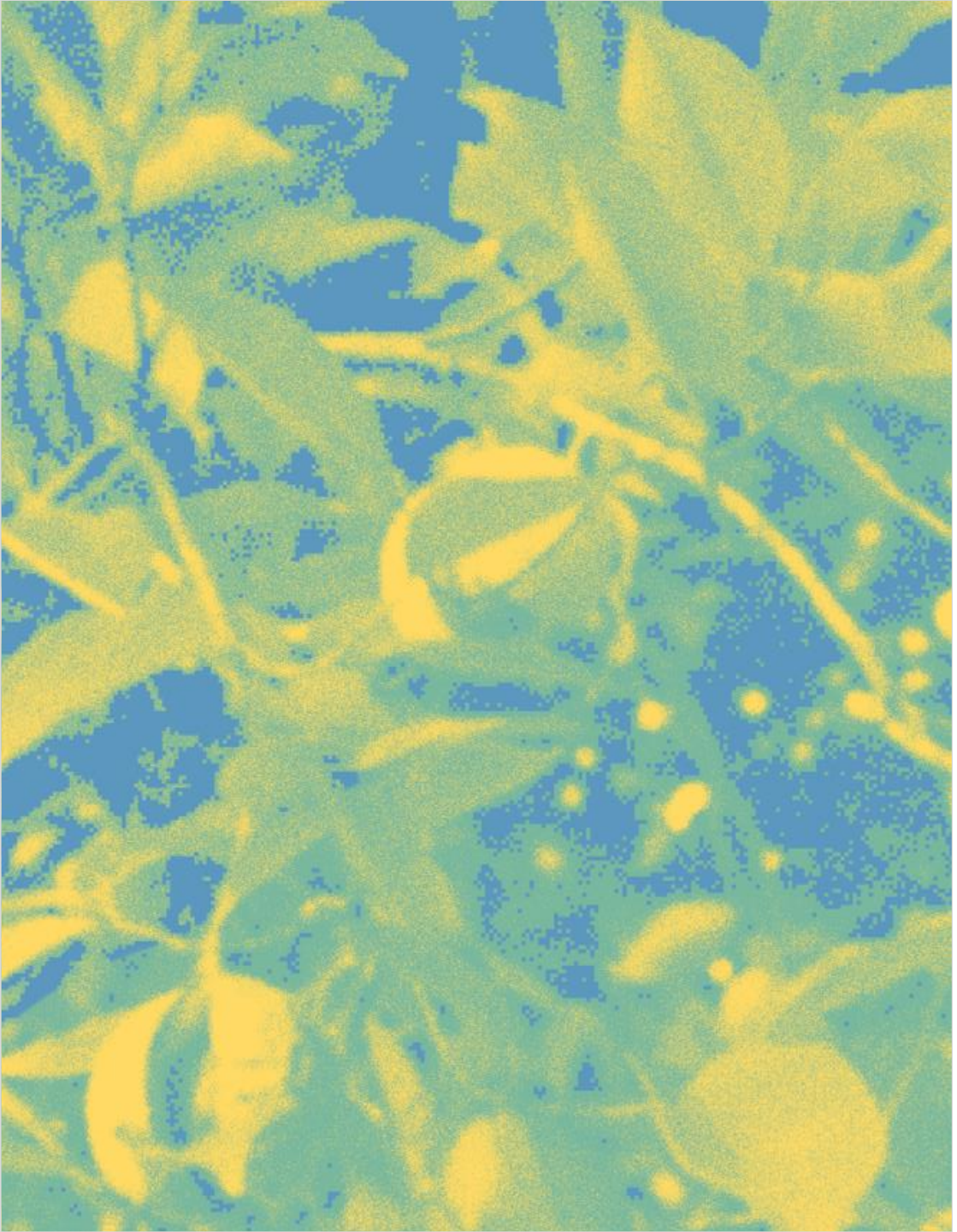
Food and Agriculture Organization of the United Nations

European Bank for Reconstruction and Development

EBRD and FAO Investment Centre's e-dialogue

Sustainable Management and Valorization of Olive Mill waste

23 September 2025



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- Introduction
- Olive Mills Waste Water Impacts, and emerging treatment technologies
- Stakeholder experiences
- Q&A

FAO/EBRD AGENDA

09:30 09:40	Opening remarks and objectives, Ms Lisa Paglietti, Economist FAO Investment Centre
09:40–09.50	Olive Mills Waste Water Impacts, and emerging treatment technologies, Dr Peter Talks, Agricultural Policy and Institution Specialist
09.50-10.00	Stakeholder experience 1: Spreading olive mill wastewater Dr Ajimi Larbi, Professor at Olive Tree Institute, Tunisia
10.00-10.15	Stakeholder experience 2: New technologies: Membrane filtration technology, Mauro Nisi, Agraria Riva Del Garda, Italy
10.15-10.30	Stakeholder experience 3: New technologies: Gasification technology, Dr Mahdi Fendri, Researcher, at Olive Tree Institute, Tunisia
10.30-10.45	Break
10.45-11.30	Q&A and moderated discussion- Dr Ayadi

FAO/EBRD introduction

- Improving the Sustainability of Olive Oil Processing
- An E-dialogue for a Green Transition
- A joint initiative under the FAO-EBRD "ACES: Green transition of key global agrifood chains" programme.

