Jornada

Indústria tèxtil i sostenibilitat

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Institut d'Investigació Tèxtil
i Cooperació Industrial de Terrassa

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ECUVal: Degradació de colorants reactius dels efluents de tintura i acabat tèxtil

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  - *Reuse*
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- **Market Replication**
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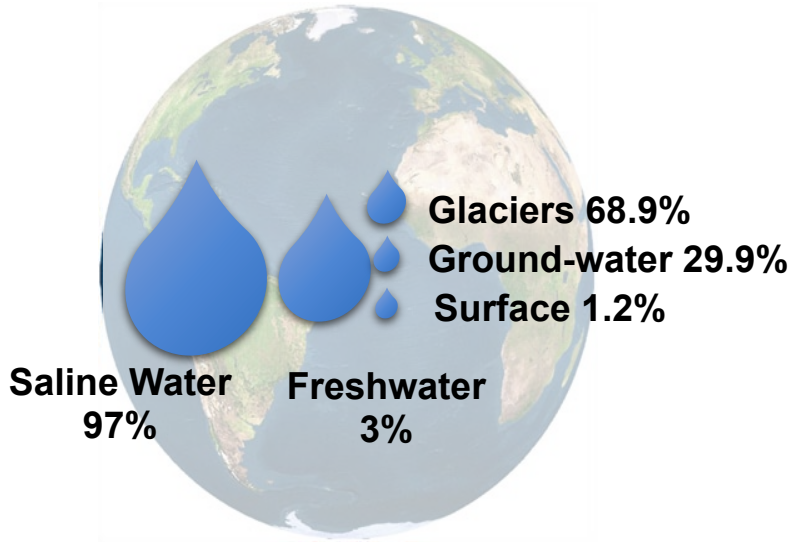
- **Additional Information**

THE PROBLEM

Water scarcity



2030:
47% of the world's population will live in areas with water stress

- **Appropriate management of water**
- **Reduction of water consumption**
- **Water reuse**

THE PROBLEM

WHY TEXTILE INDUSTRY ?

- High water consumption
  (up to 100 L/kg textile product)
- Complexity and variability of wastewater

- **Deeply coloured wastewater**

Discharge of textile effluent in the biological plant

Dyes: non biodegradable

Tertiary treatments are required to remove colour.

Salts are not removed.

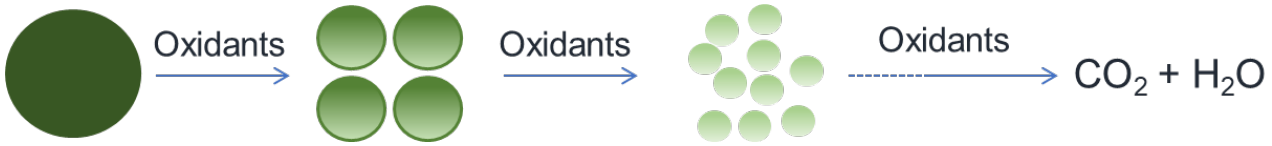
THE PROJECT

ECUVal: **electrochemical process** + **ultraviolet irradiation**.

ECUVal focused on the treatment of **saline effluents containing poorly biodegradable compounds**, such as dyes.

No chemicals are added and **no wastes** are produced.

Pollutants removed by **oxidants electro-generated** in situ from the salts contained in the effluent:



Subsequent irradiation with UV light:

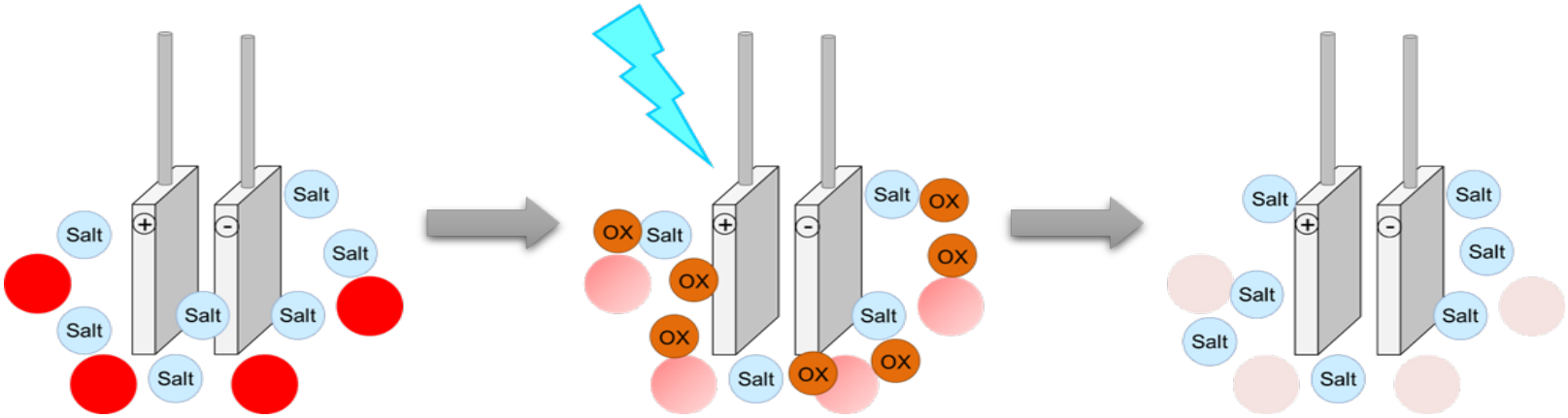
- increases the efficiency of the treatment
- removes all residual oxidants.

