



Humedales construidos para el tratamiento de efluentes vitivinícolas: análisis de la sostenibilidad

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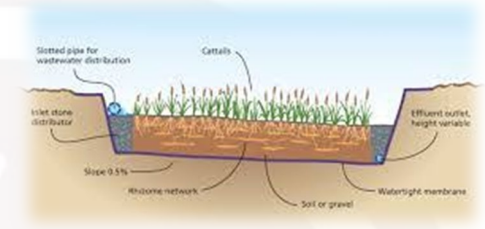
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Líneas de investigación

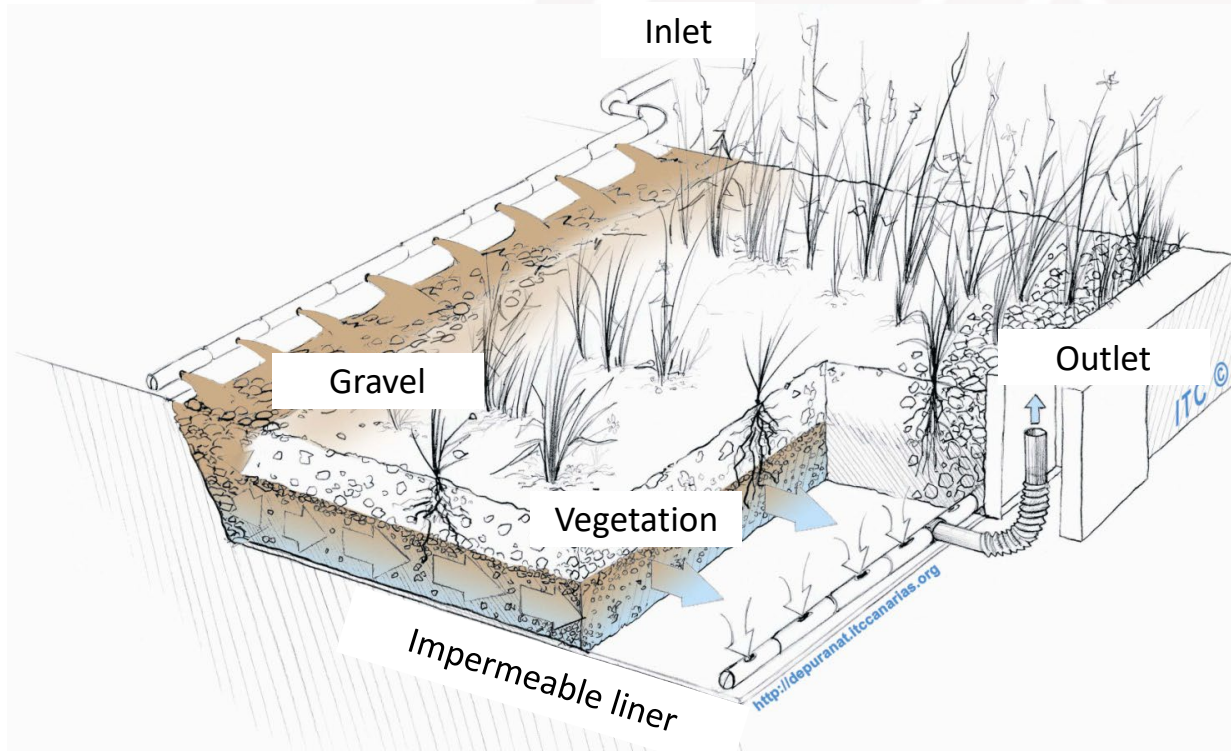
- **Soluciones basadas en la naturaleza para el tratamiento y la gestión de aguas residuales y fangos, incluyendo humedales construidos y lagunas de alta carga.**
- **Recuperación de recursos a partir de aguas residuales para la producción de bioproductos y energía.**
- **Análisis del ciclo de vida y de la sostenibilidad de tecnologías ambientales.**



Constructed wetlands

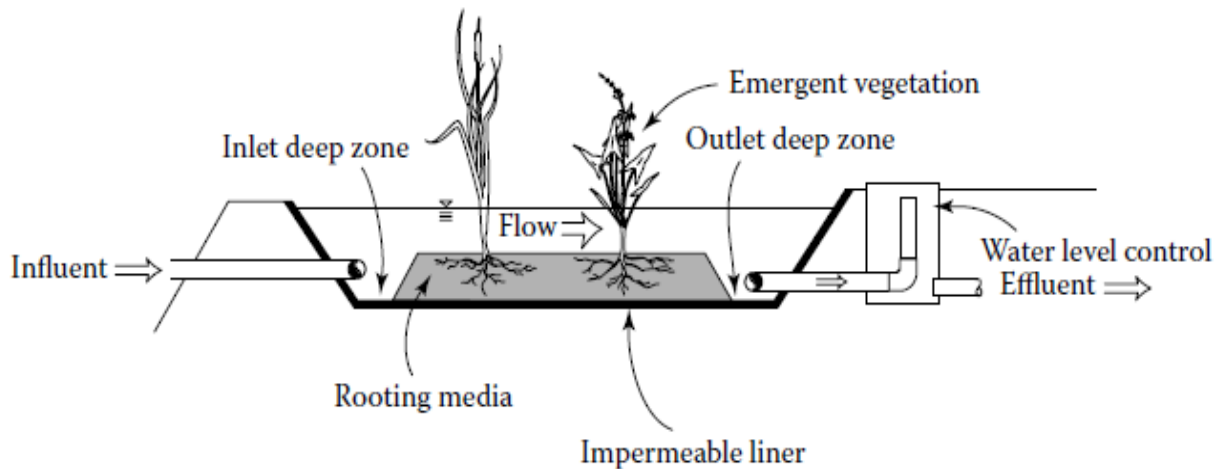
Constructed wetlands (CWs) are natural treatment technologies for household and/or municipal or industrial wastewater.

A CW is a shallow basin filled with some sort of filter material (substrate), usually sand or gravel, and planted with vegetation.



