"European awareness raising campaign for an environmentally sustainable olive mill waste management"
(LIFE07 INF/IT/438)

OMW Management *Towards* Sustainability

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OMW Management – The ISSUE

- **Seasonality** of the productive process → Concentration in 3-4 months
- High organic matter concentration → High polutant **Organic Load**
- High content in **Phenols**, lipids and organic acids→ Highly resistant to biodegradation
- **Acidic pH** → Disassembly of minerals releasing heavy metals (in soils with pH lower than 6.5)
- Highly **Phytotoxic** → Affects cultures and soil microbiology

In Europe, are produced about 4.6 million tonnes of OMW *per* year and much of this is essentially water (80- 83%) (Camarsa *et al*, 2010).

OMW is related to significant environmental impacts (Gurbuz *et al*, 2004)

OMWW discharge

The Environmental Impact

Into the Soil

The discharge of olive waste into the soil may cause, in plants, leaf and fruit abscission and inhibition of seed germination

Into the Water

The discharge of olive waste into water bodies may worryingly increase the phosphorous content, cause color alteration and bad smell

Into the Air

The discharge of olive waste in open spaces may stimulate microbial fermentation, with the production of methane and a wide array of harmful or simply bad smelling gases.

Gathering Sustainability

- **PREVENTION** is a powerful weapon in waste management
- It must be *complemented with the most appropriate processes* by means of technologies with lower requirements of materials and energy consumption.

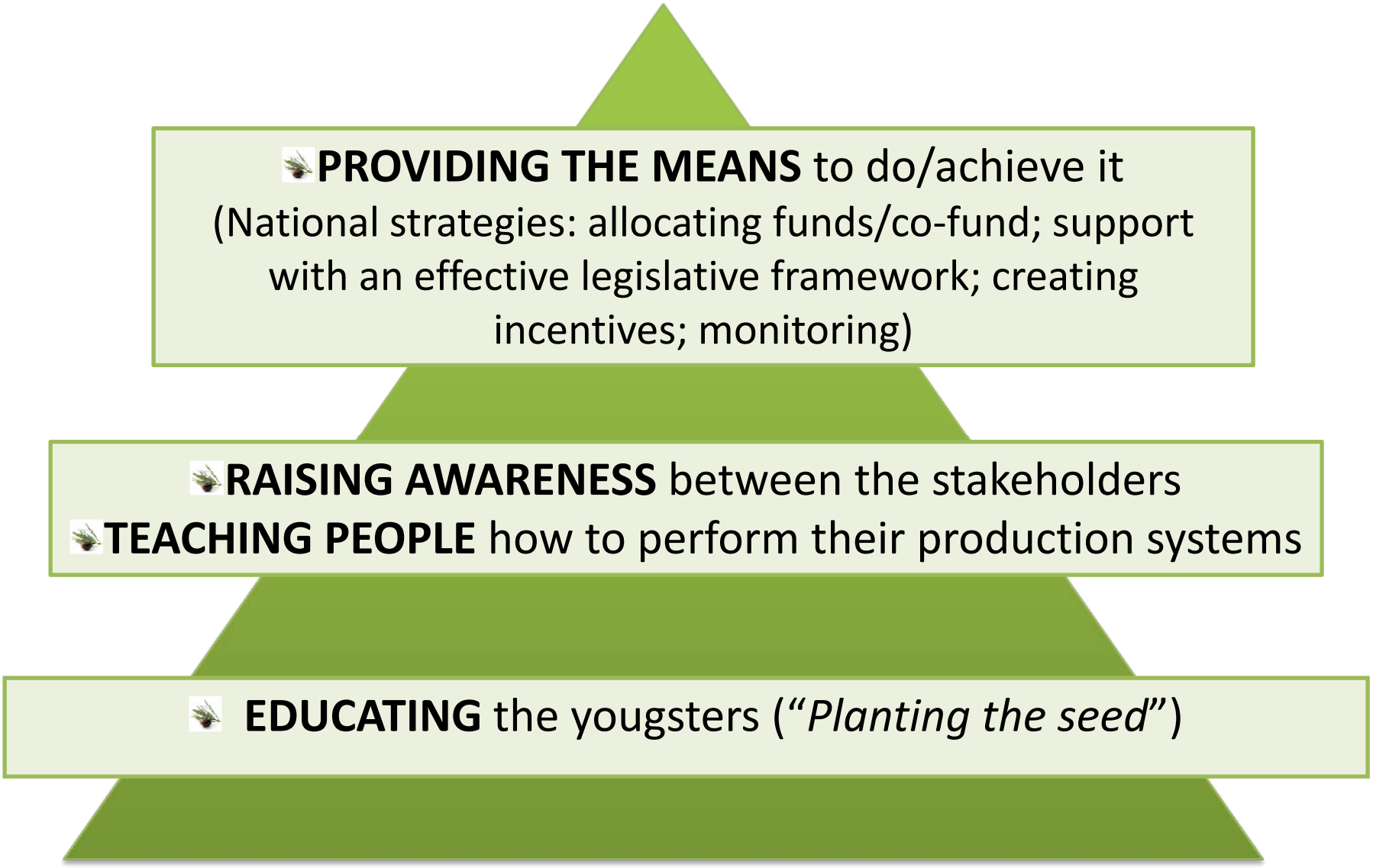
How?

Using **Cleaner Production Systems** as well as **Zero Waste Management solutions.**

- Cleaner production approaches are based on the principle of waste minimization (Gurbuz *et al*, 2004; Sikos *et al*, 2009).
- It is necessary to establish proceedings that ensure a sustainable consumption and production to avoid the repercussions of environmental impacts that may be globally irreversible (Nash *et al*, 2009).