THE PROJECT

Textile effluents

high conductivity due to the salts added during the dyeing process.

ECUVal: UV-assisted electrochemical process that **uses these residual salts as an electrolyte to generate oxidants** in the cells, thus destroying the dye molecules.

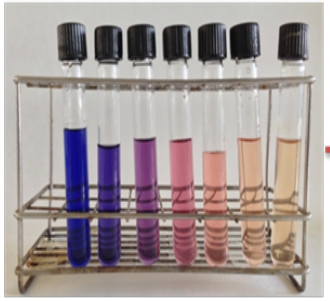


APPLICATIONS

Coloured Effluent

Containing salts

ECUVal Treatment



No chemicals added
No wastes generated

Uncoloured water containing a high amount of salts

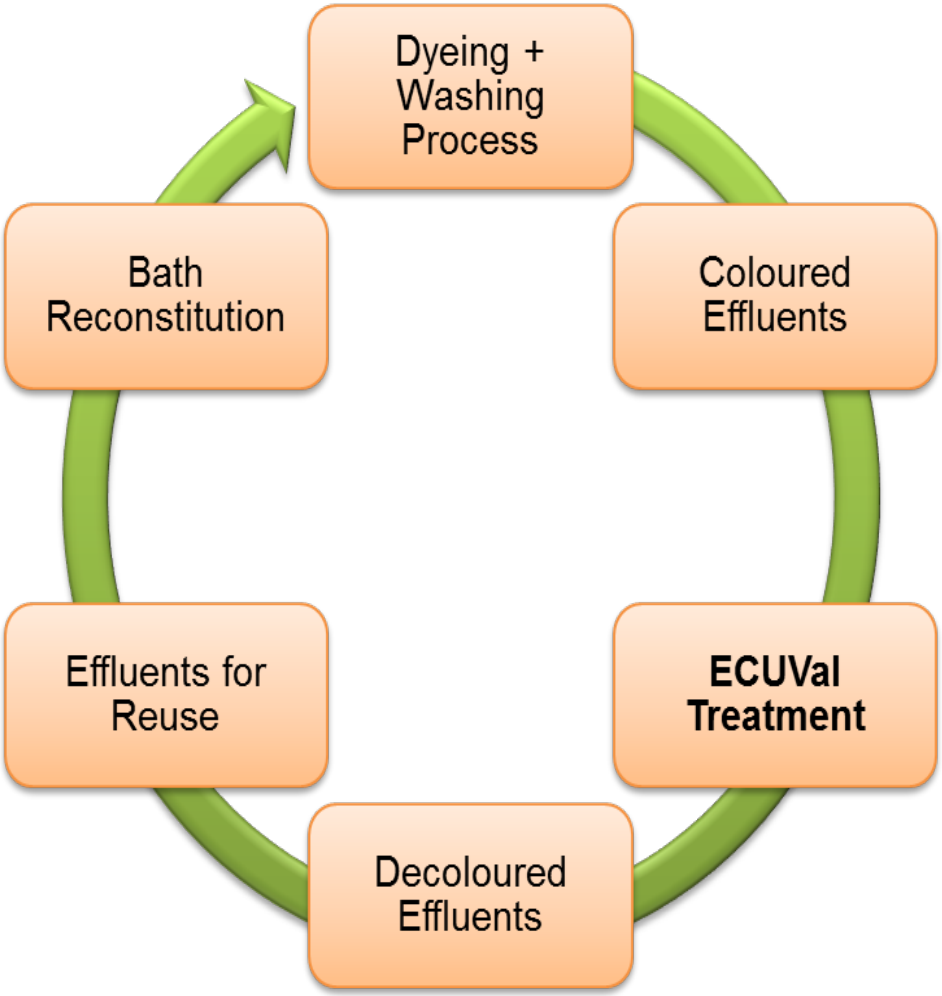
BIOLOGICAL TREATMENT for total degradation and wastewater **discharge**

