The Power of Simplicity

Serenergy®
Methanol Fuel Cells

• DMFC – Direct Methanol
• SOFC – Solid Oxide
• RMFC – Reformed Methanol
  – LT PEM based
  – HT PEM based
SerEnergy – Fischer Group

SerEnergy
• 50 people
• Making it work

Fischer Group
• 2000 people
• Making it big
Core engine
Product offering

- Methanol/water in
- Fuel Cell
- Electricity out (battery charging)
- Batteries

- 50% fuel savings compared to Diesel engine
- 40-50% electrical efficiency
- No harmful emissions (NOX or particle)
- No (Low) noise (<62dB)
Markets

Diesel Genset replacement

EV range extension
H3-5000
5kW methanol module

- Electric power: 5kW
- Elec. efficiency(LHV): 40-50%
- Weight: 70kg
- Dimensions:
  - Width: 19”/430mm
  - Length: 700mm
  - Height (6U/253mm)
  - Volume: 77L
- DC/DC: integrated – bat charging capability
- Output voltages: 48/250/350/700 VDC
- Startup electric energy consumption: <0.2kWh
- Preheating time: ~30min
- Ambient temperature: -30 to 50°C
H3-rack

Telco Cabinet - Front

- 2.5/5 or 10 kW option
- Option for integrated 48V battery pack
- Integrated 250L fuel tank
- Integrated air and fuel filtration
- Integrated 3G modem for remote support and monitoring
Methanol vision

METHANOL VISION

Battery  Fuel Cell  Tank

Methanol mix

MeOH

Energy storage

MeOH

Flaregas recovery

MeOH

Methanol Plant

Electrolysis  Power Plant  Gassification

H₂  CO₂  H₂ + CO₂

Wind turbines  Solar panels

Recycle symbol
Methanol Fuel cell vehicle

- Reduce battery to 30-50 km of range
- Implement liquid fuel tank
- Integrate heating system (cooling system)
- Adapt operation logic
Step 1
Infrastructure
Step 3

Street cleaning vehicle

- Battery Methanol fuel cell hybrid
- Extended operation – full day shifts
- 70% Co2 reduction
- Zero particles
What does it take

REM 2030 real urban and regional driving cycle

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td>67 km</td>
</tr>
<tr>
<td><strong>Average speed</strong></td>
<td>40 km/h</td>
</tr>
<tr>
<td><strong>Maximum speed</strong></td>
<td>120 km/h</td>
</tr>
</tbody>
</table>
Battery

The graph shows the remaining battery capacity [kWh] and driven distance [Km] over time [min].

- **Green dashed line**: Operation as BEV
- **Orange line**: Driven distance [Km]

The graph indicates that the battery capacity decreases significantly over time, with a corresponding increase in driven distance. The horizontal lines at 12 kWh and 300 km show the operation limits or targets.
With Range extender
Emission

- **Tank-To-Wheel Emmission**
  - Methanol: 40-60 gCo2/km
  - No particle emission

- **Well-To-Wheel CO2 emission**

<table>
<thead>
<tr>
<th>Type</th>
<th>Current status</th>
<th>Green scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel</td>
<td>132 g/km</td>
<td>100 g/km</td>
</tr>
<tr>
<td>Gasoline</td>
<td>176 g/km</td>
<td>123 g/km</td>
</tr>
<tr>
<td>Hybrid</td>
<td>142 g/km</td>
<td>80 g/km</td>
</tr>
<tr>
<td>Battery electric</td>
<td>98 g/km</td>
<td>2 g/km</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>178 g/km</td>
<td>3 g/km</td>
</tr>
<tr>
<td>Methanol</td>
<td>83 g/km</td>
<td>2 g/km</td>
</tr>
</tbody>
</table>

*Source: Alternative drivetrains 2014 – Danish department of energy*
# Basic fuel economics

<table>
<thead>
<tr>
<th></th>
<th>Diesel</th>
<th>Gasoline</th>
<th>Methanol/water Today</th>
<th>Methanol/water Tomorrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw price</td>
<td>4,46</td>
<td>4,55</td>
<td>1,51</td>
<td>1,51</td>
</tr>
<tr>
<td>Energy tax</td>
<td>2,66</td>
<td>4,14</td>
<td>2,66</td>
<td>0,70</td>
</tr>
<tr>
<td>Co2 tax</td>
<td>0,42</td>
<td>0,39</td>
<td>0,42</td>
<td></td>
</tr>
<tr>
<td>Nox tax</td>
<td>0,047</td>
<td>0,043</td>
<td>0,047</td>
<td></td>
</tr>
<tr>
<td>VAT</td>
<td>1,9</td>
<td>2,28</td>
<td>1,16</td>
<td>0,55</td>
</tr>
<tr>
<td>Pump price</td>
<td>9,587</td>
<td>11,40</td>
<td>5,79</td>
<td>2,75</td>
</tr>
<tr>
<td>Km/L</td>
<td>28</td>
<td>25</td>
<td>12,5</td>
<td>12,5</td>
</tr>
<tr>
<td>DKK/KM</td>
<td>0,33</td>
<td>0,45</td>
<td>0,46</td>
<td>0,22</td>
</tr>
<tr>
<td>Energy (kWh/L)</td>
<td>9,9</td>
<td>9,0</td>
<td>2,6</td>
<td>2,6</td>
</tr>
</tbody>
</table>

*Energy adjusted taxation = no diesel taxation of 40% water*