



Olive grove residues and olive extraction process solid biowaste streams management via thermochemical valorization

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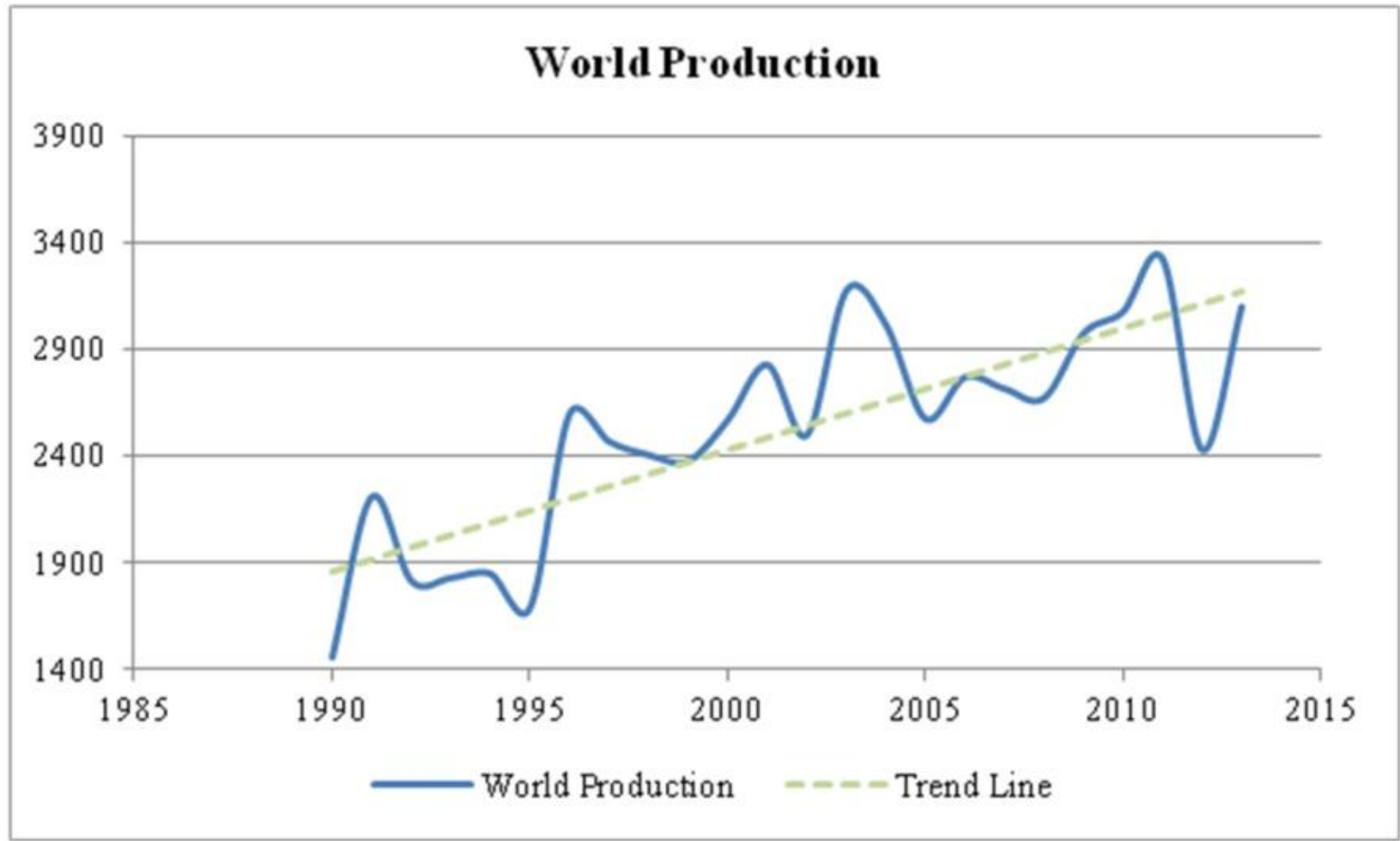
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Olive Tree Farming & Olive Oil Production

- Olive oil production is a significant economic activity in the Mediterranean basin.
- Almost the whole of the global olive oil production is done in this part of the world while Spain, Italy and Greece cover the three quarters of the total production.
- Over 700 million olive trees are grown in Spain, Italy and Greece
- In Greece, olive farming covers 60% of the country's cultivated land.
- Despite the decline in olive tree cultivation during the 70's and the 80's the last decades an expansion of new olive trees plantations occurred, especially in Spain and Greece.