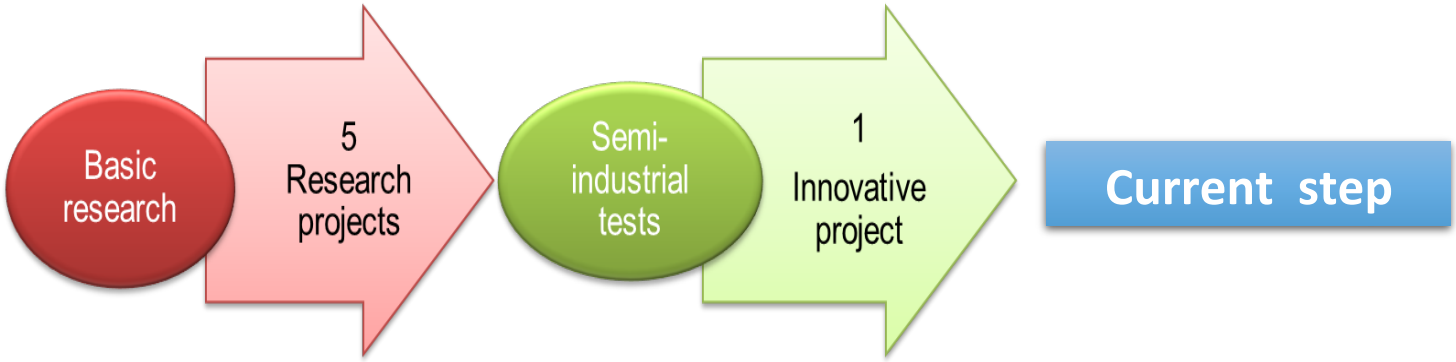
EFFLUENT AND SALT REUSE for new dyeing process

THE PROJECT

New system to treat textile wastewater and to reuse of treated effluents and salts.

- Saving water
- Saving salt
- Reduction of effluent salinity and wastewater discharge rates





ECUVal Project background

Lab. Pilot
2 L

Semi-Industrial Pilot
400 L

Industrial prototype
4m^3/h

THE PROJECT

PROJECT INFORMATION

CE- EASME:
First application and commercial replication

Execution:
36 months
(Jan 2015-Jan 2018)

UPC - INTEXTER:
Project Coordinator
Know-how, design and development, laboratory and in situ studies, LCA study,…

FITEX:
Business Plan,
Dissemination activities,…

ICOMATEX:
Manufacture and installation
Exploitation of technology

GRAUSA:
End-user
Validation

OBJECTIVES

Main objective

Introduce into the market an innovative eco-friendly technology for the treatment of industrial wastewater that provides an effluent able to be reused.

Specific objectives:

- Recycling 70-100% process water
- Recycling up to 100 % salt in the industrial processes.
- Removal of poorly biodegradable compounds.
- In the case of dyes, up to 100 % colour removal.
- Wastewater purification without the addition of chemical reagents.
- Green technology that does not produce wastes.
- Flexible system, operating at smooth conditions.
- High durability, minimal maintenance.
- Sustainable industrial processes: reduction of carbon footprint and environmental impact.
- Industrial viability to introduce the system into the market

THE ECUVal SYSTEM

1. **Decolouration function**
   4m3/h

Especially suitable for effluents of reactive dyeing

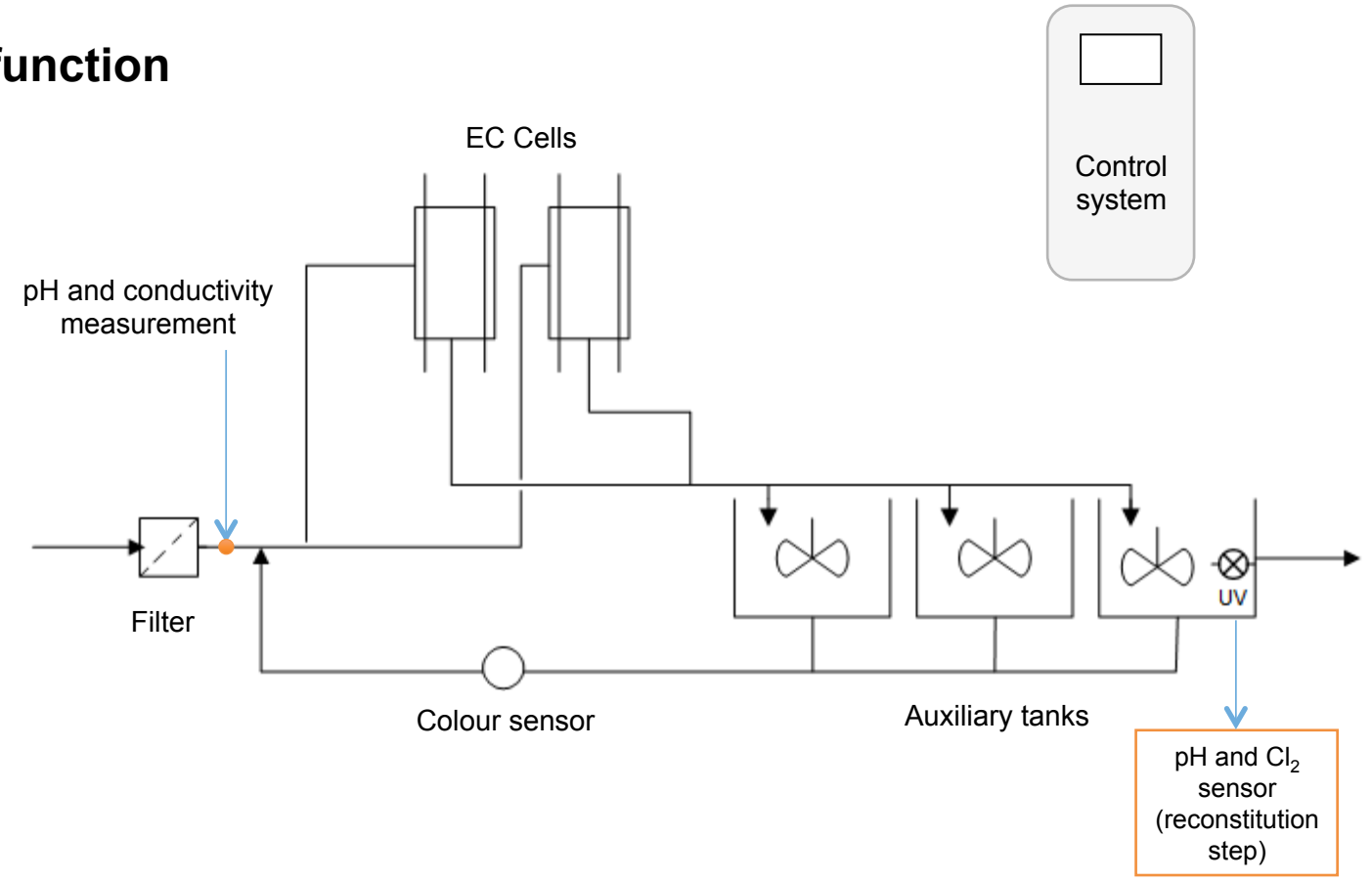
2. Reuse function
Reconstitution steps:

- Removal of carbonates and bicarbonates with an acid and stripping.
- Neutralization with alkali.
- Removal of residual oxidants with UV and reducing agent.

Licencied to Icomatex for exploitation

1. Decolouration function

2. Reuse function



WHY REACTIVE DYEING EFFLUENTS?

The most used dyes in the dyeing of cellulosic fibre.

Advantages

- Dyes react chemically with fibres

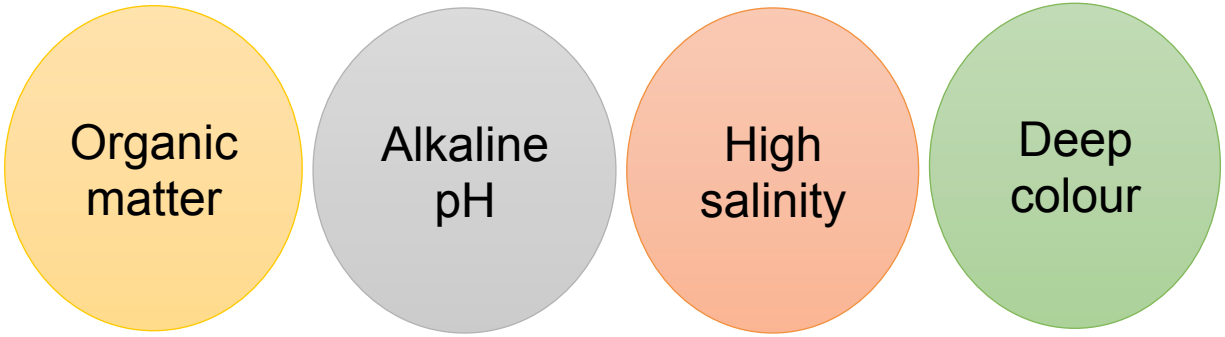
  dye-X + Cel-O$^-$ → dye-O-Cel + X$^-$
- Water soluble
- High wash and light fastness
- Wide range of shades

Disadvantages

- Dyes also react with water → hydrolysis

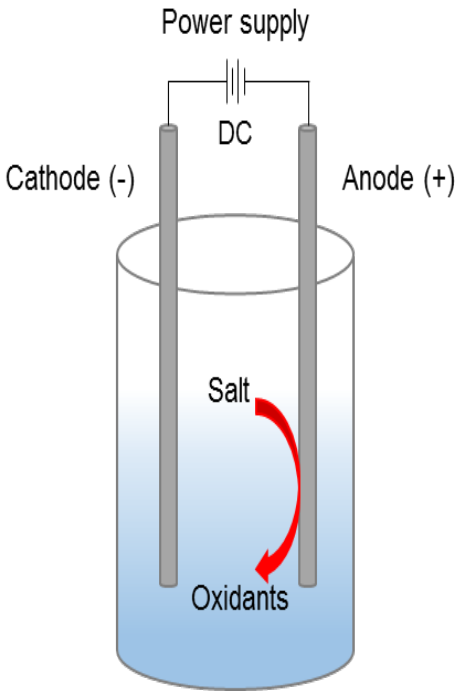
  dye-X + H_2O → dye-OH + HX
- Low exhaustion level
- Alkaline conditions and high amount of salt are required to fix dyes on the fibre