Introduction Challenge and Opportunity

The Challenge:

- The olive oil sector, a cornerstone of Mediterranean economies, faces significant environmental and economic pressures.
- The processing phase has a particular large environmental footprint, producing by-products that polluting soil and water if not properly managed.

The Opportunity:

- These by-products—pomace, olive mill wastewater (OMW), and leaves—are not just waste. They are rich in organic matter, bioactive compounds, and energy potential.
- Through a circular economy approach, these by-products can be transformed from a liability into a strategic opportunity for value creation and innovation

Introduction Environmental and economic sustainability

Linking Sustainability and Profitability

- Environmental sustainability is directly tied to the economic profitability of olive mills.
- For wide adoption, solutions must be economically viable, scalable, and cost-effective.
- The goal is to identify solution that reduce environmental impact while creating new revenue streams and strengthening sector resilience.
- Success depends on practical, adaptable innovations that millers and cooperatives can implement within real operational and financial constraints.

Introduction The Importance of Local Context

- There is no single solution for olive mill waste: approaches must be adapted to local conditions.
- Effective solutions must be designed within the specific economic, political, and social context of each country.

Emerging Technologies
Olive Mill Waste: The Impact of Technology

Dr Peter Talks, Agricultural Policy and Institution Specialist

Emerging Technologies

Olive Mill Waste: The Impact of Technology

- The type and volume of by-products are determined by the mill's extraction technology.
- Three-Phase System: Uses a large amount of fresh water (up to 1,240 litres per tonne of olives). It produces two separate waste streams: a large volume of liquid Olive Mill Wastewater (OMW) and a wet solid pomace. This system is prevalent in Turkey, Tunisia, and Jordan.
- Two-Phase System: Uses little to no added water (approx. 250 litres per tonne). It produces a single, high-moisture, semi-solid pomace known as 'alperujo' and eliminates liquid OMW. .esigned within the specific economic, political, and social context of each country.

Emerging Technologies

Two-Phase Mills: Turning Cost into Revenue

- The concentrated 'alperujo' from two-phase mills is a valuable feedstock for a circular bio-economy.
- Pathway 1: High-Value Polyphenol Recovery. 98% of an olive’s healthy polyphenols remain in the pomace. Using membrane filtration, these can be extracted to create high-margin ingredients for the cosmetic and nutraceutical markets. This pathway shows a high potential return, with a modelled Net Present Value of nearly €2 million and an IRR of 58%.
- Pathway 2: Integrated Bioenergy Production. The pomace's organic content is an excellent feedstock for energy generation via anaerobic digestion or pyrolysis. This can make a mill energy-independent, saving costs and providing a hedge against volatile prices. This pathway offers stable returns with a payback period of approximately 3 year.

Emerging Technologie Three-Phase Mills: Reducing Costs & Environmental Risk

- For three-phase mills, valorisation focuses on managing the large waste streams to reduce operational costs and mitigate environmental risks.
- Pathway 1: Integrated Biorefinery. The liquid OMWW and solid pomace are ideal for anaerobic co-digestion. This process creates two valuable outputs:
- Biogas: Used in a Combined Heat and Power (CHP) unit to generate on-site electricity and heat, significantly reducing energy bills.
- Digestate: A nutrient-rich slurry that serves as a high-quality biofertiliser, avoiding disposal costs and replacing the need for synthetic fertilisers.
- This approach transforms the mill's two largest liabilities into valuable on-site resources.

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Emerging Technologie Three-Phase Mills: Low-Cost Valorisation Pathways

Accessible, lower-investment pathways can avoid the high costs of traditional disposal (e.g., evaporation ponds can cost a medium-sized mill €25,000-€40,000 annually).

Co-Composting: The solid pomace and liquid OMWW are composted together to create a stable, organic fertiliser. This directly saves on fertiliser costs, can improve long-term olive yields, and creates a new revenue stream from surplus compost sales.

Pyrolysis for Biochar: Heating dried pomace produces biochar, a powerful soil amendment that improves water retention and sequesters carbon, with potential future access to carbon credit markets. Techno-economic analysis shows this process can have a payback period of just 2.83 years

Stakeholder experience: Spreading olive mill wastewater

Dr Ajimi Larbi, Professor at Olive Tree Institute, Tunisia

Long term impact of OMW soil spreading on soil characteristics and olive production

Italy

Di Giovacchin 2024

Tunisia

Table XI - Average results obtained by spreading OMW on soil cultivated with olive trees for 9 consecutive years

Determinations	Control plot	Plot treated with 30 L OMW/m² *
Olive production (kg/tree)	5.7	6.5
Oil content of olives (%)	17.5	17.7
Phenols content of oil (mg/kg)	196	206
Characteristics of the soil Organic matter (g/100 g)	1.77	2.18
Total nitrogen (g/100 g)	0.11	0.13
Available P (mg/kg, as P_2O_5)	34	53
Exchangeable K (mg/kg, as K_2O)	250	265
Reducing substances (mg/100 g)	0.12	0.42
Total microflora (CFU/g of soil)**	3.0×10^8	5.9×10^9

*Plot not fertilized; ** CFU: Colonies Forming Units

The recycling of OMW on cultivated soil supports sustainable agriculture by reusing natural agricultural by-products. This practice not only boosts crop yields but also enhances soil chemical and microbiological properties.