Indissociated concepts/aproaches: *Prevention* and *Minimization*

Prevention


PROVIDING THE MEANS to do/achieve it
(National strategies: allocating funds/co-fund; support with an effective legislative framework; creating incentives; monitoring)
RAISING AWARENESS between the stakeholders
TEACHING PEOPLE how to perform their production systems
EDUCATING the yougsters ("*Planting the seed*")

Cleaner Production Systems

Using the Best Available Technologies (BAT)

- Profitable
- Environmentally Sustainable

-Reduce resources use (Water, Energy, etc…)
-Incorporation of recycled materials
-Reduce Waste production
-Ecodesign (easy dismantling, recyclable products, etc…)

Zero Waste Management solutions

- Applying a “cradle to cradle” approach
- Closing the materials cycle by
  - Reintroducing by-products generated into the process of production
  - Using by-products as raw material in other product processes
  - Treat/Valorize/Remediate wastes

Integration of Inputs (raw materials, water, energy, manpower...) **and Outputs** (product, wastes, by-products, energy, water, economical profits,...) **into a unique Management process**.

Olive Oil cycle

Water
Nutrients
Soil
Weeds
Energy
Manpower
Equipments

Olive Production

Water
Others
Olives
Energy
Manpower
Equipments

Processing

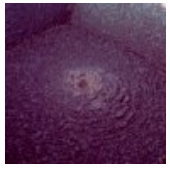
Olive Oil

Pruning

Leaves

OMWW

2POMW



3POMW

Pulp

Pits

Water
Energy
Manpower
Equipments

Treatment

Technology of OMW Treatment/Recovery/Valorization

By-products
(With economical value)

Ecofriendly Technologies for OMW

Biological Technologies:

- **Aerobic biological treatment** – University of Ioannina - Greece
- **Anaerobic Co-digestion in WWTP** – INETI-DER - Portugal
- **Phytoremediation** – ISRIM SC arc – Italy
- **Composting** – Agraria OLEARUM SL and CotoBajo – Spain;
  EPDRS – Portugal, ISAFoM-CNR – Italy

Physico-Chemical Technologies:

- **Biocombus** – UTAD - Portugal
- **EHO** ® - Evaporation-Hydrolysis-Oxidation – Envitec SA - Greece
- **Electro-coagulation** – Cyclus ID – Spain
- **Ultrafiltration** - Industria Olearia Biagio Mataluni S.r.l.

Aerobic Biological Treatment

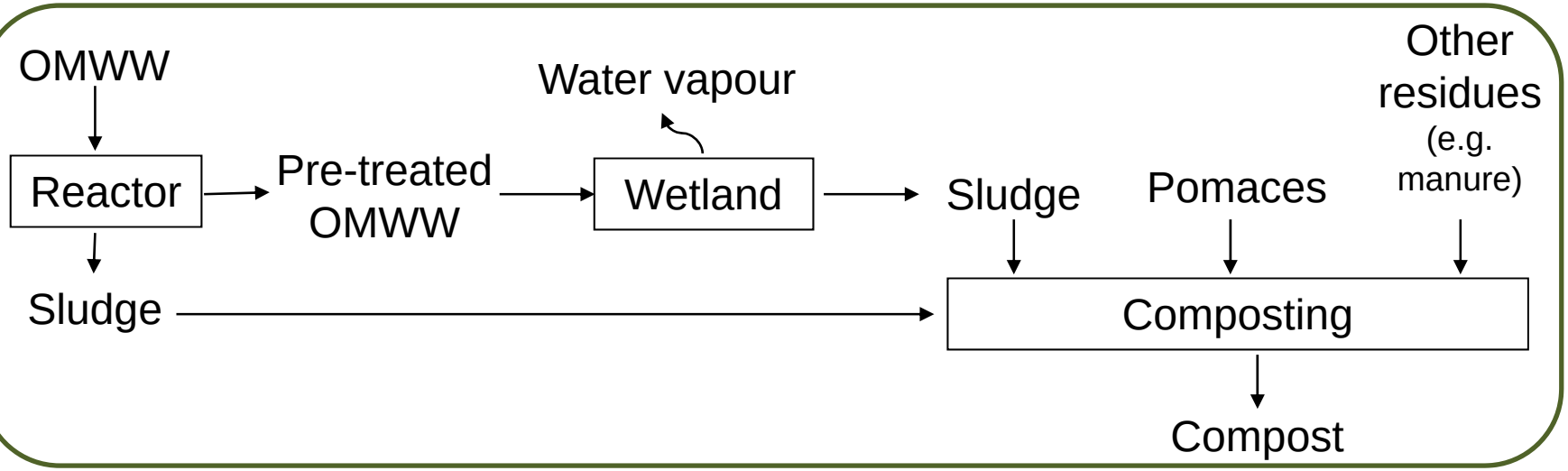
Technology owner – Country : University of Ioannina – Greece

Application Field : OMWW, Pomaces, Leaves

By-products/residues : Compost, water / no residues

Transferability of residues : possible for other wastewaters

Process Description : Aerobic oxidation of OMWW in trickling filter (reactor), followed by evaporation in wetland and sludge composting .



SWOT Analysis - Aerobic biological treatment

Strength: Low man power and skills; no smelling gases emitted

Opportunities: Law requirement in agreement with olive mill owners necessities

Weakness: Large area required for wetland; long term procedure

Threats: Difficulties in technology diffusion due to lack of awareness, single technology owner and Patent