Main characteristics of reactive dyeing effluents



DECOLOURATION MODE:

Electrochemical reactions:



(Anodic Oxidation) $2Cl^- \rightarrow Cl_{2\,(aq)} + 2e^-$

(Cathodic Reduction) $2H_2O + 2e^- \rightarrow 2OH^- + H_2$

Subsequent reactions:

(Hydrolysis) $Cl_{2\,(aq)} + 2OH^- \rightarrow H_2O + ClO^- + Cl^-$

(Oxidation of dye) **Dye** + $ClO^-/ Cl_{2\,(aq)} \rightarrow$
dye fragments + $Cl^- \rightarrow CO_2 + H_2O + Cl^-$

(decoloration) (mineralization)

REUSE MODE
Reactions:

1. Removal of carbonates and bicarbonates with acid:

$$Na_2CO_3 + 2HCl \rightarrow 2\ NaCl + CO_2 + H_2O$$

HCl is added until pH 5 to ensure the complete removal

2. Neutralization of acid in excess by adding alkali:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

3. Removal of residual oxidants with:
- UV irradiation and
- a reducing agent (only if required)

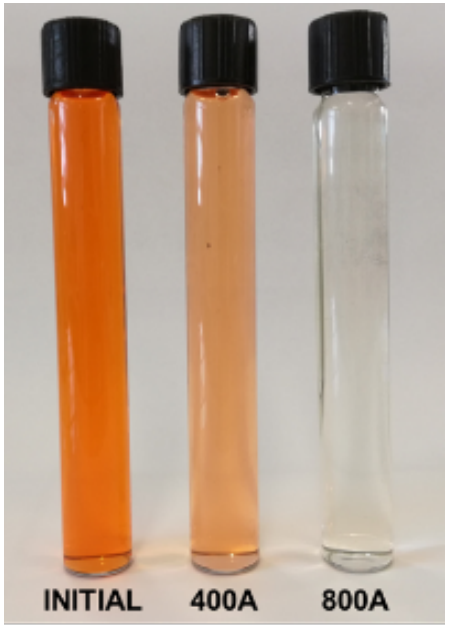
Colour removal: up to 100%

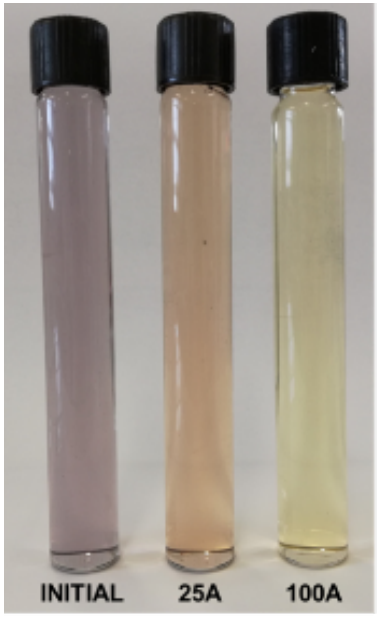
No chemicals added
No wastes generated

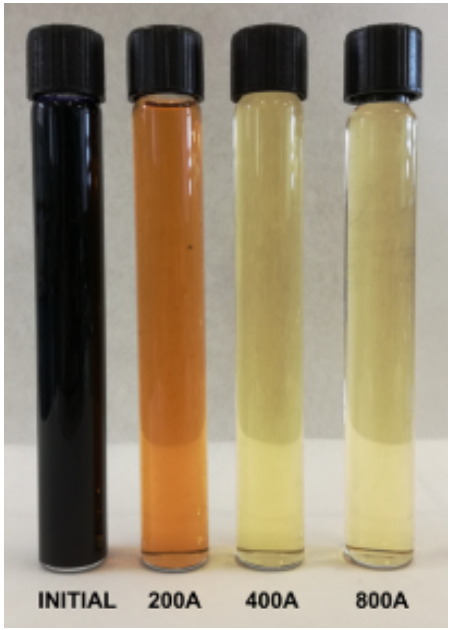
Exhausted reactive dyebaths (Jet)

RESULTS

Colour removal:







depends on:

- the **current intensity** and
- the **effluent conductivity**

The higher the intensity and the conductivity, the higher the amount of generated oxidants and the more efficient the decolouration.