		Control	50 m³/ha	100 m³/ha
Average of 12 years	Olive yield (Kg/ha)	746,8	799,7 7%	950,5 27%
Soil attributes after 12 years	OM (%)	0,12	0,41	0,71
	N (ppm)	187	420	795
	P (ppm)	25	34	64
	K (ppm)	151	750	1075

OMWW = Fertiliser?

82 Kg UREA

920 Kg potassium sulphate

30 tons of manure

80 Kg Super phosphate 45

Adoption of Olive Mill Wastewater (OMW) Land-Spreading Practices Across Producing Countries

Long-term experimental studies on OMW land application have assessed impacts on soils, olive trees, and other crops (e.g vine and maize) providing decision-makers with the evidence to establish clear regulations for its land application

- In Morocco, land application of OMW requires specific authorization, with legislation still under development.

In other producer countries, soil spreading of OMW is still prohibited.

Italy

- Law 574/1996, Decree 152/2006.
- **50 m³/ha/year** *traditional*

  *(press) mills-***80 m³/ha/year**

  centrifugal / continuous

  extraction mills

Technical rules for the agronomic use (spreading) of olive mill wastewaters and other mill wastes:

- defining buffer zones (e.g. distances from water bodies, slopes, land types)
- excluding certain land from being used
- preventing mixing with other wastewaters

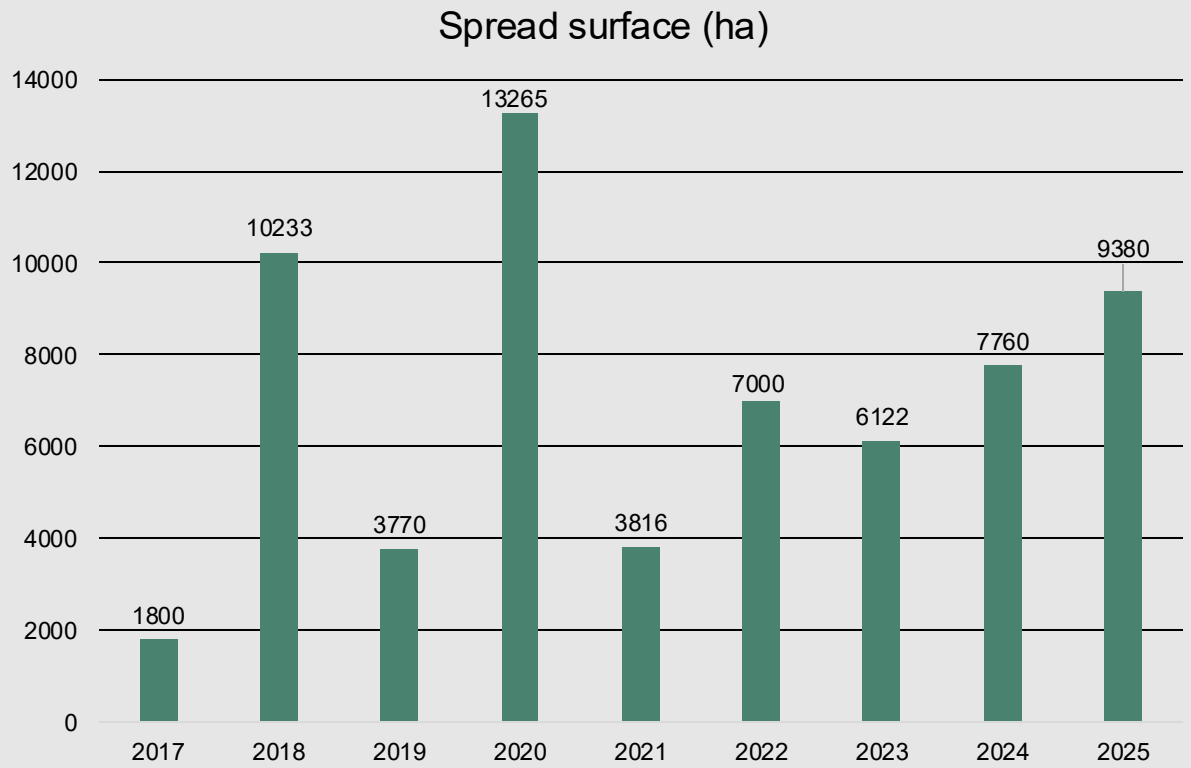
Tunisia

- Law Decree 2013-1038
- **50 m³/ha** of fresh OMWW each two years
- Obligation to use **fresh OMW** (not stored or degraded)
- Application allowed only on soils with an **appropriate slope** (to avoid runoff and erosion).
- **Minimum distance** must be respected from rivers and water bodies
- Spreading is limited to **fruit tree plantations** (not for vegetables or shallow-rooted crops)

❖ **Official protocol for the use of OMW**

- Olive mill signs an agreement with farmers wishing to amend their soil with OMW
- Application submitted to the Regional Commissariat
- Joint commission from the Ministries of Environment and Agriculture inspects and verifies compliance of spreading sites with national regulations
- Olive mill is responsible for carrying out the spreading operation

➢ Since the law was implemented in Tunisia, the area **treated with OMWW** has shown a significant **increase**.