Constructed wetlands

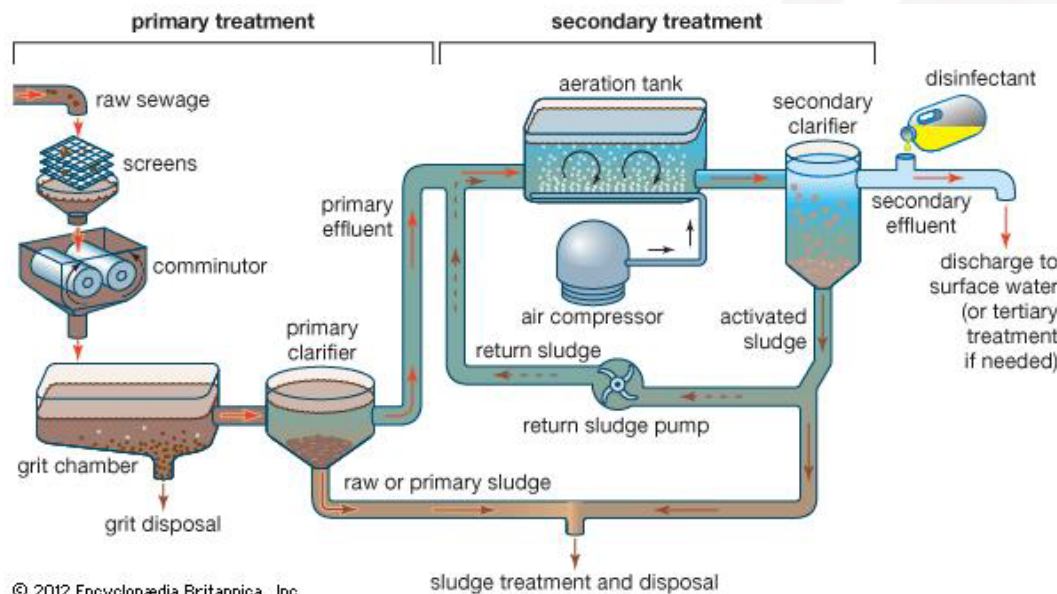
Wastewater is introduced into the basin and flows over the surface or through the substrate.



The mechanisms that occur in CW systems for wastewater treatment are complex and include *chemical*, *physical* and *biological* processes (sedimentation, filtration, oxidation, reduction, adsorption, precipitation, pathogen removal)

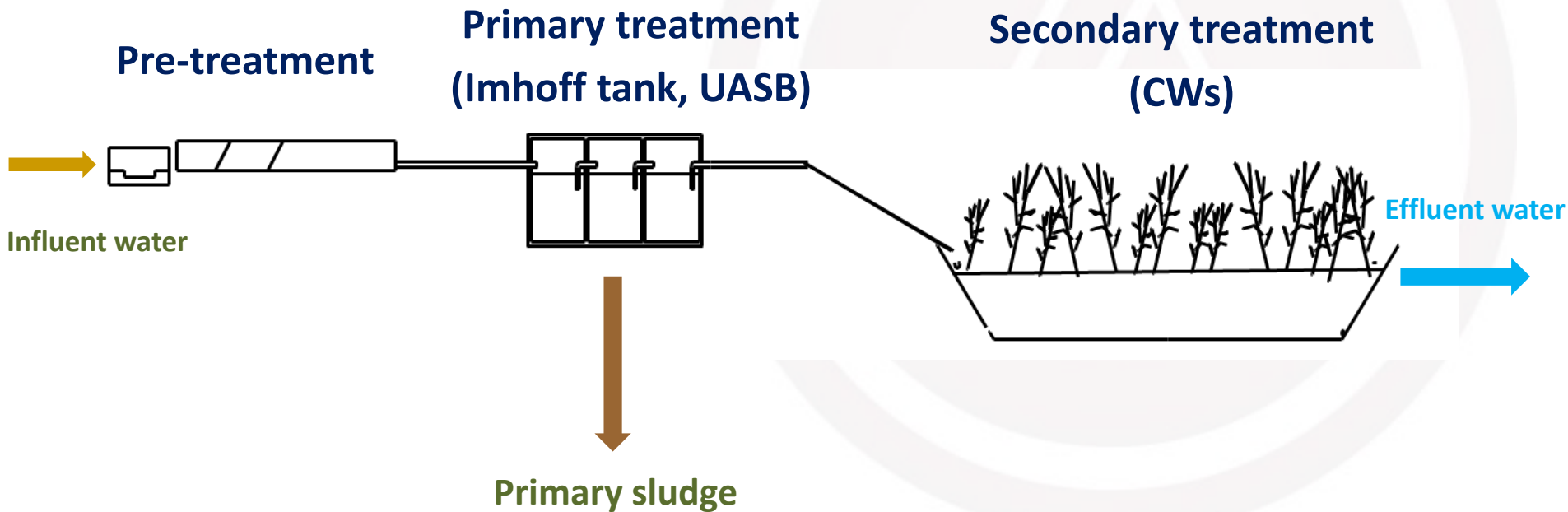
Conventional technologies

Conventional wastewater treatment plant (e.g. activated sludge system) are characterized by high energy and chemicals consumption.