Electric consumption

INTENSITY (A)	CONSUMPTION (kWh/m³)
25	0.5
100	2.1
200	4.2
400	8.5

** Cost kWh = 0.092€*

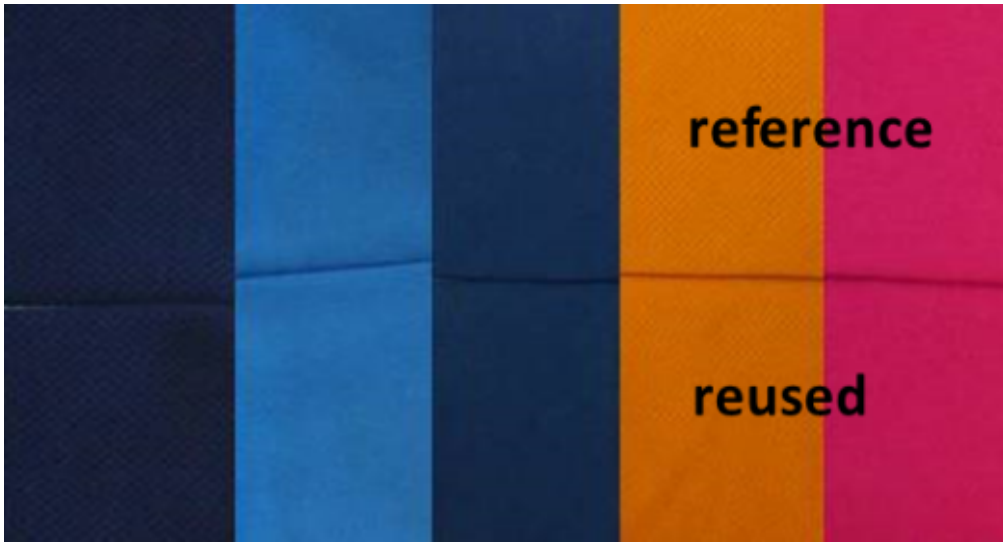
Decolouration:

- **The electricity is the only cost**
- **No reagents are required**
- **No wastes are generated**
- **The wastewater treatment is more efficient**

RESULTS

Reuse :

The clarified effluents
still contain high levels of salts.



Savings:
- 70-100 % dyeing water
- up to 100% salt

ECUVal
- solves the problem of effluent colouration
- and enables the reuse of water and salts in new dyeing processes
- with a low energy consumption.

BENEFITS

ENVIRONMENTAL: life cycle assessment

LCA 1: environmental impact in the dyeing process (unit: kg textile)

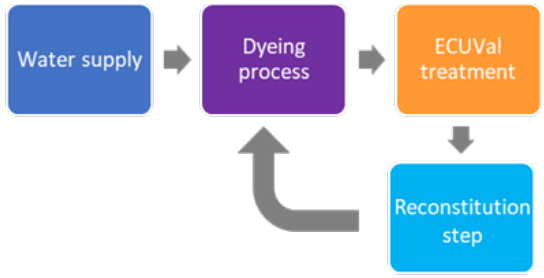
Three scenarios:

Current process

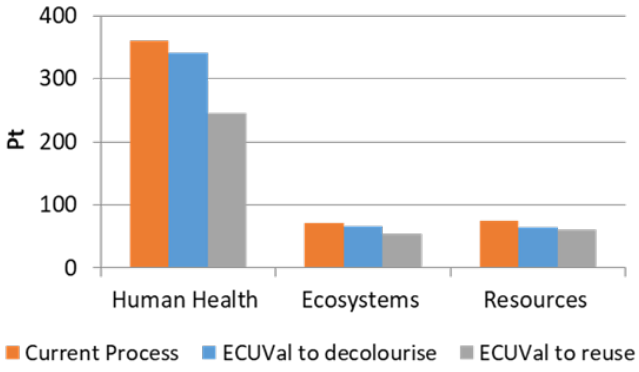
ECUVal to decolourise

The environmental impact decreases in 5%

ECUVal to reuse



The environmental impact is reduced in 30%

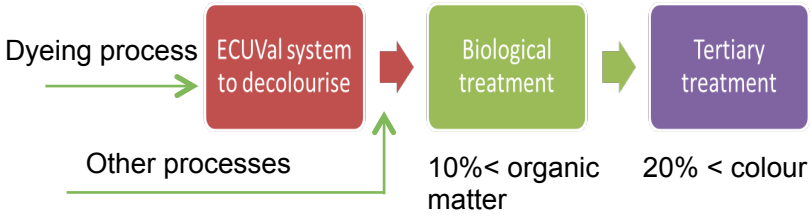


BENEFITS

Life cycle assessment 2: Environmental impact in the wastewater (unit: m3 wastewater)