✓ The spreading surface depends on the amount of OMW produced. Between 2017 and 2025, it averaged around **6,500 hectares**, corresponding to approximately **350,000 m³ of OMW**.

What are the limitations and potential negative impacts of this approach?

Deviation from the recommended application rate and method of implementation."

Pollution and phytotoxcity

- Restricted period available for the land application of fresh olive mill wastewater
- Prolonged administrative procedure required to secure the necessary permits for land application
- The land application period overlaps with the rainy season, thereby restricting the timeframe for spreading
- Olive mill operators show reluctance to apply spreading on distant fields because of the high transportation costs
- Even with this approach, the quantities remain very high, especially during years of high production

Hence, there is a need to develop additional strategies for the management of olive mill wastewater

Transitioning from a waste elimination logic to a circular valorisation model based on energy, biofertilisers and biomolecules

Thank you

Stakeholder experience: Simplify the management and disposal of vegetation water

MAURO NISI, EXTRA VIRGIN OLIVE OIL DIVISION,
AGRARIA RIVA DEL GARDA, ITALY

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AGRARIA RIVA DEL GARDA

EXTRA VIRGIN OLIVE OIL DIVISION

- Agraria Riva del Garda Cooperative Mill
- Located in northern Italy, near the 46th Parallel
- the most northerly areas for olive cultivation
- 270 hectares managed by members
- 1,000 tons of olives processed annually

The Challenge

Simplify the management and disposal of vegetation water

Conventional disposal not feasible due to:

- Small and densely populated area
- Italian regulations restrict disposal near lakes and homes
- Steep, rocky farmland – difficult access for tractors

The Solution

Adopt concentration of wastewater to reduce waste

Technologies used: ultrafiltration and reverse osmosis

Outcomes:

• Clean water for washing

• Polyphenol concentrate – rich in antioxidants (product for sale) → The volume of waste is reduced by 60 times.

Achieved Goals

- 1. Reduced wastewater disposal needs
- 2. Created circular economy – added value to waste
- 3. Obtained a high-quality product from perceived waste
- 4. Enhanced cooperative image

ADVANTAGES AND DISADVANTAGES

Advantages:

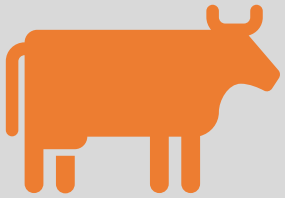
- Economic savings in spreading and transport
- Improved sustainability and corporate image

Disadvantages:

- High initial investment cost
- Difficulty in standardizing the product

IMPORTANT: there must be no pesticide residues in the olives, because those too become concentrated.

FUTURE OUTLOOK



Current market: animal feed

Current trials in human nutrition show significant benefits

Future plans: commercialization as ingredient in functional foods and supplements

AGRARIA RIVA DEL GARDA

EXTRA VIRGIN OLIVE OIL DIVISION

THANK YOU

Concluding remarks

We will be organizing future e-dialogues focused on production as well as downstream aspects, including logistics, distribution, and marketing. These will take place after the olive oil campaign concludes, and we will ensure to provide ample notice ahead of the next session.

In parallel, we are preparing an investment brief — a concise document highlighting key technologies and environmental sustainability solutions.

In the next steps, we will also be working closely with the Turkish industry to explore how environmental sustainability can be effectively implemented in practice.

Thank you very much for your participation and enthusiasm today. Your contributions are well noted and greatly appreciated.

As you know, we operate in a complex environment where it is essential to bring together finance, cooperatives, and development partners to test solutions and make them accessible.

Finally, we would like to thank EBRD for the opportunity to explore how environmental sustainability

REFFECT AFRICA
RENEWABLE ENERGIES FOR AFRICA:
EFFECTIVE VALORIZATION OF
AGRI-FOOD WASTES

This project has received funding from the European Union's Horizon 2020 research and Innovation programme under grant agreement Nº 101036900

REFFECT AFRICA

Renewable energies for Africa: effective valorization of agri-food wastes

Biomass valorization in olive oil mills though gasification technology: pilot demonstration unit

REFFECT AFRICA TEAM represented by: Dr. Mahdi Fendri. Olive Tree Institute (Tunisia)