Constructed wetlands

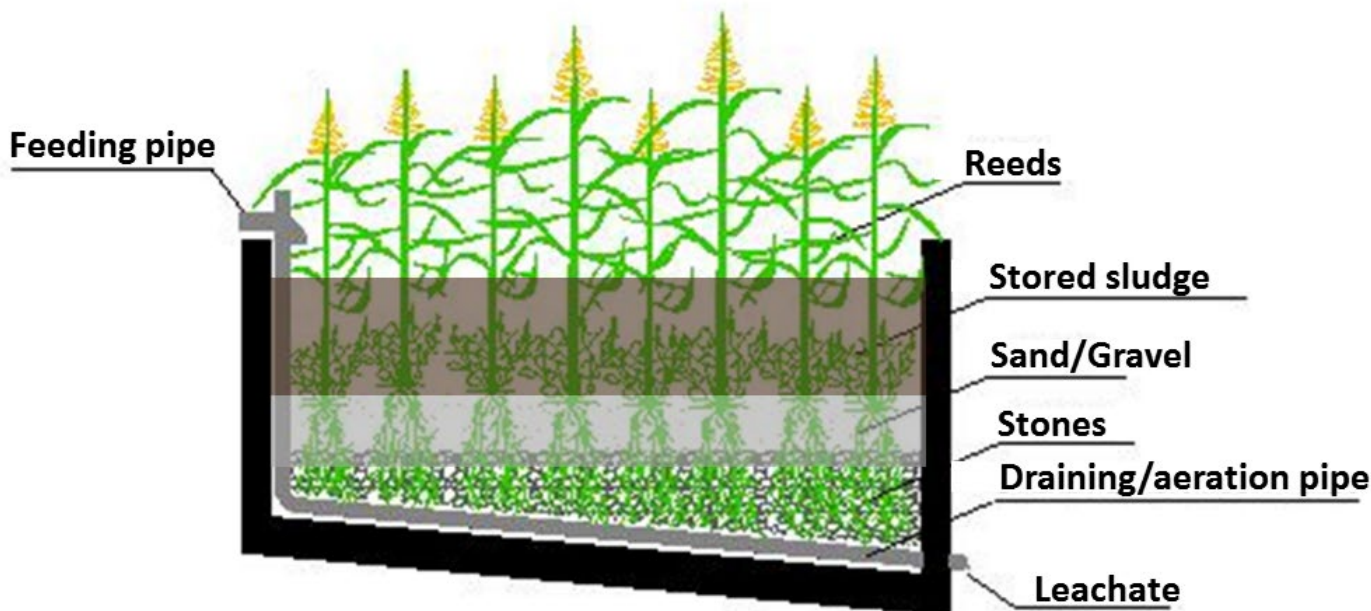
- Pre-treatment and primary treatment



Constructed wetlands

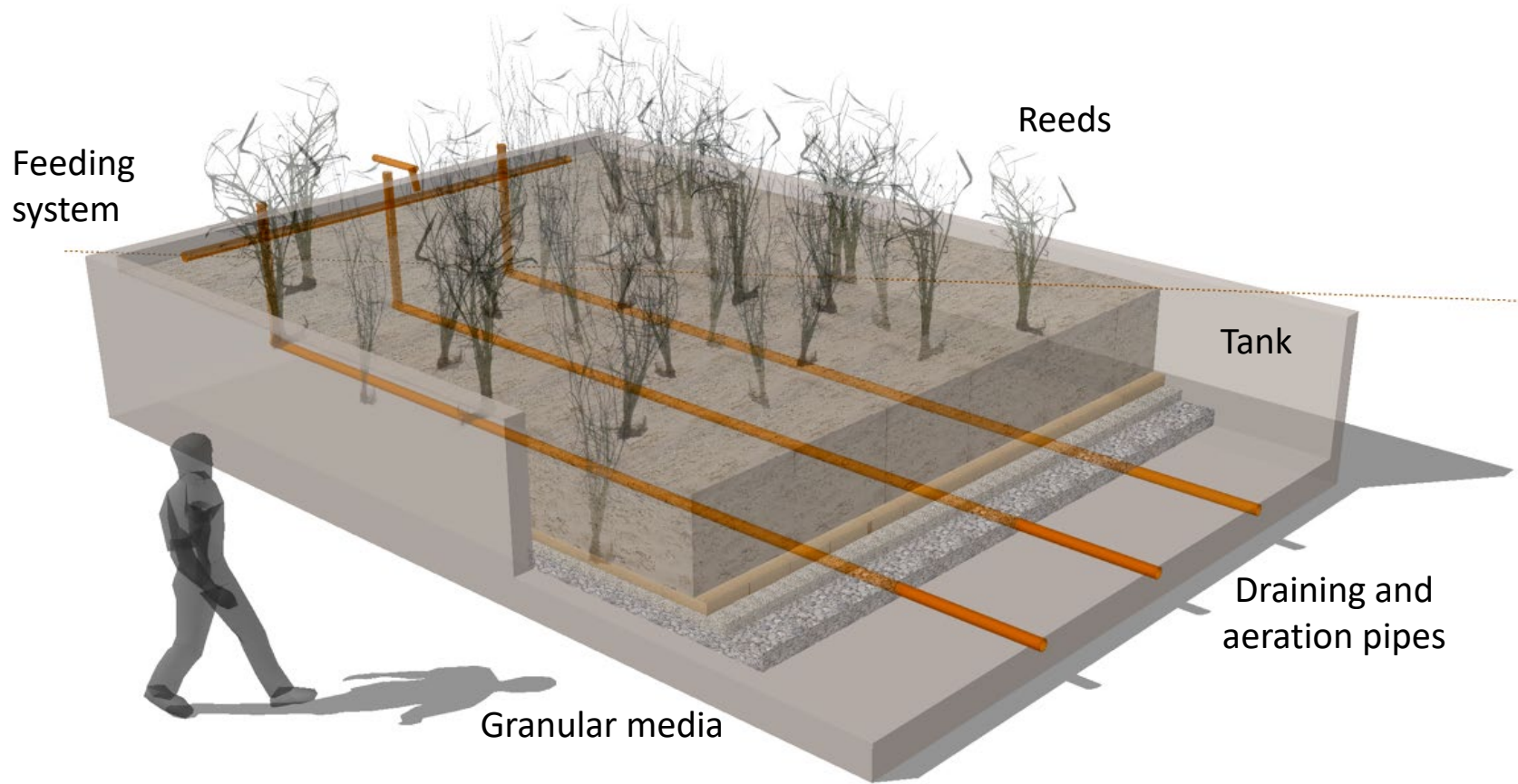
- Sludge treatment wetlands

They are low cost technologies for primary and secondary sludge treatment. They are made up of shallow ponds, beds or trenches filled with a gravel layer and planted with emergent rooted wetland vegetation such as *Phragmites australis* (common reed).

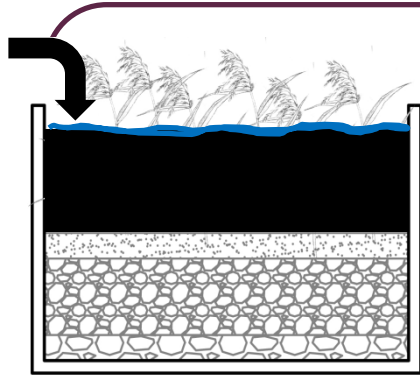




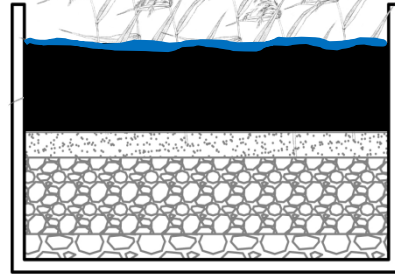
Constructed wetlands



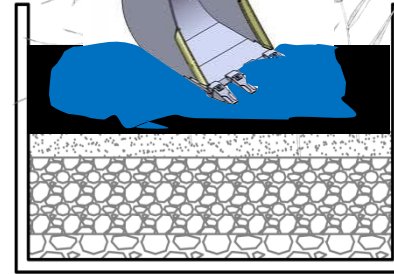
Constructed wetlands



Feeding period
5-10 years



Final resting
period
3-24 months



Biosolids
removal



Composting plant



Reuse in agriculture





Winery wastewater treatment

Constructed Wetlands are a suitable solution for winery wastewater and sludge treatment.



Winery wastewater treatment

- Large volumes of wastewater are originated from various processes and operations carried out during wine production ($3-6 L_{\text{water}}/L_{\text{wine}}$).
- Highly variable flows and loadings: More than half of the annual wastewater flow and load is produced during the vintage season.
- Spain is one of the world's largest wine-producing countries.
- Lack of a proper wastewater treatment system.
- Direct wastewater discharge into the environment.





Winery wastewater treatment

In this context, Constructed Wetlands are a suitable solution for winery wastewater treatment.



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The WETWINE project



Winery wastewater treatment

Goal: To provide innovative and sustainable solutions for winery wastewater treatment.

HOW?

1. Implementing and demonstrating an innovative CW system for winery wastewater and sludge treatment.
2. Evaluating environmental and economic benefits.
3. Disseminating the results among the winery industries in the SUDOE area

8 partners:



Total Budget: 1.254.642,00 €

July 2016 – June 2019 (3 years)



Work packages

- WP1- Design, construction and start up of the CW system
- WP2- Operation and optimization (system monitoring)
- WP3- Evaluation of sludge potential as fertilizer/soil conditioner
- WP4- Environmental impact assessment (LCA)
- WP5- Development of a (user-friendly) computational tool for system design



WETWINE system implementation

Winery located in Pontevedra (Galicia, Spain).