OMW Co-Digestion

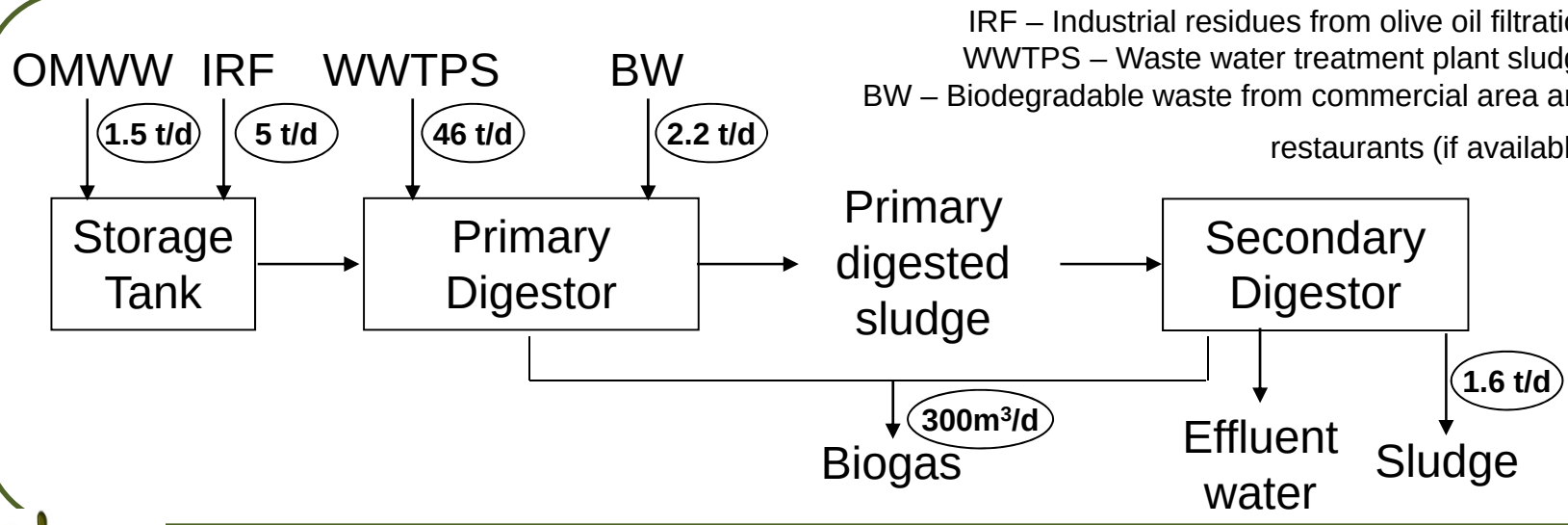
Technology owner – Country : INETI-DER - Portugal

Application Field : OMWW; Pomaces and Pulp

By-products/residues: Compost, water, Biogas / no residues

Transferability of residues: other residues are co-digested (WWTP sludges)

Process Description : Anaerobic Digestion Process, suitable for the olive mill wastewater treatment in an urban WWTP. Patent n. 102284 .



SWOT Analysis - Co-digestion in WWTP

Strength: Low man power and medium skills; no smelling gases emitted; possibility to use exiting infrastructures; biogas production and energy selling; no need for landfill disposal

Opportunities: Law requirement in agreement with olive mill owners necessities; new regulations on OMWW collection.

Weakness: High initial investment cost; Licence and Patent costs; Influent control need (heavy metals) and need of storage and consequent process difficulties.

Threats: Difficulties in technology diffusion due to lack of awareness, single technology owner and Patent; difficulties in Transport and in OMWW with with heavy metals content.

Phytoremediation

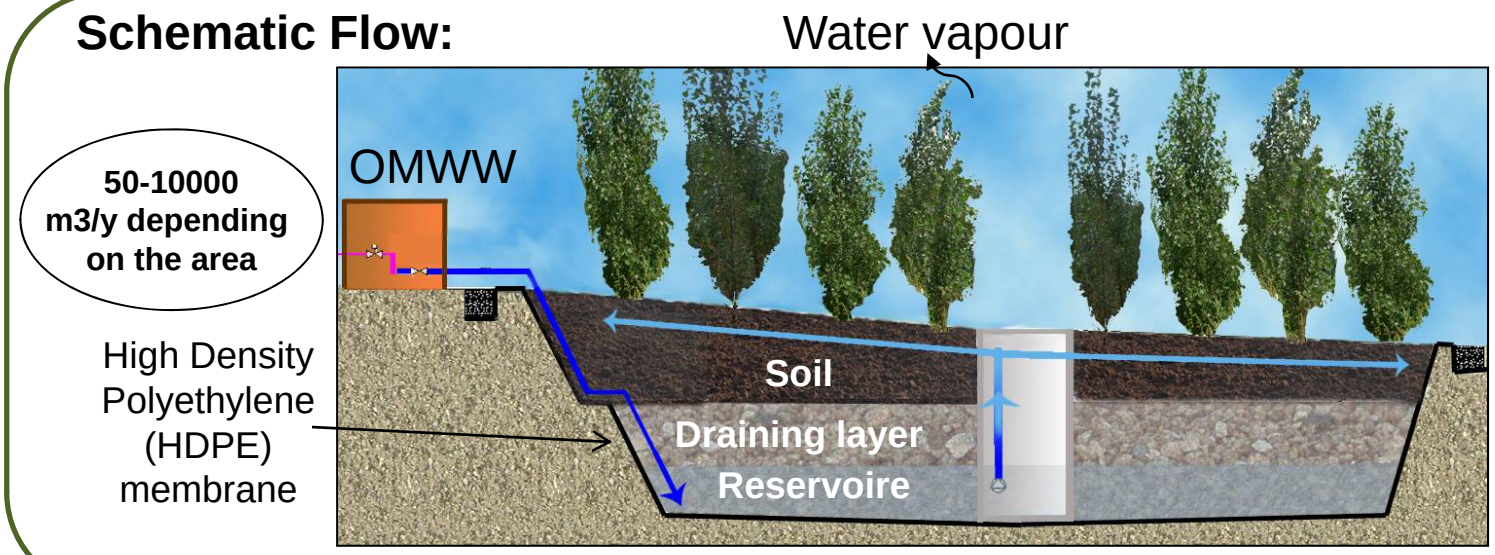
Technology owner – Country : INETI-DER - Portugal

Application Field : OMWW

By-products/residues: woody biomass / no residues

Process Description : Phytoremediation of OMWW by Poplar trees and microorganisms of the rhizosphere community. Patent EP 1216963.

Schematic Flow:



SWOT Analysis - Phytoremediation

Strength: Low man power and medium skills; positive visual and landscape impacts; wood production for biofuel; no CO2 footprint

Opportunities: Law requirement in agreement with olive mill owners necessities; new regulations on OMWW collection.

Weakness: Capital cost; Licence costs; climate unfavourable for Poplar tree growth; parasite attack; OMWW with high organic load

Threats: Difficulties in technology diffusion due to lack of awareness, single technology owner; Difficult in changing from 3 to 2 phase production process.