Presentation prepared by
With modifications

IrRADIARE
Science for Evolution

BACKGROUND

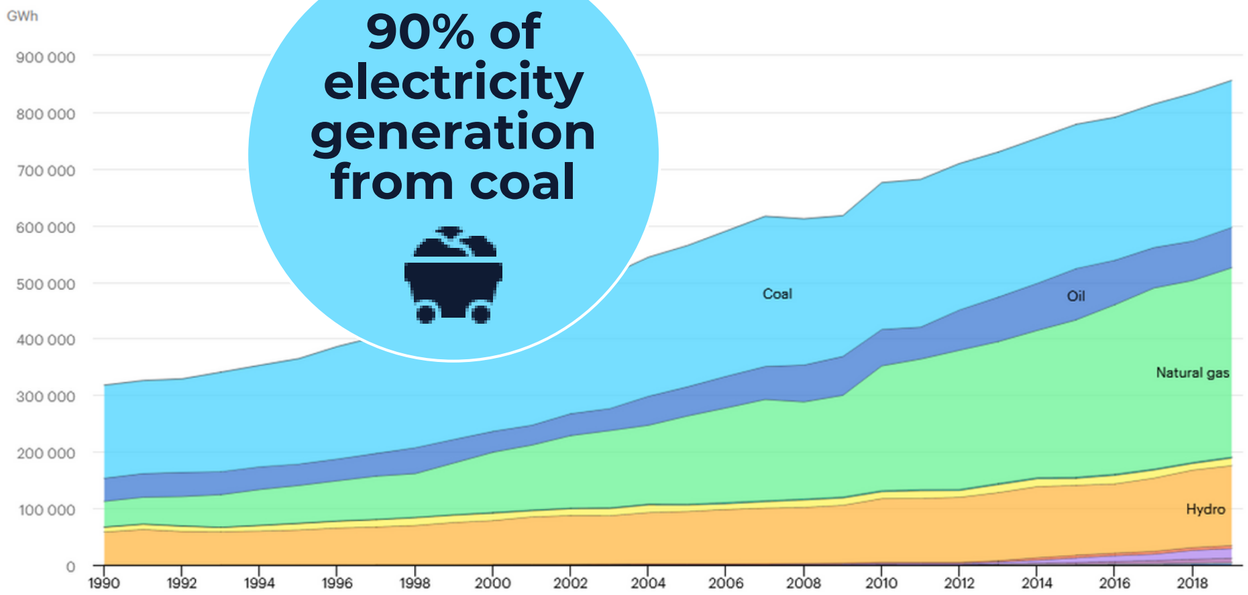
“In sub-Saharan Africa 55% of people lack access to ELECTRICITY; in 13 countries, more than 75% of population do not have access to electricity”

About 600 million people in Africa do not have access to electricity

“

IEA, 2019. Data and statistics

90% of electricity generation from coal

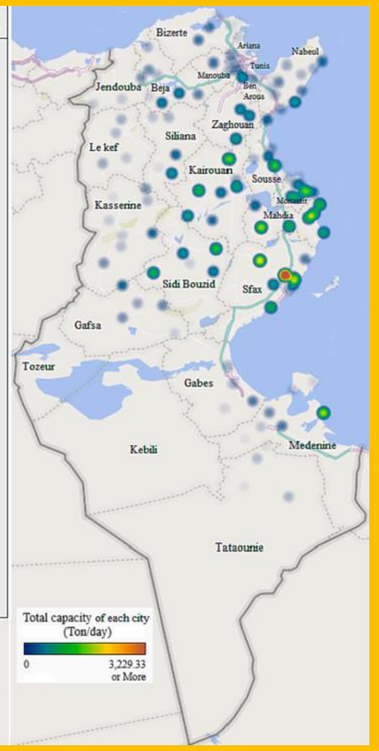


Electricity generation by source in Africa (source: IEA, 2019)

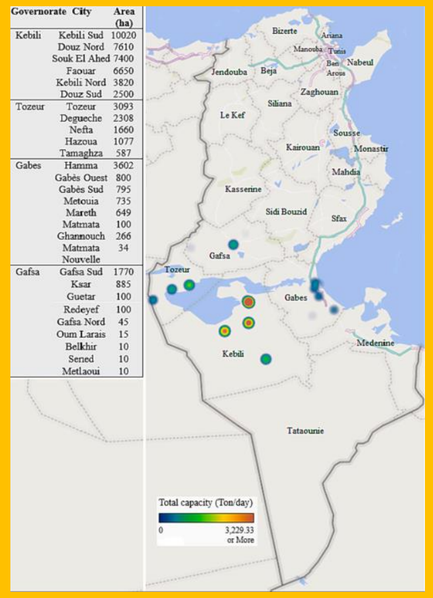
BACKGROUND

Availability of agri-food wastes: biomass potential for bioenergy

Governorate	Capacity (ton/day)
Tunis	263.5
Ben arous	870
Ariana	340
Manouba	706
Zaghouan	2927
Bizerte	871
Béja	1937
Jendouba	568
Le Kaf	553
Siliana	1883
Nabeul	2623
Sousse	4591
Monastir	5383
Mahdia	11671
Kasserine	1370
Kairouan	11216
Sidi Bouzid	3996
Gafsa	1341
Gabès	674
Tataouine	273
Médenine	3500
Sfax	13642