Vineyard: 33.5 ha

Wine production (white wine): 368,000 L/year

Water consumption for wine production: $3.3 L_{\text{water}}/L_{\text{wine}}$

Vintage season (september – october): 60 days

Flow: $620 m^3$ /vintage season

Rest of the year: 305 days

Flow: $778 m^3$ /rest of the year

Total annual flow: $1,398 m^3$ /year



Current wastewater treatment: Imhoff tank + transport + third-party wastewater management and disposal

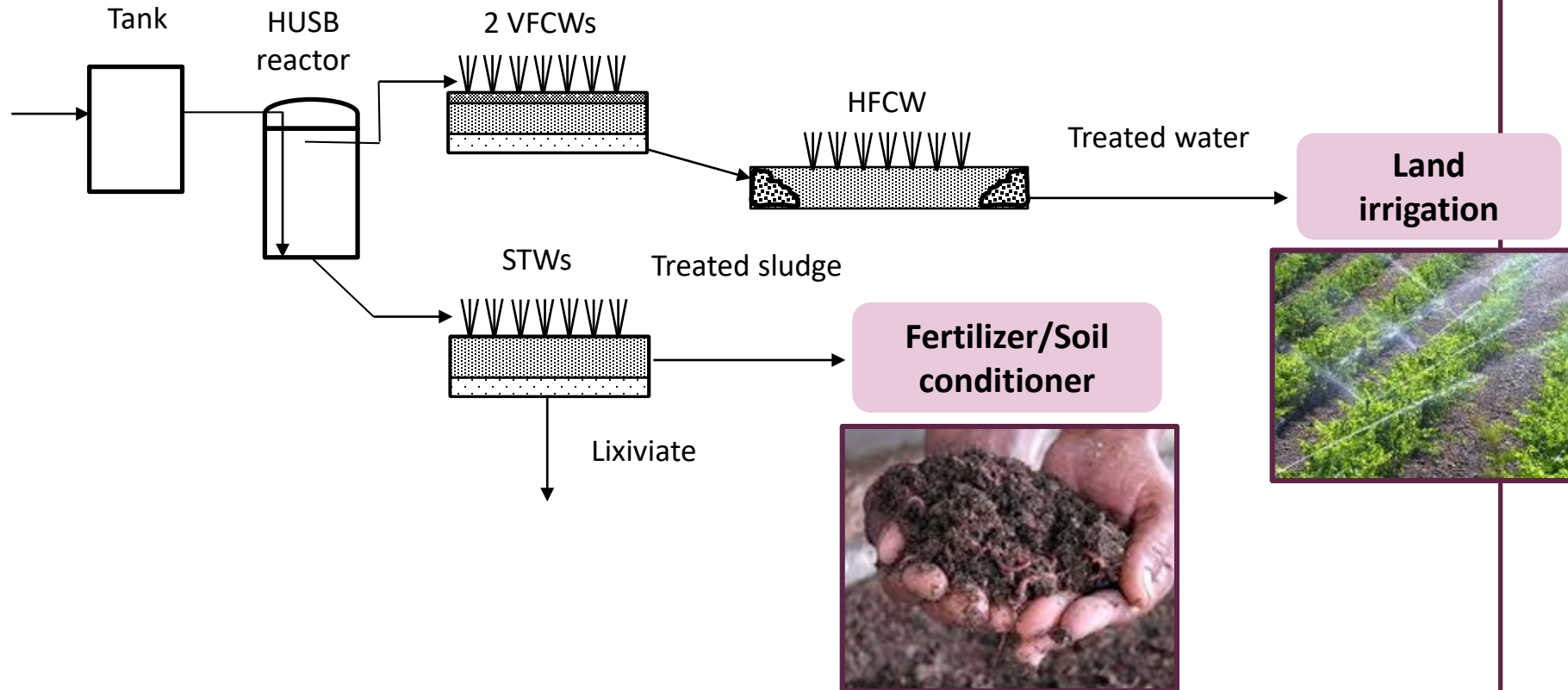




Average Wastewater characteristics

Parameter		Wastewater characteristics (Vintage season)*
pH		4
TSS	(mg/L)	2,190
COD	(mgO ₂ /L)	11,957
BOD ₅	(mgO ₂ /L)	4,110
TN	(mgN/L)	170

*During the rest of the year the wastewater generated in the winery is similar to urban wastewater



The pilot WETWINE system consists of an anaerobic hydrolytic upflow blanket reactor (1.25 m³ useful volume), 2 VFCW (30 m²), 1 HFCW (30 m²), and a one-stage STW (20 m²)



System construction



Constructed wetlands I



Constructed wetlands II



The WETWINE CW system



System construction



HUSB reactor



Vertical flow constructed wetland

System construction



System implementation finalized: June 2017
Start up: June/July 2017
System Monitoring: September 2017

Sludge treatment wetland, planted



The WETWINE CW system



System construction



The WETWINE CW system

System construction



Winery wastewater treatment

Current technologies/strategies for winery wastewater treatment

vs.

WETWINE system



Environmental impact assessment

- Questionnaires to different wineries of the SUDOE area



UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Group of Environmental Engineering
and Microbiology



WETWINE

Plantilla de datos para el desarrollo del Análisis del Ciclo de Vida a rellenar por la Bodega

Los resultados de esta plantilla tienen un propósito científico-informativo de obtención de datos para un estudio exclusivo del proyecto WETWINE. Tanto el formulario como los resultados obtenidos a posteriori del análisis de impacto ambiental de la gestión de las aguas residuales en la bodega serán anónimos. Si lo desea podrá obtener los resultados del análisis de impacto ambiental únicamente de su bodega comparada con el resto de bodegas de forma anónima.

Instrucciones previas: Rellenar la plantilla con los datos referidos al último año considerando la época de vendimia y fuera de vendimia.**

** Se entiende por época de vendimia el período que va desde la entrada de la uva hasta el final de la fermentación.

Los campos marcados con un asterisco (*) son campos imprescindibles.

Cualquier duda puede comunicarla a través de un correo electrónico a: marlanna.garfi@upc.edu; laura.flores.rosell@gmail.com.



