VFA as a Route to Renewable Transport Fuel

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Biowastes for 2nd generation biofuel

105m t (wet)
30m t (wet)
16m t (wet)
VFA concept

Substrates → Volatile fatty acids → CH4 & CO2 → Alcohols, Esters
VFA route for food and farm waste

- Pre-treatment
- Fermentation
- VFA Recovery

Residue for fertilizer
VFA export
VFA route for sewage sludge

Pre-treatment → Fermentation → VFA Recovery → Anaerobic Digestion

Residue for fertilizer

Biogas → VFA export
Alcohol and/or ester production

Farm Operations

Municipal Operations

Sludge Operations

Central Bio-refinery

Fuel Blending Distribution
## Biofuel route vs. Biogas route

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Biofuel route</th>
<th>Biogas route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital requirements</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Operational cost</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Carbon footprint</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Biofuel contribution</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

### Average All consumers

<table>
<thead>
<tr>
<th>UK industry (2009-10)</th>
<th>Pence per kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>0.86</td>
</tr>
<tr>
<td>Gas oil</td>
<td>4.32</td>
</tr>
<tr>
<td>Gas</td>
<td>1.67</td>
</tr>
</tbody>
</table>

### UK industry (2009-10)

- **Coal**: 0.86 Pence per kWh
- **Gas oil**: 4.32 Pence per kWh
- **Gas**: 1.67 Pence per kWh
Summary

- VFA offer a possible and convenient route for biofuel production from waste organic streams.

- The remaining challenges include
  1. More efficient substrate hydrolysis to achieve greater VFA yield;
  2. Effective VFA recovery (Reverse Osmosis or Absorption)
  3. Low cost catalysts and better reactor design for Biofuel production
Thank you