Composting (1)

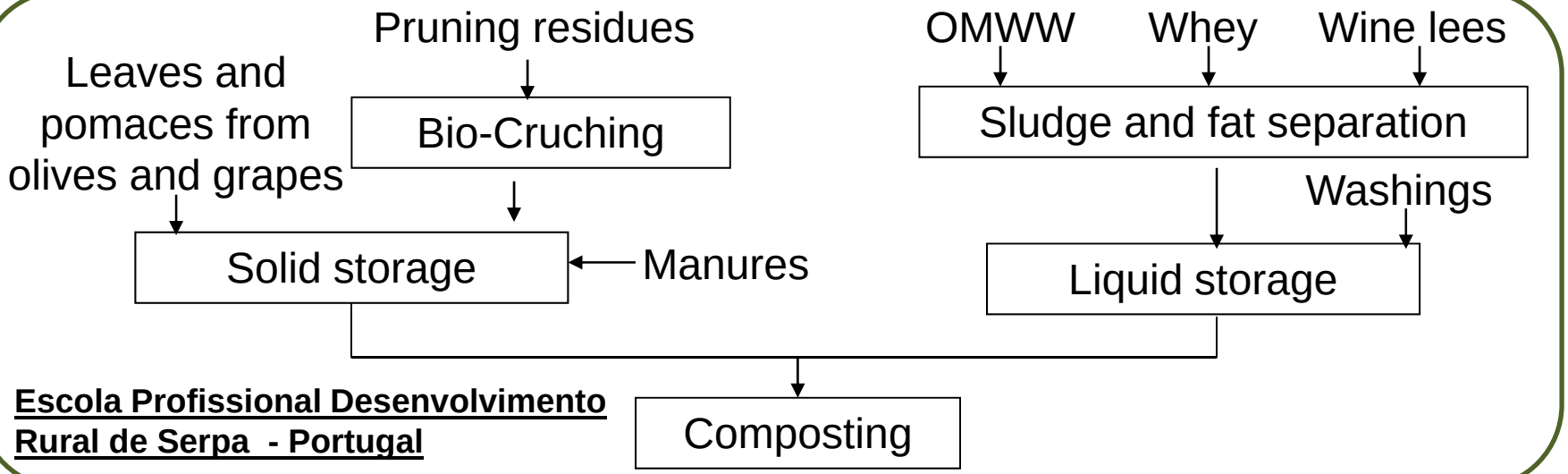
Technology owner – Country : Agraria OLEARUM SL and CotoBajo – Spain;
Escola Profissional Desenvolvimento Rural de Serpa – Portugal

Application Field : OMWW, 2 and 3P Pomaces, Pits and Pulps, Pruning residues

By-products/residues: organic compost / no residues

Transferability of residues: All organic residues from farms

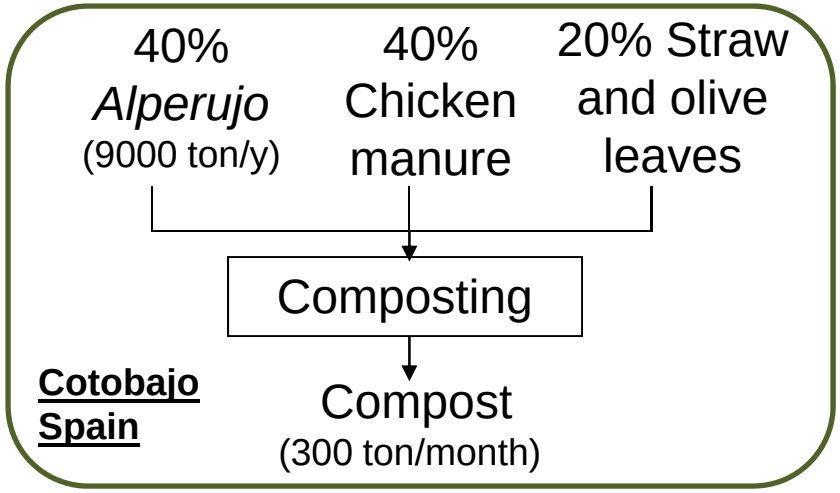
Process Description : Composting technology based on controlled aerobic fermentation of OMW and others farm residues.

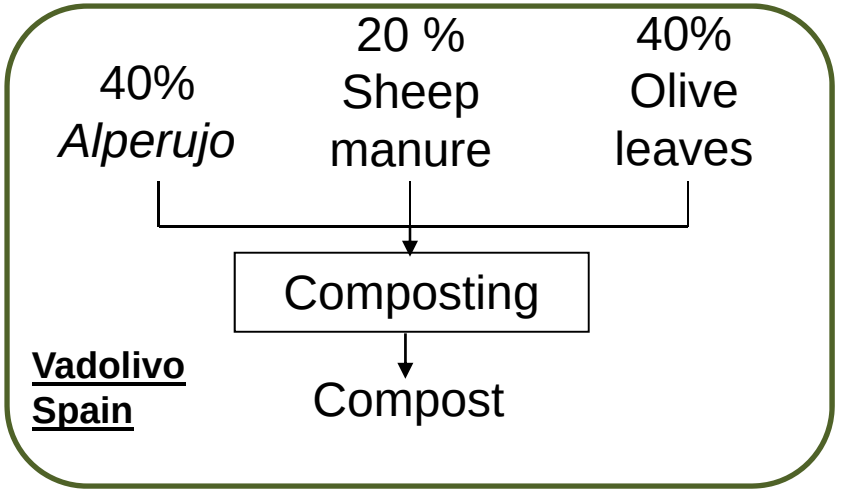


Composting (2)

In **Spain**, the most used process of olive oil production is the **2-phase centrifugation**, in which results a pomace with a higher moisture concentration, the ***Alperujo***.

Here, the need of moisturizing the pile is lower, and OMWW are treated in evaporation ponds mostly.





SWOT Analysis - Composting

Strength: Low man power and medium skills;

Opportunities: Law requirement in agreement with olive mill owners necessities; Treatment of many wastes; Low cost and no licence costs; Potential market for compost.

Weakness: Needs of storage and large area; Difficulties in management during extreme meteorological events.

