INTRODUCTION
Nowadays, the shortage of fossil fuels and the irreparable damage done to the environment has induced an increase in biofuels production. The most common biofuel in Europe is biodiesel. During this chemical process, crude glycerol is produced as a by-product; it has a negative influence on the price of biodiesel because the current market is unable to absorb the large increase of crude glycerol production due to the level of impurities. The production of pure glycerol from this residual glycerol involves high costs and requires complex purification methods. Thus, the process is not economically viable and other alternatives have been found. One of the strongest alternatives is to ferment the crude glycerol with a bacterial strain which is able to tolerate impurities and produce valuable products like 1,3-Propanediol.

OBJECTIVES
Find a way to use crude glycerol as a carbon source for bacteria and obtain 1,3-Propanediol.

CRUDE GLYCEROL
1,3-PDO
Understand basics of biorefinery. Discuss which strain is the optimal for the process.

MICROORGANISMS

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>Chrobarbacter</th>
<th>Clostridium</th>
<th>Klebsiella</th>
<th>Enterobacter</th>
<th>Lactobacillus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Productivity</td>
<td>0.58</td>
<td>1.96</td>
<td>1.22</td>
<td>NF</td>
<td>0.33</td>
</tr>
<tr>
<td>Yield</td>
<td>0.86</td>
<td>0.53</td>
<td>0.5</td>
<td>0.51</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Klebsiella pneumoniae

One of its well-known applications is the formation of methyl ethyl ketone, by dehydration, which can be used as a liquid fuel additive.

PRODUCTS

1,3-PROPANEDIOL
2,3-BUTANEDIOL

CHEMICAL SYNTHESIS
Applications of PDO vary from polymers production, such as polyester and polyurethanes as PTT, to cosmetic and pharmaceutical uses.

GLOBAL MARKET

BIO-BASED PDO PRODUCTION

Lactic acid is used as a monomer for the production of polyactic acid (PLA). Lactate (PDO) is an important class of biodegradable polymers. Klebsiella Pneumoniae is able to produce highly pure D-lactate.

PLANT LOCATION

Wesseling, Cologne, Germany

This company produces 12,000 tons of crude glycerol every year. 4,000 tons/year of PDO are going to be produced.

CONCLUSIONS
In this project, biorefinery has been discussed as a good alternative to use this waste glycerol as a carbon source for bacteria to obtain 1,3-propanediol. There are different bacterial strains that can use it as a substrate to produce 1,3-propanediol. To go through our process and trying to achieve an optimal final product concentration, taking into account the productivity of each strain, we finally decided to use the microorganism Klebsiella pneumoniae which can produce not only 1,3-propanediol, but also other products such as 2,3-butanediol or lactic acid.

What is next? Analyze different operation procedures to select the best process to produce 1,3-PDO with high productivity and benefits in an eco-friendly way.

SELECTED REFERENCES