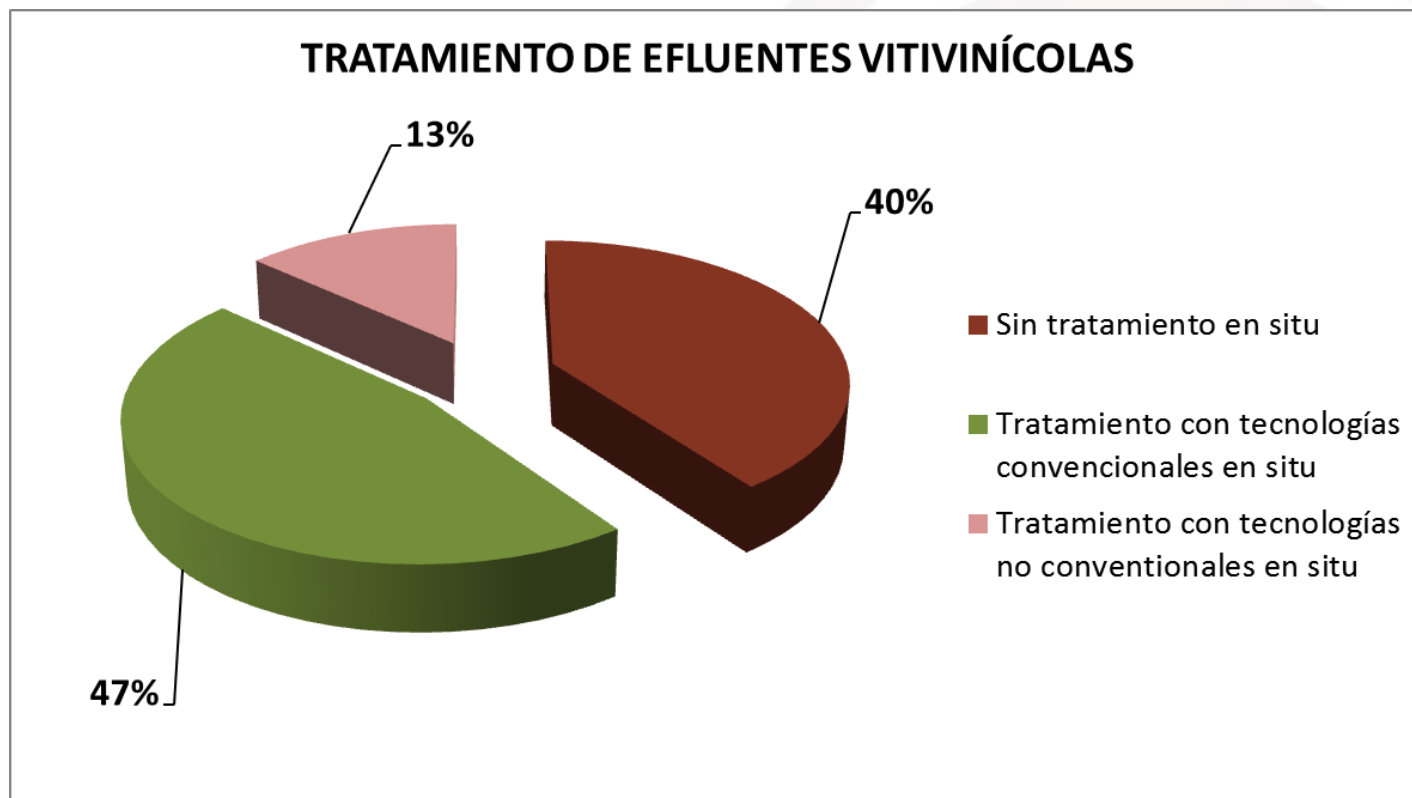
Datos de contacto	
Código:	(a rellenar por UPC)
Nombre de la bodega*:	
Localización (ciudad, comunidad y país)*:	
Persona de contacto*:	
Teléfono*:	
Email*:	

Datos sobre el viñedo (propio)	
Superficie de viñedo:	ha
Tipo de uva en viñedo:	<input type="checkbox"/> Blanca <input type="checkbox"/> Tinta <input type="checkbox"/> Otra. (Especificar)
Fertilizante utilizado en el viñedo:	<input type="checkbox"/> Orgánico <input type="checkbox"/> Inorgánico (mineral) <input type="checkbox"/> Simple <input type="checkbox"/> Compuesto
Composición N-P-K: (Especificar índice N-P-K)	
Cantidad anual:	<input type="checkbox"/> kg/año <input type="checkbox"/> l/año
Cantidad por ha:	kg/ha
Otra información. (Especificar)	

Datos sobre el proceso de elaboración del vino	
Descripción breve del proceso de producción del vino*:	

Environmental impact assessment

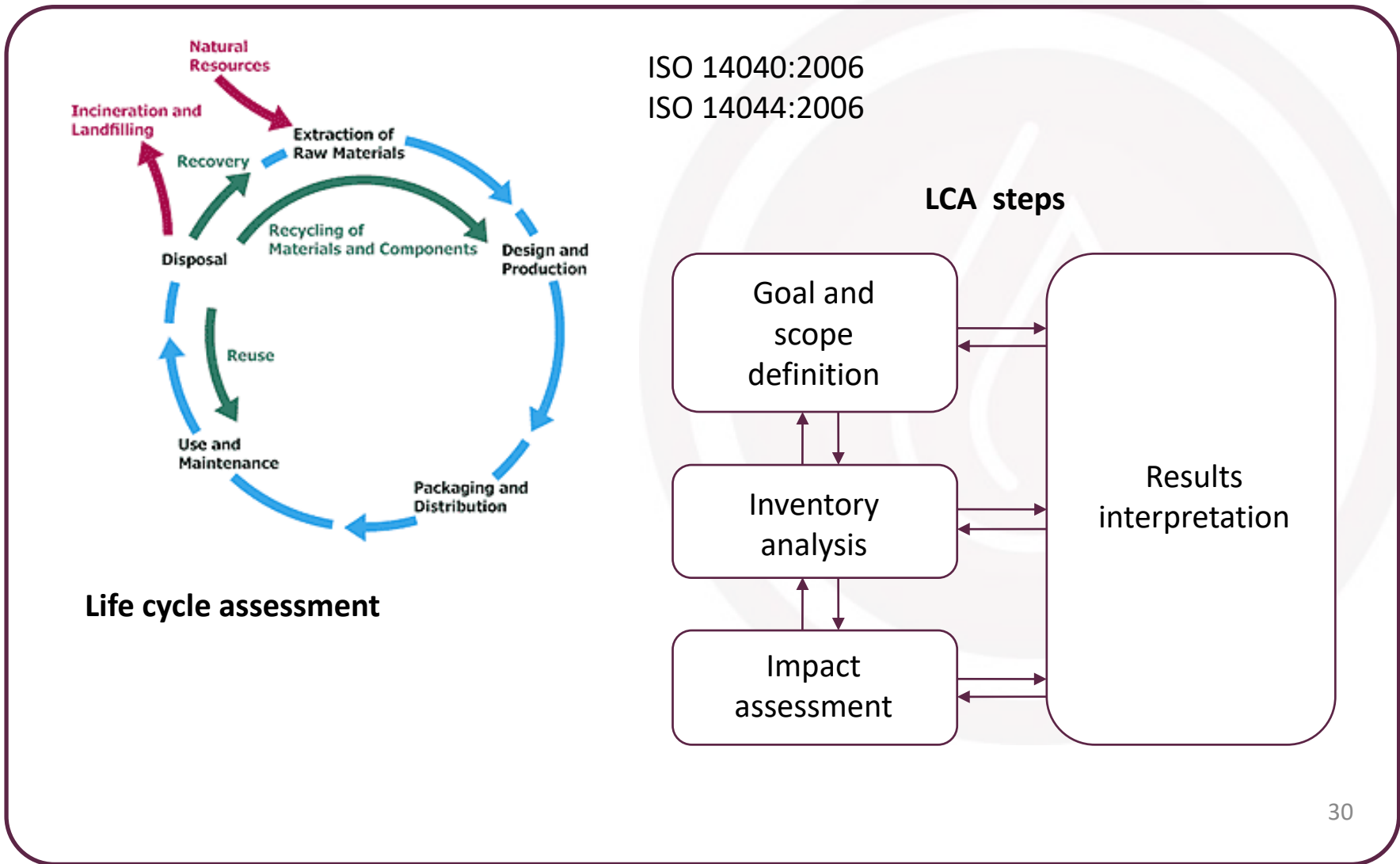
16 Wineries from Spain, Portugal and France (10,000 – 8,000,000 L of wine/year)