Threats: High organic load residues; N content that disturbs C/N ration of the pile; Difficult commercializing compost, because of chemical fertilization preference.

Tirsav and Tirsav plus

Technology owner: ISAFoM-CNR – Italy

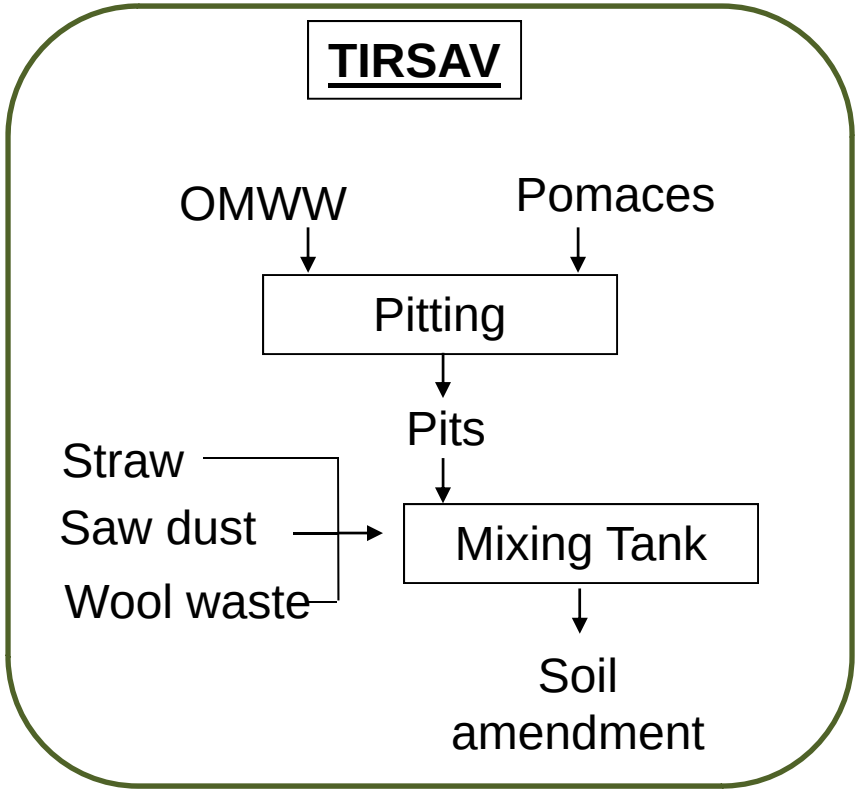
Application Field : OMWW, 2 and 3P Pomaces, Pruning residues

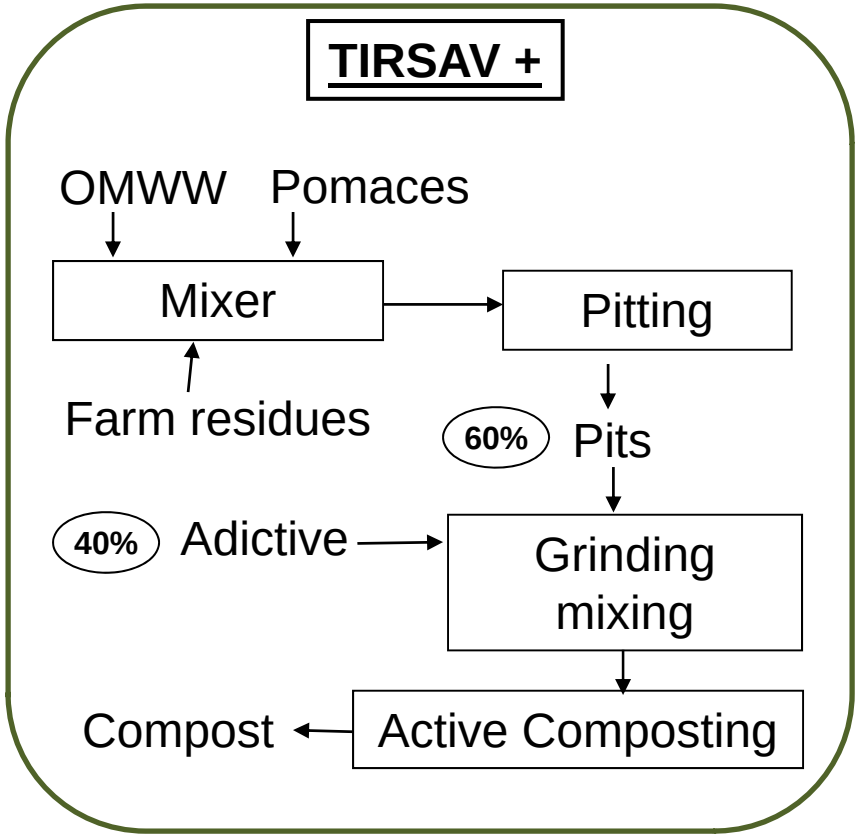
By-products/residues: organic compost or Bio-fuel/ no residues

Transferability of residues: agronomical residues (orange industry, market waste…)

Process Description : reclaim OMWW for agronomical purpose (omww and 2P pomaces) through a located biostabilization process in situ (**TIRSAV** project Life00 ENV/IT/223) or through composting the aforementioned mould/stub in a centralized plant (**TIRSAV+** project LIFE05 ENV/IT/845). Patent RM2004A000084

Tirsav and Tirsav plus (2)





SWOT Analysis – Tirsav and Tirsav plus

Strength: Low man power and medium skills; Tirsav is applied in the mill

Opportunities: Law requirement in agreement with olive mill owners necessities; Potential market for Compost and Bio-fuel

Weakness: Needs of transport for Tirsav +; Licenses for technology, storage and delivery; Energy and water consumption

Threats: Tirsav feets well for 2Phase process, but 3P mills need more working capacity for profitably, Traditional has a negative economic balance