Governorate	City	Area (ha)
Kebili	Kebili Sud	10020
	Douz Nord	7610
	Souk El Ahed	7400
	Faouar	6650
	Kebili Nord	3820
	Douz Sud	2500
Tozeur	Tozeur	3093
	Degueche	2308
	Nefta	1660
	Hazoua	1077
	Tamaghza	587
Gabes	Hamma	3602
	Gabès Ouest	800
	Gabès Sud	795
	Metouia	735
	Mareth	649
	Matmata	100
	Ghannouch	266
	Matmata Nouvelle	34
Gafsa	Gafsa Sud	1770
	Kasr	885
	Guetar	100
	Redeyef	100
	Gafsa Nord	45
	Oum Larais	15
	Belkhir	10
	Sened	10
	Metlaoui	10



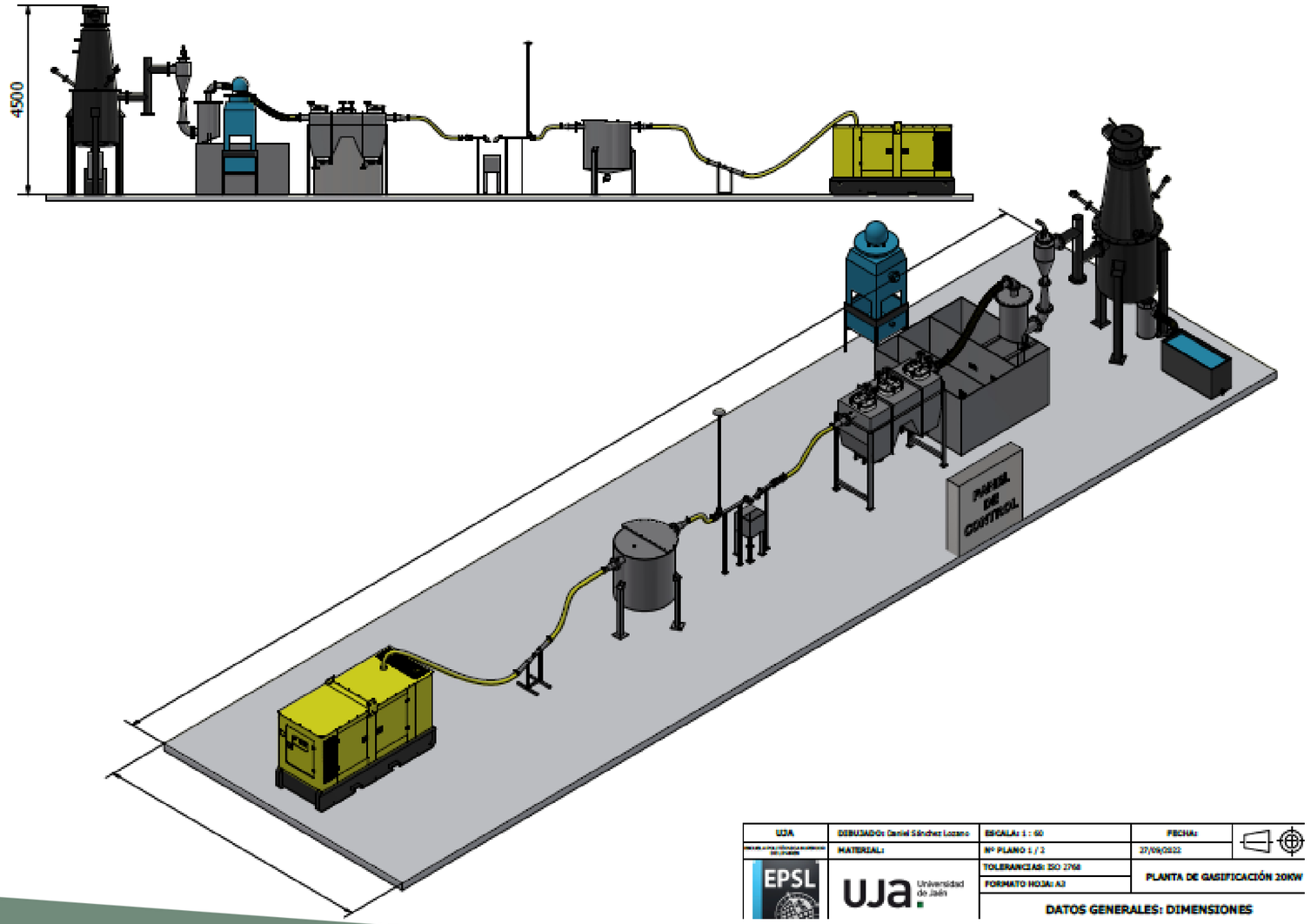
Anvari et al.,2024

Alternative uses of wastes and by- products for bioenergy production and environmental impact reduction