>85% third-party sludge management and disposal

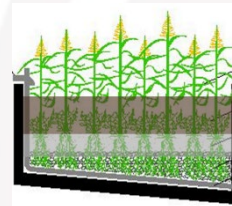


Methodology



WETWINE system implementation

Scenario 1 : Third-party wastewater management (before the implementation of the WETWINE system)



Scenario 2 : WETWINE system

Winery located in Galicia, Spain

Wine production (white wine): 368,000 L/year

Water consumption per wine production: $3.5 L_{\text{water}}/L_{\text{wine}}$

Vintage season (september – october): 26 days

Flow: 620 m³/vintage season

Rest of the year: 305 days

Flow: 778 m³/rest of the year

Total annual flow: 1,398 m³/year



Scenarios

Scenario 3 : Activated sludge system (AS) implemented in a winery located in Galicia

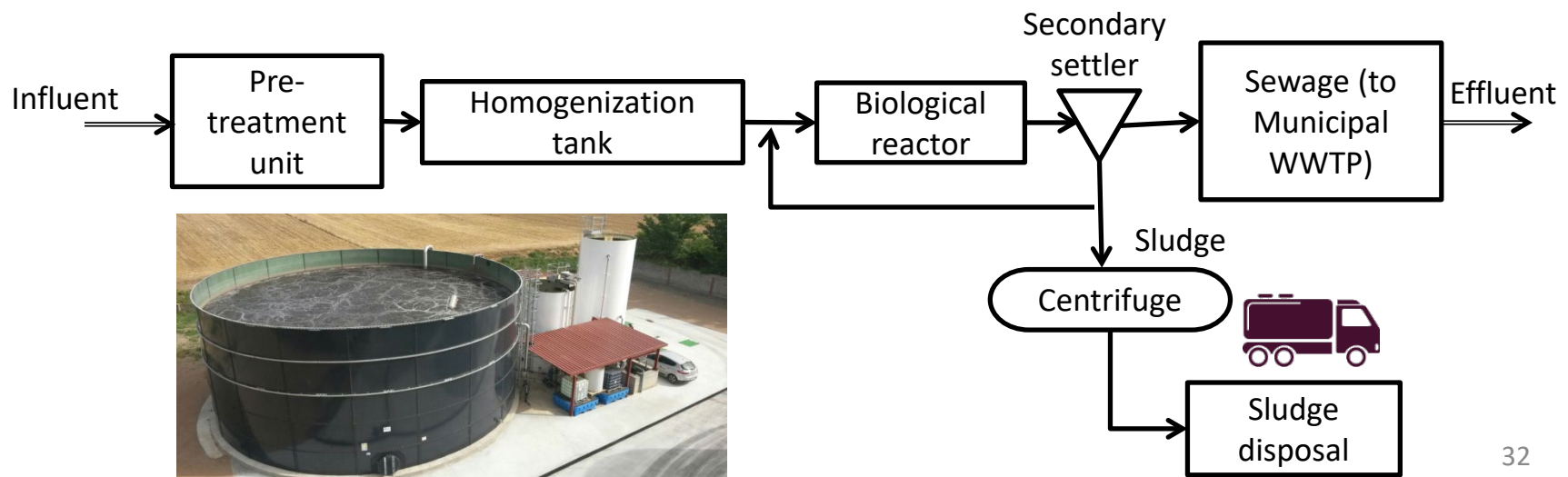
Wine production: 3,850,000 L/year

Water consumption per wine production: $1.25 L_{\text{water}}/L_{\text{wine}}$

Vintage season: 15 days; Flow: 2,416 m³/vintage season

Rest of the year: 350 days; Flow: 2,417 m³/rest of the year

Total annual flow: 4,833 m³/year



Goal & Scope

Goal: To compare the environmental impacts of CWs and activated sludge systems for winery wastewater treatment



Functional Unit: 1 m³ of water

System boundaries:

Third-party wastewater management	WETWINE system	AS system
Materials and energy for systems construction and operation (e.g. construction materials, electricity, chemicals)		
Third-party wastewater management (including transport and treatment)	Sludge application as soil conditioner (including emissions to soil and air and avoided fertilizer)	Sludge management (including transport and incineration)
Emissions to water	Direct GHG emissions	Direct GHG emissions
	Emissions to water	Additional treatment in a municipal WWTP
		Emissions to water

Life Cycle Impact Assessment

Software, Database and Method:

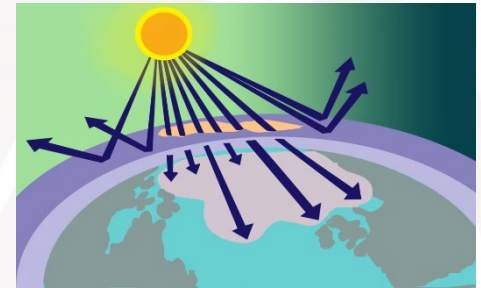
SimaPro 8.2.3;

Ecoinvent v3.2 database;

ReCiPe Midpoint (H)

