Efficiency and Equity trade-off in pyrolysis supply chain

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Contents

✓ The context of Foggia related to pyrolysis technology.
✓ The pyrolysis supply chain.
✓ SWOT Analysis of a pyrolysis project in Foggia: efficiency.
✓ Analysis of social acceptance of the pyrolysis plant development in Foggia: equity.
✓ Conclusions.
THE CONTEXT OF FOGGIA

- Average population density of 91.61 ab./km² (201.71 ab./km² national average)
- Firms distributed in agricultural (40.65 %), retail and wholesale (24.64 %) and building (10.72%) sector (PRGRU, 2013)
- Important productive tank of biomass and renewable energy

http://atlasole.gse.it/atlasole/  http://atlaimpianti.gse.it/atlavento/
FEEDSTOCK AVAILABILITY IN FOGGIA

Source: our elaboration from (http://www.rifiutiebonifica.puglia.it/)
URBAN SOLID WASTE (USW)

Urban solid Waste

Mixed municipal waste (as is) + residuals from the cleaning of streets and

Wet organic; 5.42%

Paper and cardboard; 4.85%

Altra; 6.14%

Waste from

Vegetal oil; 0.03%

Mineral oil; 0.00%

Used tires; 0.12%

Plastic; 2.46%

Textil; 0.72%

Wood; 2.46%

Source: our elaboration from (http://www.rifiutiebonifica.puglia.it/)
NET AVAILABLE BIOMASS FROM AGRO-INDUSTRY

Source: our elaboration from (http://www.rifiutiebonifica.puglia.it/)
EXISTING EQUIVALENT COMBUSTION PLANTS IN FOGGIA

Planned in 1990 and actived from 2013
RESEARCH INSTITUTE INVOLVED IN COMBUSTION TECHNOLOGY

Facility center of Star*AgroEnergy
The pyrolysis supply chain
Snapshot of the pyrolysis process
MATERIALS

✓ Cellulose
✓ Hemicellulose
✓ Lignin
✓ Some minerals
✓ Minor organic molecules
✓ Polymers
PYROLYSIS REACTION

✓ Process start
  • external energy (LPG, electricity)

✓ Reactor
  • temperature: up to 1000°C
  • oxygen concentration: < 2%
  • different types of reactors
  • link more devices together
Chemical processes
PRODUCTS

✓ pyrolysis gas
  • synthesis gas
  • bio-oil

✓ charcoal
ENERGY BALANCE

✓ Start up energy (⅓ pyrolysis gas and ⅔ char)

✓ Total efficiency: 90 – 95 %

✓ Process thermal efficiency:

\[
\text{PTE} = \frac{\text{Energy gas} + \text{Energy liquid} + \text{Energy char}}{\text{Energy biomass} + \text{External energy}}
\]
SWOT Analysis

**Strengths**
- Possibility to use any source of heat.
- Low-tech process.
- Low-quality feedstock.
- Few particle emissions.
- No useless waste.
- Biochar production.
- Potential for development.
- Possibility of using old incinerators.

**Weaknesses**
- Undeveloped market.
- Lack of knowledge.
- Metal concentration.
- High up-front investments.
- High cost of maintenance.
- Odour.

**Opportunities**
- Suitable feedstock in Foggia.
- Preexisting facilities.
- Good urban development planning.
- Restrained transport.
- UNIFG.

**Threats**
- Limited experimental research.
- Few scale up pilots.
- Social reluctance.
- Generalized emphasis on innovation.
STRENGTHS

✔ Possibility to use any source of heat, even solar energy.
✔ Low-tech process (pyrolysis reactors, cooling system, gas burning system, oil separation system, and wastewater plants), easy-to-understand technology.
✔ Low-quality feedstock, despite low calorific value or water level.
✔ Few particle emissions, less than a conventional biomass combustion.
✔ No useless waste.
✔ Biochar production, useful for soil composition, water purification and carbon sequestration.
✔ Potential for development.
✔ Possibility of using old incinerators, after little adjustments.
WEAKNESSES

✓ Undeveloped market, difficult customization.
✓ Lack of knowledge.
✓ Metal concentration, transfer from feedstock to biochar.
✓ High up-front investments, 300,000 €.
✓ High cost of maintenance, 5% of the investment.
✓ Odour.
OPPORTUNITIES