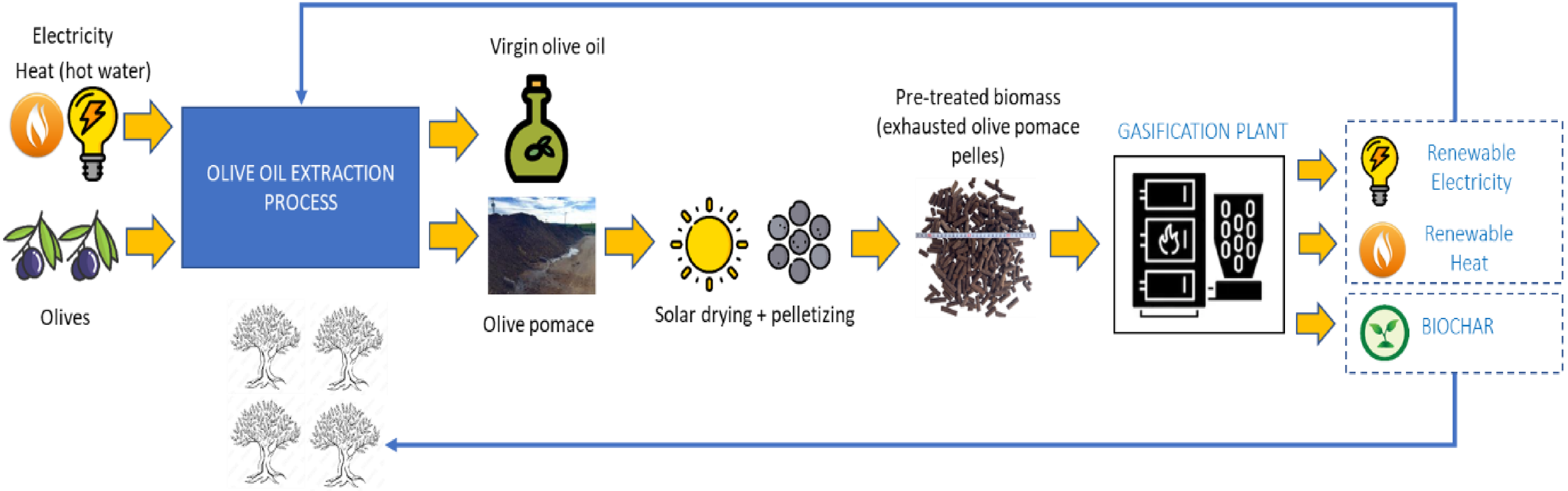
AIM & OBJECTIVES

- **State-of-the-art of the 3 most important agri-food value chains in each African Country**
  - Biomasspotential, watersources, energy and soilanalyses.
- **Installation and validation of three full-scale demonstrators in Morocco, Ghana and South Africa**
  - Based on gasification technology together with other renewables and water regulation and lab tests.
- **To perform a Life Cycle Assessment of each value chain before and after the solution proposed.**
- **To establish three Living labs → for future research and networking.**
  - Knowledge transfer to the stakeholders and digitalization.

GAZIFICATION TECHNOLOGY: Typical Layout of a biomass gasification plant for power generation



GAZIFICATION TECHNOLOGY: Replication scenario



TECHNOLOGY: BIOMASS GASIFICATION

Agri-food biomass sources

Cost = 2.000 €/kWe
Payback = 4-6 years

250 kWe = 350 m2
1.2-1.4 kg/kWh

Renewable Electricity (15%)

Renewable Heat (50-60%)

Biochar (15%)

- Soil amendment
- Extremely porous activated carbon
- Absorbs water and nutrients (5 times its weight)
- High cation exchange capacity
- Improve the soil microbial life

LOCATION OF THE DEMONSTRATORS

DEMO-SITE	ELECTRICAL POWER RANGE	THERMAL RECOVERY UNIT
MOROCCO off-grid	• 60-70 kW GASIFIER • 60-70 kW Diesel genset (backup)	• HEAT EXCHANGER for olive oil process
GHANA off grid & on-grid	• 20-25 kW GASIFIER • 20 kW PV system • 80-100 kWh of battery bank	• ABSORTION CHILLER for food storage
SOUTH AFRICA on-grid	• 70 kW GASIFIER	• ORC SYSTEM

Morocco

An on-grid application at the Zoyout Essaouira Cooperative that allow the energetic reuse of the olive tree value chain

Sawla-Tuna-Kalba

A rural off-grid application in Ghana at a school compound, which includes a small medical clinic.

Cape Town WasteMart

A gasification plant at Waste Mart in Cape Town, generating on-site power and selling surplus to Eskom

MOROCCO DEMO-SITE

ESSAOUIRA OLIVE MILL

SOME RESULTS

- Olive oil production and wastes generated.
- Capacity power & size of the gasification plant: 60 kWe.
- Thermal necessities (hot water for the extractions).
- Load profile.
- Biomass available at the mill: husk, prunings.
- Design of the HRU for biomass pretreatment or heating. mill necesities: heat exchanger.
- Distance to the utility grid.