Biocombus

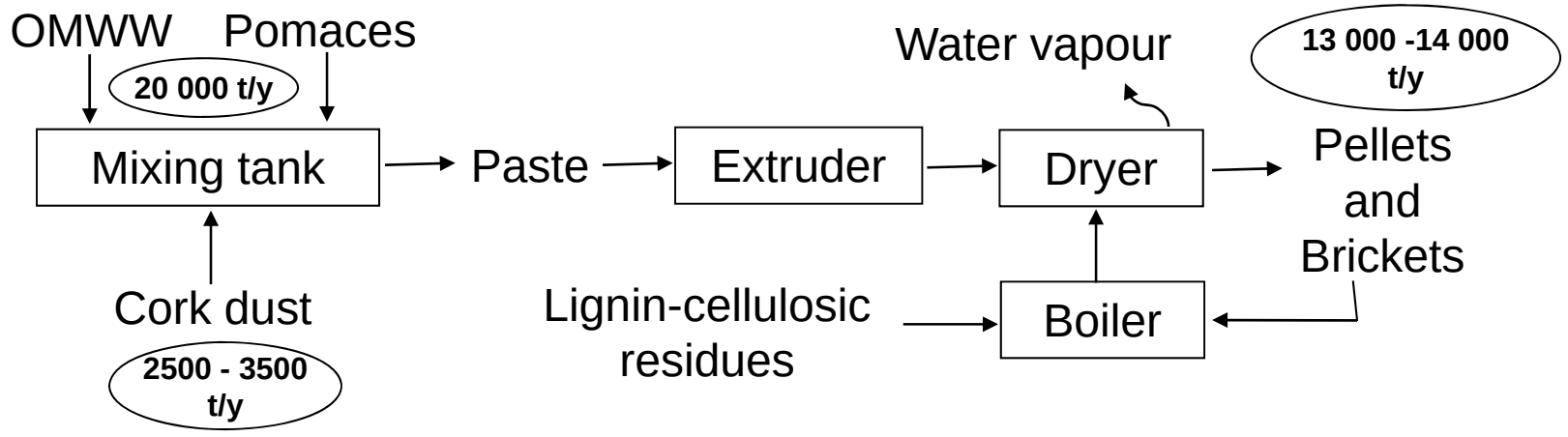
Technology owner: University of Tras-os-Montes e Alto Douro (UTAD) – Portugal

Application Field : OMWW, 2 and 3 phase pomaces , pulps and pickles

By-products/residues: pellets and briquettes / no residue

Transferability of residues: in the boiler cork dust can be replaced by pruning residues or wood chips.

Process Description : Pellets and Brickets production using OMW and Cork industry residues (cork powder and cork dust). Patents: PT 103407 and EP 073980008.8.



SWOT Analysis - Biocombus

Pellets and Brickets from OMW

9% humidity

SCP = 22 MJ/kg

ICP = 20 MJ/kg

Ash = 4%

Brickets of pine – ICP = 16,7 MJ/kg

Brickets of forest residues – ICP 17,2 MJ/kg

Strength: Low man power and skills; Solving of environmental impact of cork industry; Renewal energy market; No CO2 footprint.

Opportunities: Portugal and Spain are main world cork producers.

Weakness: High capital costs and Licence and Patent costs; High Energy consumption.

Threats: Single one technology owner; Low importance for no producer countries.

E.H.O.® Evaporation-Hydrolysis-Oxidation

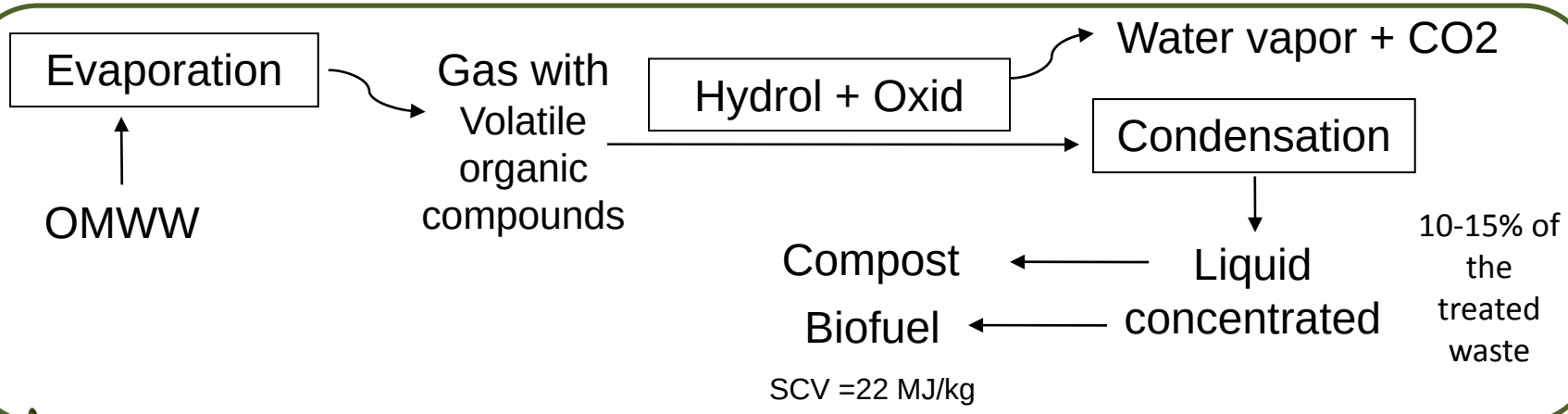
Technology owner: Envitec SA - Greece

Application Field : OMWW

By-products/residues: Water, Biofuel / few residues

Transferability of residues: Agro-industrial residues (manure, galvanise plants, dairy industry, tomato and orange industry

Process Description : Thermal evaporation of the waste water and at the same time, under controlled temperature and oxygen conditions, the hydrolysis and oxidation of the organic combinations. Patent n. EP1019324 B1



SWOT Analysis - EHO® – Evapo-Hydrolysis-Oxidation

Strength: Low man power; Minimal land need; Minimal waste after; no smelling gases

Opportunities: New regulation on OMWW collection;

Weakness: High capital costs and Licence and Patent costs; Qualified personnel; Transport costs; Solar energy needed for evaporation and Energy consumption.

Threats: No enforcement of environmental legislation; Single one technology owner; There are simpler technologies in the market.