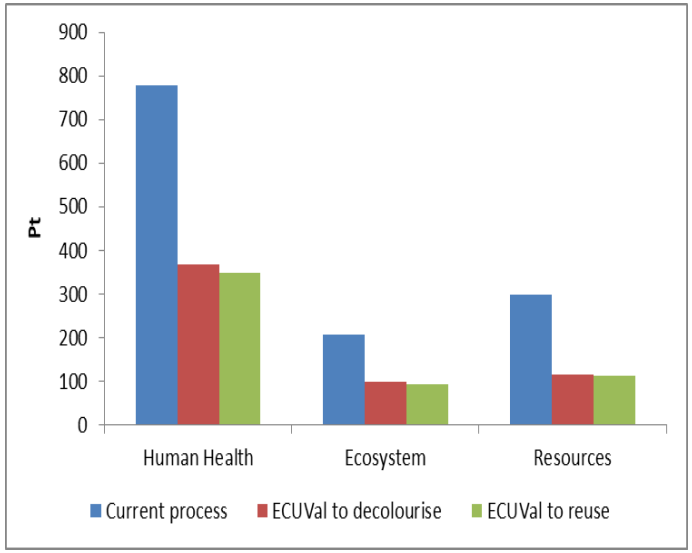
Current WW treatment

ECUVal to decolourise



ECUVal to reuse

20% < colour



Reduction of the environmental impact: **55%**

Reduction in CO_2 generation: **56%**

BENEFITS

Saving up to 100% salt

Saving 70-100% water

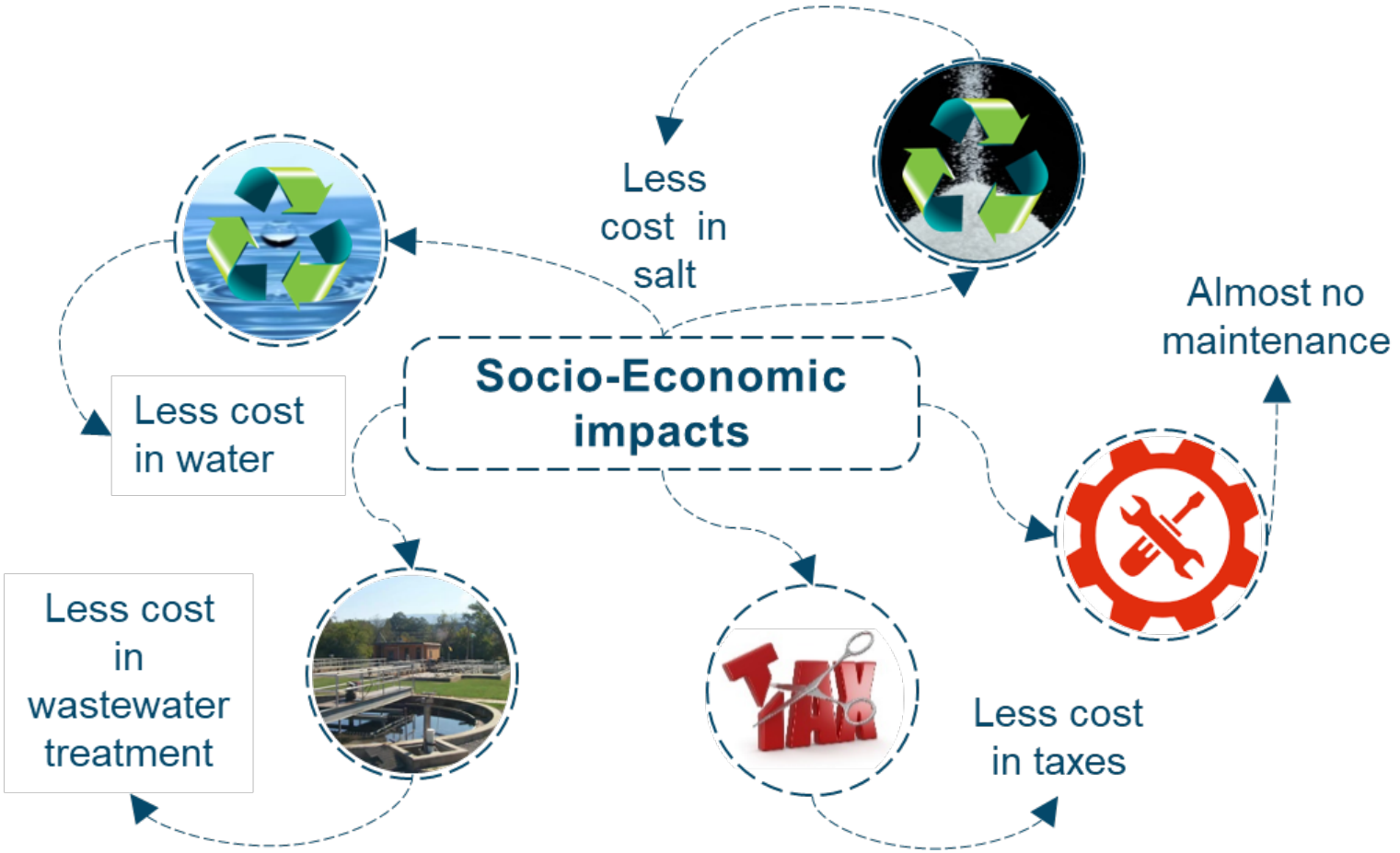
21% reduction of carbon footprint

Environmental impacts

Less chemicals in the wastewater treatment

wastewater with lower salinity and lower colour

BENEFITS


Less cost in salt
Almost no maintenance
Socio-Economic impacts
Less cost in water
Less cost in wastewater treatment
Less cost in taxes