Intensive cultivation (350 trees/ha)
420 tonnes of olives (70-80 tons olive oil)
> 250 tons of wastes (husk, pruning)
currently 100 kVA diesel genset

ESSA olive mill (ON grid connection)

REFERENCES

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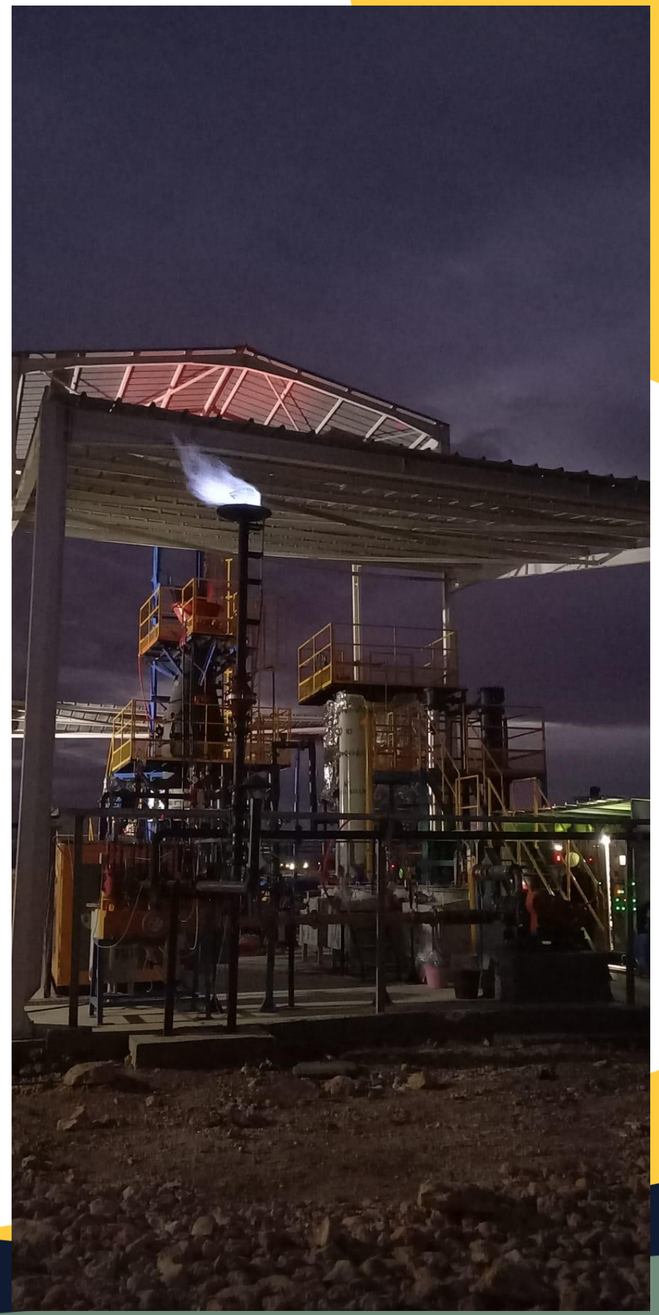
AGRI-FOOD WASTES
警告/WARNING



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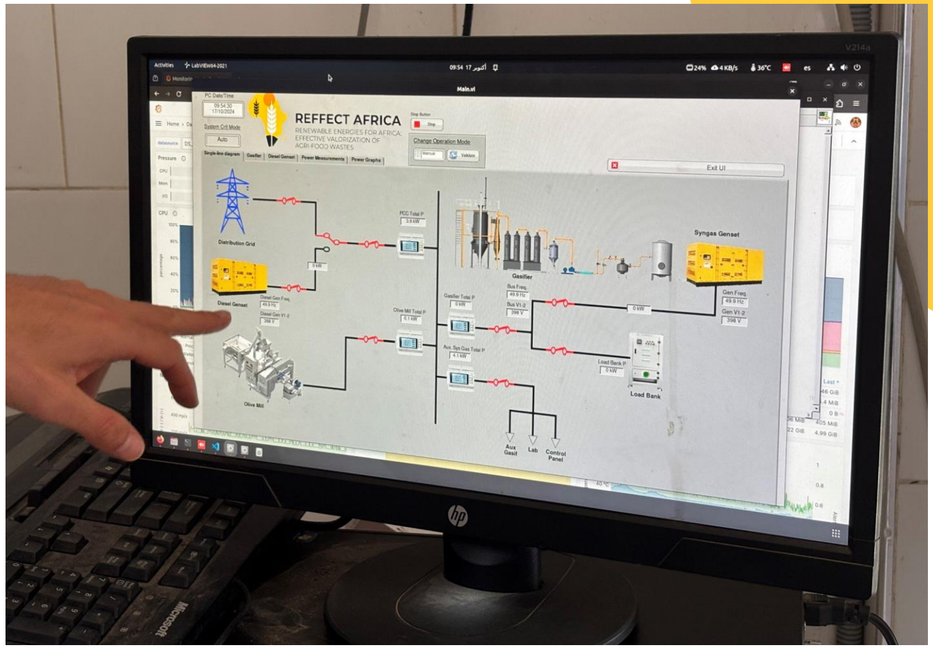
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Distribution Grid
Diesel Genset
Olive Mill
Gasifier
Syngas Genset
Load Bank
Aux Gasif
Lab
Control Panel

REFERENCES

https://www.youtube.com/watch?v=wAPrd6-XsKw

https://drive.google.com/file/d/10kI03DMt7Tkym7hKYK9jZfeZkYKoojWM/view?usp=sharing

https://www.youtube.com/watch?v=wAPrd6-XsKw

https://www.youtube.com/watch?v=owuP2E-WEK0

REFFECT AFRICA

29 Partners:

- > 100 participants
- 40 % women

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THANK YOU!

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