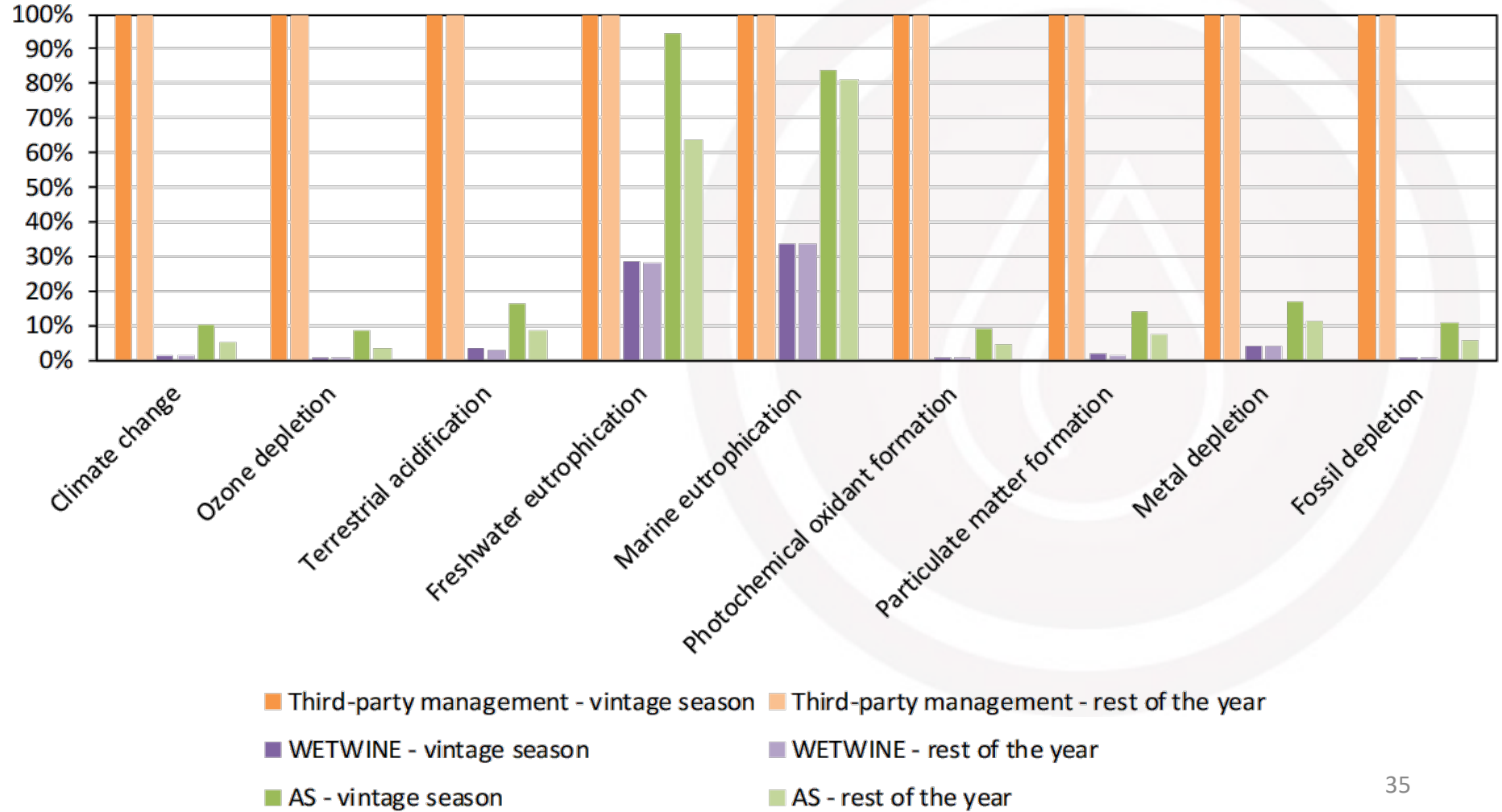
Impact categories:

- Climate change (kg CO₂ eq)
- Ozone depletion (kg CFC-11 eq)
- Terrestrial acidification (kg SO₂ eq)
- Freshwater eutrophication (kg P eq)
- Marine eutrophication (kg N eq)
- Photochemical oxidant formation (kg NMVOC)
- Particulate matter formation (kg PM₁₀ eq)
- Metal depletion (kg Fe eq)
- Fossil depletion (kg oil eq)