Electro-coagulation device

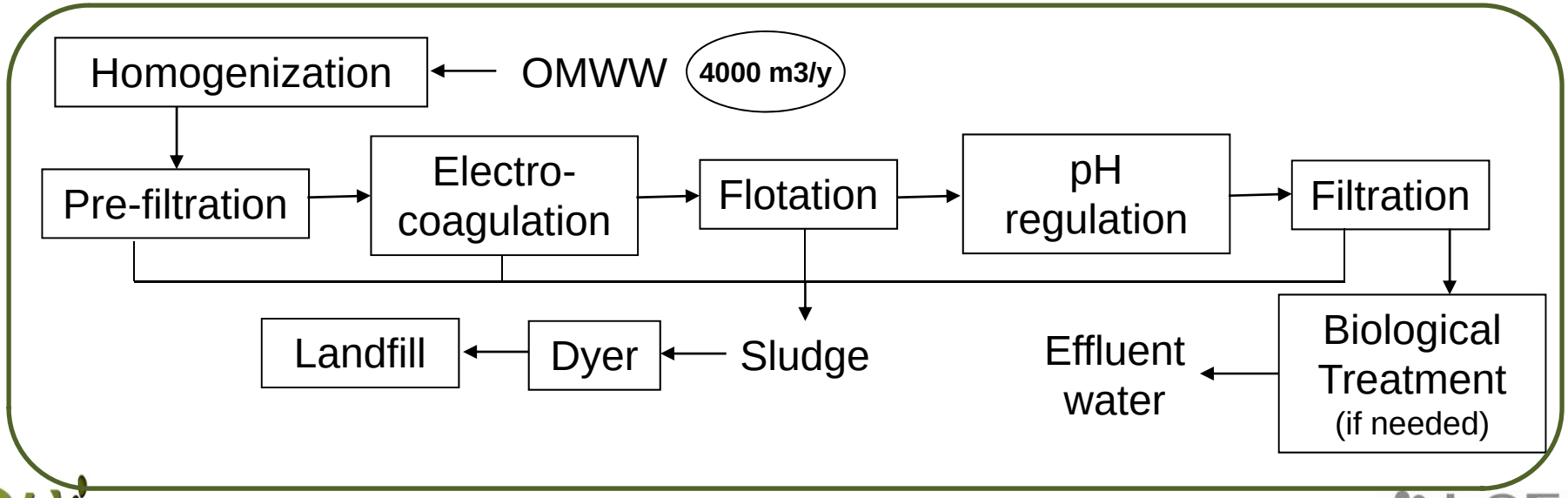
Technology owner: Cyclus ID

Application Field : centrifuge OMWW and washing waters

By-products/residues: no by-products / water for sewage, sludge to disposal

Transferability of residues: other wastewaters from olive table, slaughterhouse and fish industry

Process Description : Process of electro-coagulation for the treatment of OMWW.



SWOT Analysis – Electro-coagulation

Strength: Automated process; No time consuming;
No environmental impact.

Opportunities: New regulation on OMWW collection;

Weakness: Skilled work; High capital costs and Licence costs;
Chemical reagents need; Need of sludge disposal.

Threats: No revenues from by-products

Ultrafiltration (1)

Technology owner: Industria Olearia Biagio Mataluni srl;

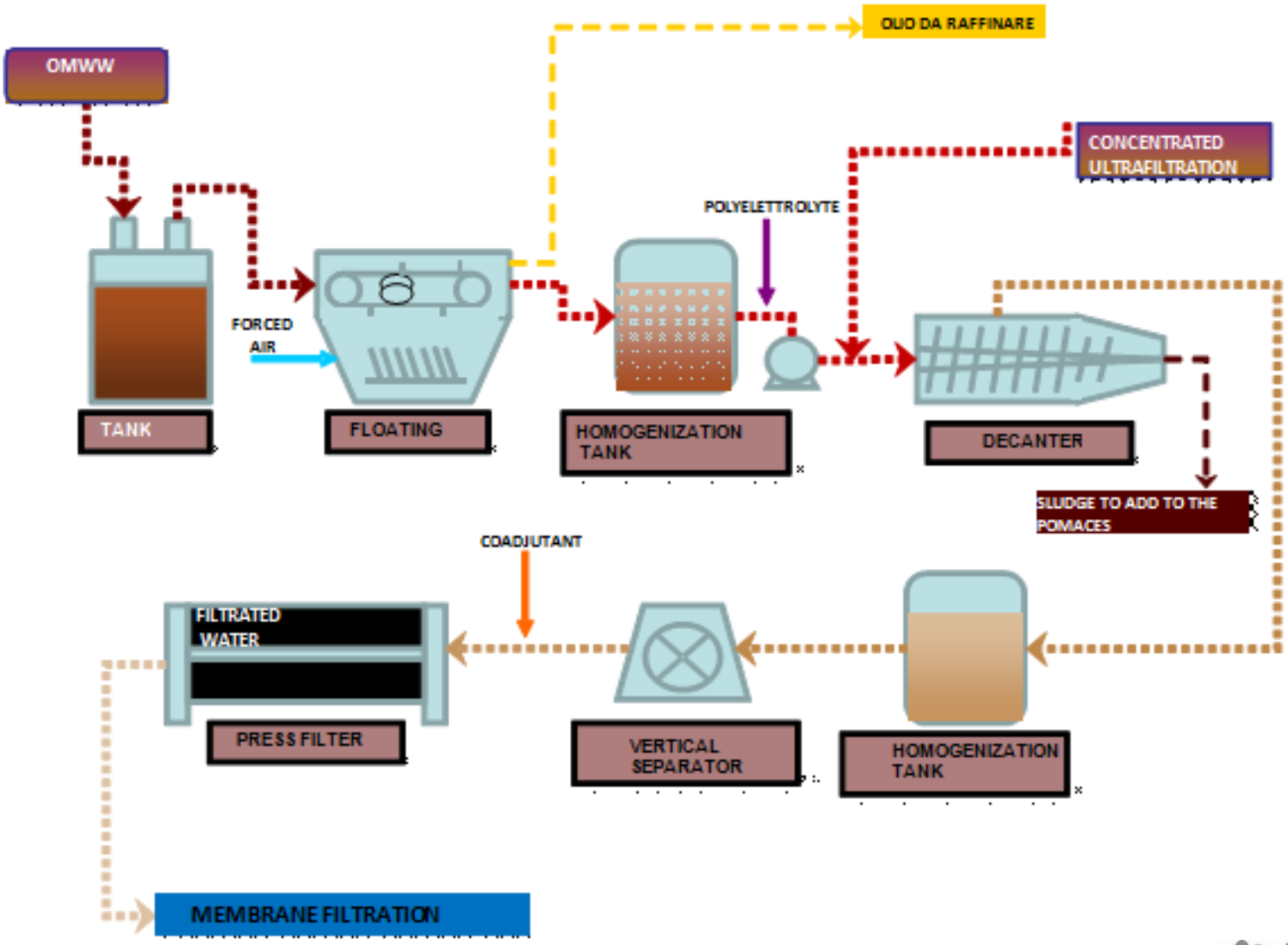
Application Field : OMWW from 3 phase centrifugation

