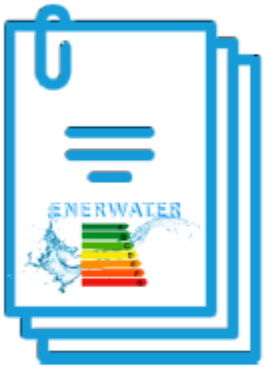
ENERWATER methodology



Technical Report

European Standard

Preparing report jointly with Working Group 40

To be voted by CEN/TC-165 members

Abstract of the minutes of the CEN/TC 165/WG 40 meeting in Lisbon on November 2018:

Item 14 Enerwater paper conversion to TR: Advice has been sought from the TC165 secretary on the CEN process for conversion to a TR:

First step would be to include the CEN/TR as a work item in the work programme (via CIB);
Second step would be to submit the Final draft via TC Secretariat to CCMC, […];
During the vote, the CEN National Members submit their vote and their comments [….];
A TR is an informative document made available by CEN in at least one of the three official languages;
A TR is established and approved by a CEN Technical Committee or the CEN Technical Board by a simple majority vote of the CEN National Members.

Based upon the WG40 earlier opinions, the Convenor has requested a Work Item. CIB will be launched.

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Thank you very much for your kind attention

(almudena.hospido@usc.es)

Acknowledgements & Disclaimer:

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Further Information: www.enerwater.eu

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