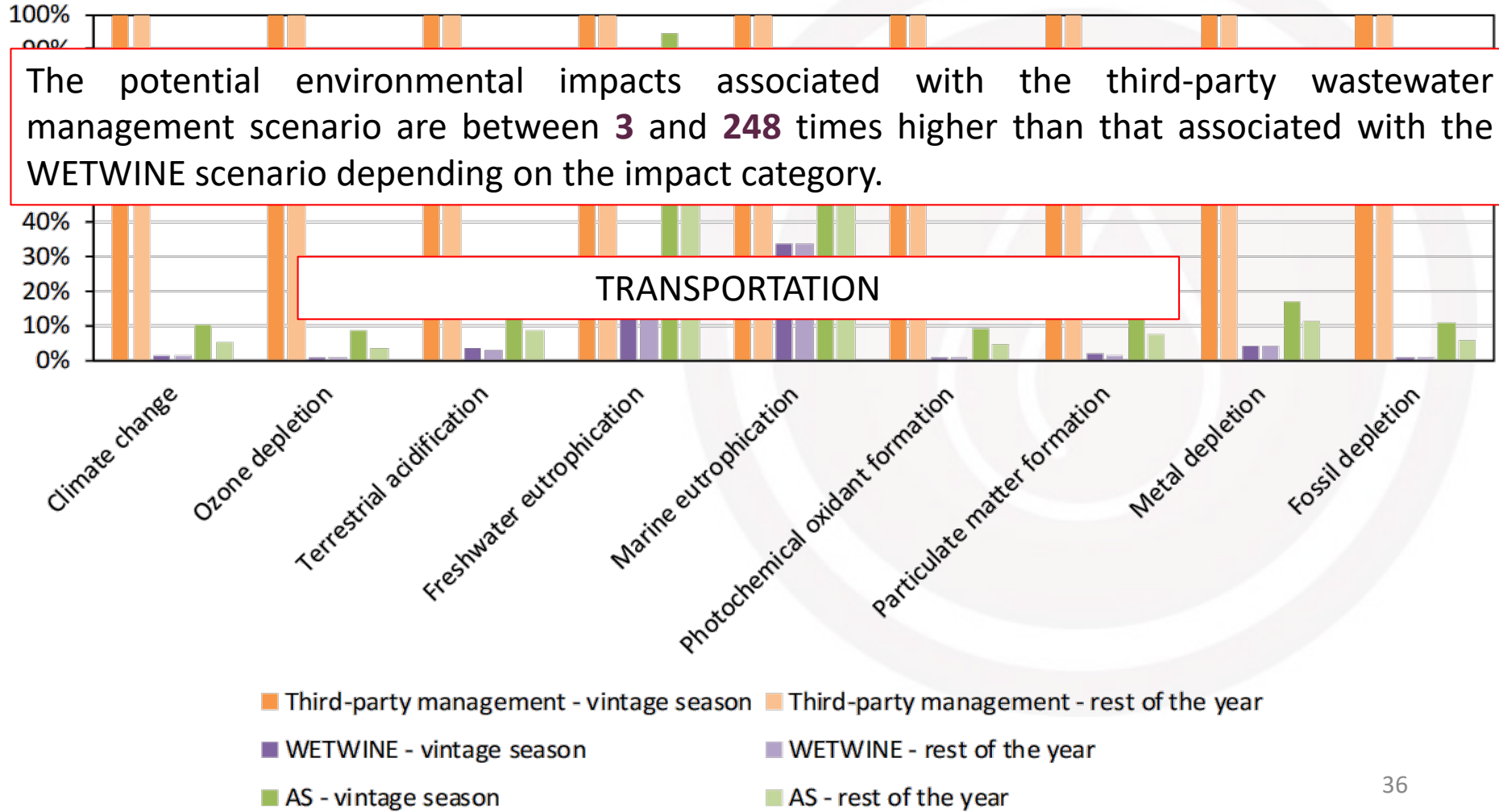
Results

Environmental impact assessment results



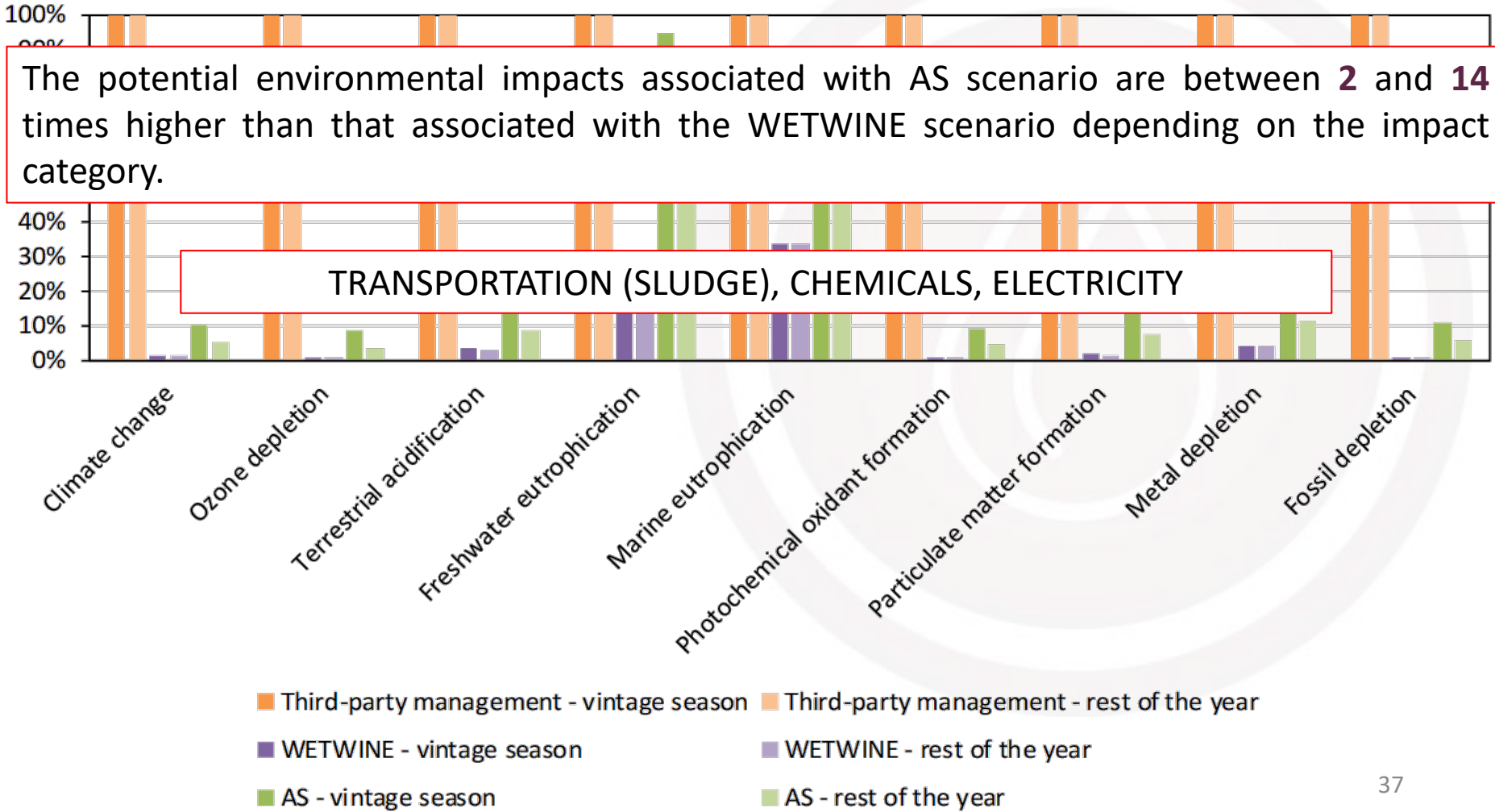
Results

Environmental impact assessment results



Results

Environmental impact assessment results



Results

CO₂ saving and Global warming potential

WETWINE scenario

vs.

Previous scenario

(transport + third-party wastewater management and disposal)

around 40,000 kg CO₂_{equ} are saved per year

**Global warming is reduced up
50 times**



Results

Costs savings

Table 5

Capital and operation and maintenance costs of the considered scenarios expressed in terms of euros per cubic meter of treated water.

	Unit	Scenarios		
		W1	W2	W3
Capital cost	€ m ⁻³	0.20	2.30	2.58
Operation and maintenance cost	€ m ⁻³	1.76	0.04	2.49

Scenarios: W1: third-party management; W2: constructed wetland system; W3: activated sludge system.



CW would reduce the capital, operation and maintenance costs associated with winery wastewater treatment up **60 times**



Results

Social benefits

No need for specialized workers as the operation and maintenance of the systems are simpler than in conventional systems. The construction of these systems may provide **job opportunities to local people**

CWs improve the **landscape** quality around the wineries transforming it into a rich ecosystem with an esthetic appearance, **zero noise and odour** production and a huge added value as a **recreative area** for **visitors** or **educational purposes**

Further studies!!!





Results





Wastewater characteristics

This system reaches the **TSS and COD** value required by the Regulation on minimum requirements for water reuse for agricultural irrigation.

However, in our study **E.coli removal has not been studied** and issues that must be considered in further studies.

CWs can treat the heavy and variable load of wine industry while producing water of suitable for agricultural irrigation, since it meets the requirements of RD 1620/2007 on the **minimum requirements for water reuse in irrigation of forests, green areas and other areas not accessible to the public.**





Results

- Constructed Wetlands and Sludge Treatment Wetlands are *appropriate technologies* for wastewater and sludge treatment in *wineries*.
- They help to improve *sustainability* associated with wastewater and sludge treatment in *wineries*.



European Regional Development Fund





WETWINE

<https://wetwinesoftware.eu/>

Software WETWINE

El software WETWINE permite de forma rápida y sencilla **simular la configuración óptima** de un sistema de tratamiento de efluentes vinícolas basado en tecnologías naturales de humedales construidos.

Para ello es necesaria la introducción de una serie de parámetros que permitirán un **cálculo aproximado para el caso particular de cada bodega**, obteniendo como resultado la siguiente información:



Un pre-dimensionamiento de las instalaciones



Una aproximación de costes de inversión y de mantenimiento



Un análisis del impacto medioambiental en comparación con otros sistemas de gestión de efluentes.



Información de la normativa de aplicación en base a la localización de la bodega.

EMPEZAR

References

<https://wetwinesoftware.eu/>

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Thank you for your attention!



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