Olive Tree Farming & Olive Oil Production



International Olive Council, 2013

Environmental Impact of Olive Oil Production

- **The cultivation of the olives could be considered as environmental friendly procedure:**
 - **the use of large quantities of chemicals and fertilizers is not necessary,**
 - **the use of energy is limited to the operation of tractors, diesel saws and electric peaveys, and**
 - **the energy use related to the olive oil production is not considered as a major issue**

Environmental Impacts of Olive Oil Production

- Nevertheless, the olive farming and the olive mills are generating large quantities ***of solid and semi solid wastes and wastewater***, the handling of which is a major task for the majority of the olive processing facilities.
- The disposal of these residues is a one of the ***biggest environmental problems*** that Europe is facing today and the olive oil industry ***is considered one of the most heavily polluting food industries***
- Last but not least ***is soil erosion*** that considered as the most serious environmental problem associated with ***olive farming***

Olive Extraction Methods

- ***Traditional (or Batch Process)***: the olive oil is extracted by pressure → Olive Cake & Olive oil
- ***The continuous process***: use of centrifugal decanters
 - ***3 Phase Process → Olive Oil, Moist Pomace & Waste Water***
 - ***2 Phase Process → Olive Oil & Wet Pomace (ave. 60% humidity)***
- Most of the world's oil is extracted by the continuous process → 2 phase process, (“ecological” process).
 - ***requires less quantities of water,***
 - ***uses less energy and***
 - ***does not generate any olive mill waste water (vegetable water)***