By-products/residues: Water for industrial purpose, chemicals, organic matter for fertilizers/ Membranes and resin washing (to destine to the company purifier)

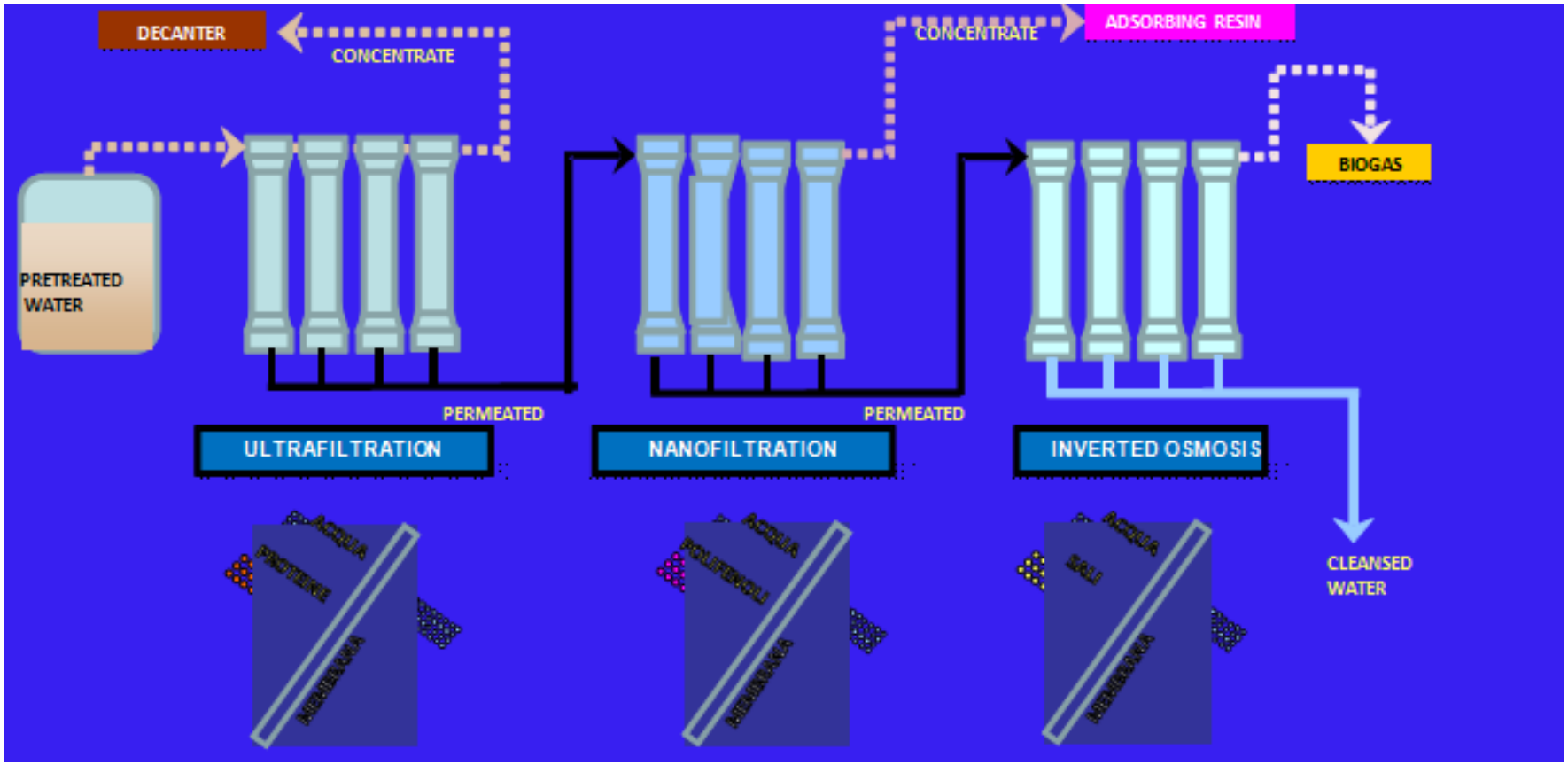
Transferability: Dairy and canning industry wastewater (during the summer)

Process Description : Combined process of membrane filtration, adsorption on polymeric resin and anaerobic digestion, with production of biogas and antioxidant extracts;

Ultrafiltration (2)



Ultrafiltration (3)



SWOT Analysis – Ultrafiltration

Strength: it reduces the overall environmental impact the olive oil sector. The process may products biogas.

Opportunities: many different by-products

Weakness: skilled work needed, high investment and maintenance costs, many chemicals need, energy consumption

Threats: Complex technology, preference for simpler and economical technologies available

Conclusion

Using **Strategies** such as:

- Closing materials life cycle
- Improving Production Eficiency
- Choosing the **Best Available Techniques** to treat/valorise/remediate
- Gathering awareness

Provide **Olive Mill Industry Sustainability** by:

- Enhancing Profits
- Reducing Environmental Impacts

Thank You!

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2nd IAMAW Conference

Izmir, Turkey

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