✓ Suitable **feedstock** in Foggia, more herbaceous than woody.
✓ Preexisting facilities, Gruppo Marcegaglia's incinerator (Manfredonia).
✓ Good **urban development planning**, comfortable transport.
✓ Restrained transport, less cost and CO2 emissions.
✓ **UNIFG**, expertise development.
THREATS

- Limited experimental research, necessity of institutional financing.
- Few scale up pilots, from theory to practice.
- Social reluctance, protests and lawsuits.
- Generalized emphasis on innovation, counter-productive if not objective or specific.
SOCIAL ACCEPTANCE OF THE PYROLYSIS PLANT

✓ Simulation exercise in order to assess the Stakeholders Involvement in the Foggia area pyrolysis plant

✓ Application of the Fuzzy Cognitive Map to identify policy drivers aimed at development of the Foggia Area Pyrolysis Plant
By doing a simulation exercise where the authors had been proposed to be stakeholders representatives as following:

- Marina: Economists/bankers
- Zoi Eleni: Pyrolysis plant company representatives
- Matteo: Farmers/inhabitants
- Claudiu: Local government analyst

Each stakeholders representative should rank from 1 to 8 the main criteria of importance according to their group representation.
## ASSESSMENT OF THE STAKEHOLDERS INVOLVEMENT IN THE FOGGIA AREA PYROLYSIS PLANT

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Stakeholders</th>
<th>Economists bankers</th>
<th>Pyrolysis plant company</th>
<th>Farmers inhabitants</th>
<th>Local government</th>
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<tbody>
<tr>
<td>Return on investment</td>
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<td>2</td>
<td>3</td>
<td>3</td>
<td>7</td>
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<tr>
<td>Annual revenues</td>
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<tr>
<td>Regional/Local Economy</td>
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<tr>
<td>Application of New/Innovative Technologies</td>
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<tr>
<td>Employment</td>
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<td>Environment</td>
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<td>Political and institutional benefits</td>
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### ASSESSMENT OF THE STAKEHOLDERS INVOLVEMENT IN THE FOGGIA AREA PYROLYSIS PLANT

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<tr>
<th>Criteria</th>
<th>Average grades</th>
<th>Final ranking</th>
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<td>Employment</td>
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<td>IV</td>
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<tr>
<td>Environment</td>
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<td>VI</td>
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<tr>
<td>Political and institutional benefits</td>
<td>5,25</td>
<td>VII</td>
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As analyzing the results can be seen that the region is looking for increasing its economy while keeping in control the environment. That way the focus of the region should be put on new innovative technologies that will gives to the inhabitants a good trade-off between the economic point of view and environment.
APPLICATION OF THE FUZZY COGNITIVE MAP TO IDENTIFY POLICY DRIVERS AIMED AT DEVELOPMENT OF THE FOGGIA AREA PYROLYSIS PLANT
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<table>
<thead>
<tr>
<th>Concept</th>
<th>Adjacency</th>
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<th>2</th>
<th>3</th>
<th>4</th>
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<th>7</th>
<th>8</th>
<th>9</th>
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<tbody>
<tr>
<td>1. Subsidies for pyrolysis plant</td>
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<td>2. Food non/food farming competition</td>
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<td>+1</td>
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<td>6. Valorization of residual</td>
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<td>7. Employment</td>
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<td>8. Biomass supply from forest, sawmill and farming</td>
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<td>10. Area's image</td>
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<th>Research</th>
<th>Territorial</th>
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The economic concepts are putting pressure on the environment, research and territorial concepts in the sense that the region needs an economic development but also it need to be taken cares of the environmental impact, area’s image and technological innovation.

The main fear is related to the fact that the policy measures enhancing the non food crops may induce a critical agricultural land use change, with fears in terms of environmental sustainability, due to the introduction of alien species, or unsuitable farming practice. Otherwise, the development of the pyrolysis plant will bring benefits of the community by valorisation of wastes and residuals, slightly improving the employment rate but also by bringing additional income for the agricultural sector, being able to sell or to be exempted for paying some taxes on the generated wastes.
1. The available amount and composition of feedstock is suitable for the
development of a Pyrolysis supply-chain (need of trade-off analysis).
2. Need of active promotion of opportunities/threats to overcome social
skepticism.
3. Set up of proper solutions for reducing the grade of uncertainty, lack of
information, investment costs.
Grazie!

Ευχαριστούμε!

Mulțumesc!