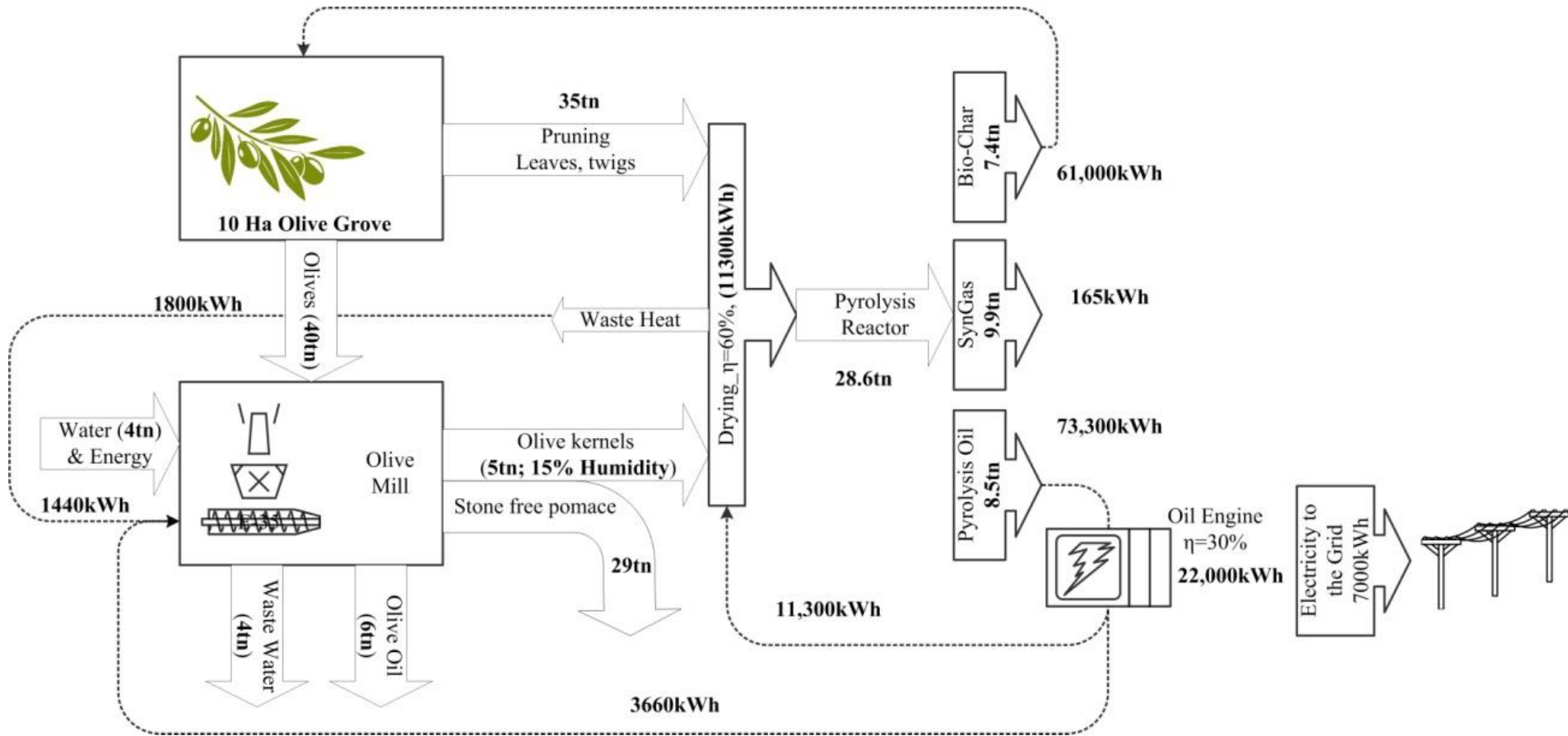
Solid Waste Streams

- ***Olive farming:***
 - *Olive Branches*
 - *Olive Pruning*
 - *Olive Twigs and Leaves*
- ***2 phase Olive Mill:***
 - *Olive kernels*
 - *Olive leaves*
- ***Semi- Solid Wastes: Olive Mill wet pomace*
*→ To olive refineries for Olive Oil Extraction***

Solid Waste Management

- *Current situation* → Combustion in furnaces or open fireplaces (heat & CO₂)
- *Proposed Scheme*
- Investigation of the potential of the reuse of the solid wastes from olive farming and olive milling (kernels)
- Scope: Is the development of an energy autonomous Olive Grove/ Olive mill system
- *ROUTES*
 - *Pyrolysis* → *Energy & Materials*
 - *Gasification* → *Energy*