BENEFITS

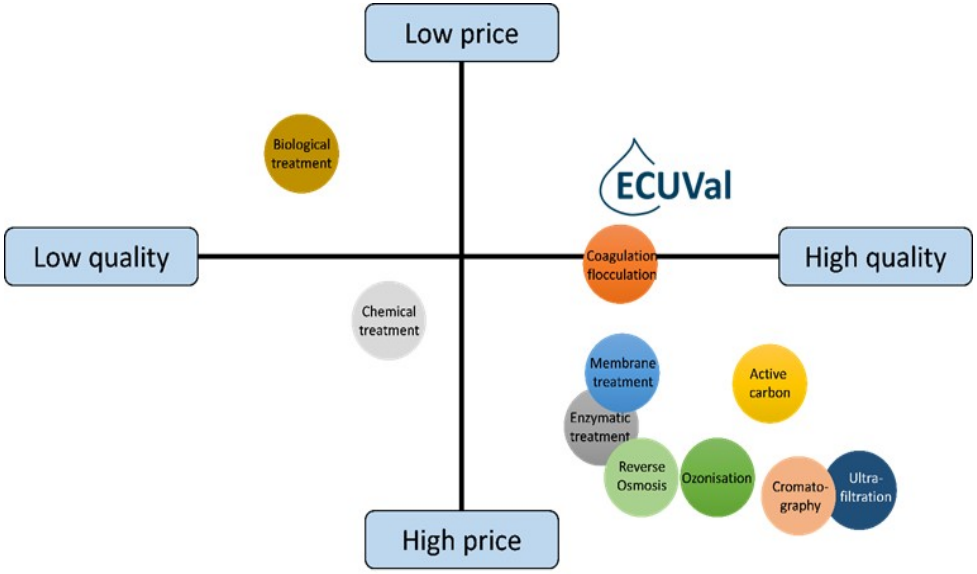
Economic benefits of ECUVal:

- No chemicals added
- No wastes are generated.
- Only cost: electric power supply.
- Only a part of wastewater is treated,
- Significant reduction of reagents and sludge disposal costs.
- Discharge taxes are lowered due to the reduction of wastewater salinity.
- No maintenance. Electrodes stable over 5-10 years.
- Less cost in water and salt.

ECUVal investment will be depreciated in 4-5 years.

BENEFITS

Market segmentation
of ECUVal
with respect
to other technologies



Method	Colour removal	Rate	Cost	Other specifications
Active carbon	Very good	Low	High	Regeneration
Membranes	Good	High	High	Maintenance and cleaning
Ozonization	Good	Medium	Very high	By-products
Coagulation– flocculation	Good	Medium–High	Medium	Sludge generation
ECUVal	Good	High	Medium	Clean and recycle option

MARKET: POTENTIAL USERS

INDUSTRIAL SECTORS:

- Generation of non degradable compounds
- Receptors of green technologies (reuse of water…)

Validated

Textile Sector

Other potencial users

Chemical Sector

Paper Sector

Pharma Sector

Leather Sector

MARKET REPLICATION

NEW PROJECT

A flexible smaller pilot

Validated

Textile Sector

SPECIFIC OBJECTIVES:

- Demonstrations in fairs
- Companies could use the technology in situ and verify its efficiency
- Evaluate other applications of the technology such as direct dyes removal

FINAL OBJECTIVE:
to achieve the introduction of the technology into the market

MARKET REPLICATION

Paper Sector

Chemical Sector

Leather Sector

NEW PROJECT: ELDE

ELECTRO-DEPURACIÓ D'AIGÜES RESIDUALS INDUSTRIALS: VIABILITAT TÈCNICA, AMBIENTAL I ECONÒMICA

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IREC Institut de Recerca en Energia de Catalunya Catalonia Institute for Energy Research

lavola cosostenibilitat

PERE VALLS

ctm CENTRE TECNOLÒGIC

WATER OLOGIES

cim aigua

RIS3CAT – COMUNITAT AIGÜES (ACCIÓ)

CONCLUSIONS

ECUVal is particularly efficient in the treatment and reuse of reactive dyeing and washing effluents.

Environmental and economic benefits

- No chemicals are required to remove colour.
- No residues are generated.
- Saving water.
- Saving salt.
- Lower salinity of wastewater.
- Lower cost of the wastewater discharge.
- Low maintenance

CONCLUSIONS

ECUVal is addressed mainly to companies that generate effluents with high salinity and low biodegradability.

This new technology will reduce the environmental impact associated to the removal the poorly biodegradable compounds from wastewater.

ECUVal will also contribute to reduce the salinity of effluents (very important in low flow rivers)

Currently, there is no other wastewater treatment available for this purpose, economically feasible.

Additional information on ECUVal project:

- Website (English, Spanish and Catalan): www.ecuval.eu
- Papers in water and textile journals

- Fairs

- Conferences and congresses
- Demonstrations and workshops

- Video on ECUVal project

THANK YOU !!

www.ecuval.eu