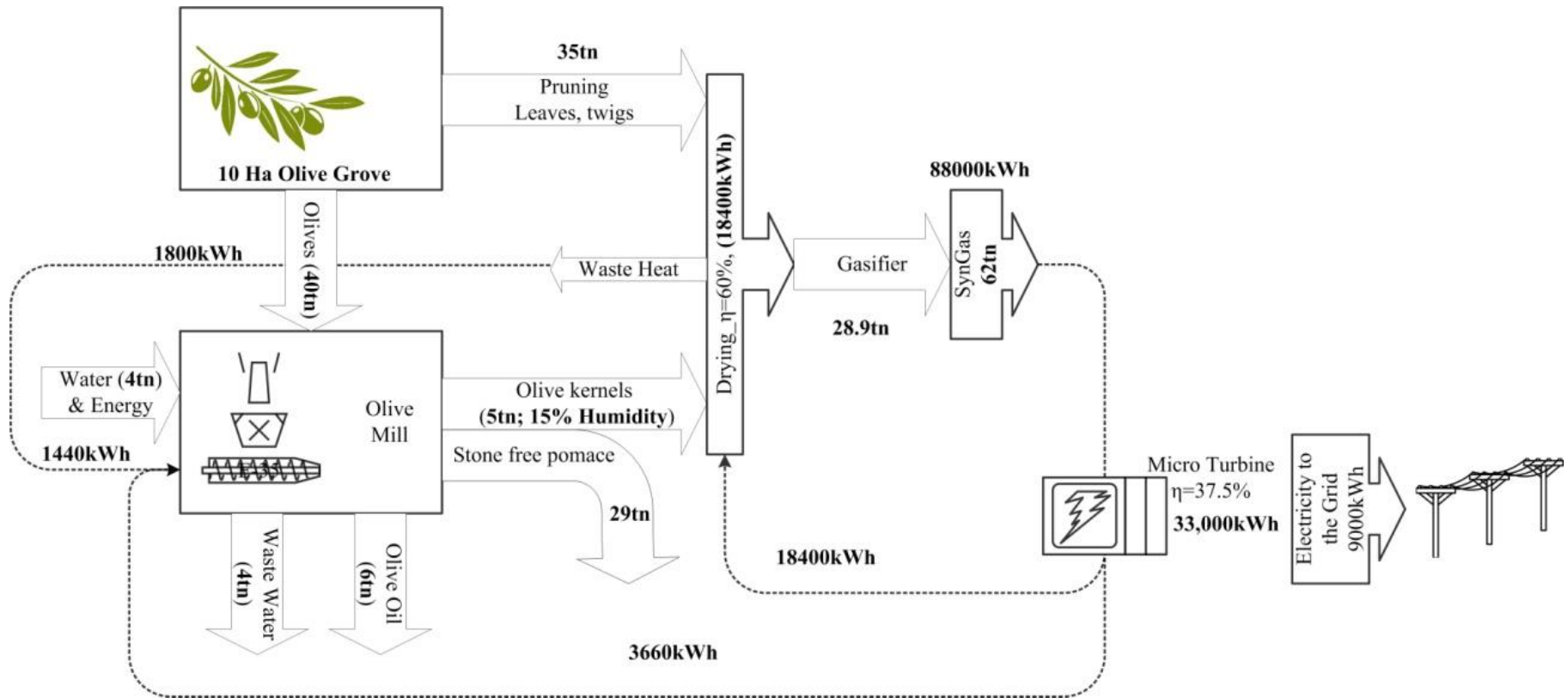
Solid Waste Management - Pyrolysis Process



Solid Waste Management - Pyrolysis Process

- The pyrolysis temperature set at 600 °C, with an approximate heating rate of 200 °C/s
- The producer gas is a mixture of CO (99%) with minor fractions of CO₂ and CH₄ resulting in a **low enthalpy** SynGas that is **inefficient for use** for energy production and apparently is considered as **by product** of the procedure.
- The pyrolysis also produces 7.4 t of bio-char with an average LHV of 29MJ/kg and 8.5 t of bio-oil with an average LHV of 31MJ/kg
- ***Bio-char*** could be used in the olive grove as an ***soil amendment*** in order to preserve the fragile soil quality, a practice that is in line with the principles of ***ecology and sustainable agriculture***.

Solid Waste Management - Gasification Process



Solid Waste Management - Gasification Process

- The gasification temperature set at 800 °C, while the ER is at 0.3 (maximization of SynGas Production/LHV)
- The producer gas has an average LHV of 5.0MJ/kg and
- The micro turbine (Brayton cycle) has 37,5% efficiency
- Gasification process generates an additional 2000kWh_{e1} for the same input (compare to pyrolysis)

Conclusions

- Both systems are producing enough electricity to cover the needs of the olive mill operation and together they are having a surplus that can be sold to the power corporation and provide an extra salary.
- Gasification is producing more electricity (9,000kWh) and is more suitable in energy intensive olive farms while pyrolysis is producing bio-char (7.4 t) that can efficiently be used as a soil amendment and is more suited when the increase in production & the soil erosion is in question.

Conclusions

- Depending the olive mill/ olive grove requirements, the pyrolysis temperature, the heating rate, the pressure, the residence time, etc. could be modified accordingly resulting in different yields (increase yield of bio oil or increase yield of bio-char)
- The proposed method managed 40 t of woody biomass generated from a 10 ha olive grove in an environmental align manner following the concept of sustainable development.

Acknowledgements

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Thank you for your Attention

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