Development of first Estonian FC Car Iseauto and energy storage demo complex in Chemicum

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2021
Why hydrogen not electric vehicles?
Whats wrong?

Ruhnu elektriauto akut laetakse diisli jõul (31)
Was it wrong?

• Diesel generator efficiency is ~3.5 kWh per Litre
• 2.68 kg CO₂ per Litre of diesel
• 200 Wh per kilometer

• 153 g CO₂ per kilometer when using diesel generator for charging EV compared to 292 g per kilometer using power grid
Is Hydrogen a passing trend?
Auvetech Iseauto

- Self driving vehicle for autonomous transportation
- Originally Electric Vehicle with 15kWh battery
- Charging upto 6 hours
- 80% recharge 30min with quick charger
Auvetech Iseauto powered by hydrogen

- 20kWh hydrogen storage
- Refuelling time 3 minutes
- Ability to quick refuel on site
- Possible to expand hydrogen storage 50+ kWh
- Modular FC design
- Can have carbon emission close to 0g per KM
Hydrogen supply and distribution system of Auve Tech Iseaauto Liisu

- Filling inlet
- Venting valve
- CV1
- CV2
- CV3
- Fuel Cell
Energy supply and distribution system of Auve Tech Iseauto Liisu
But.... Does it work?
How to refill (connecting)
How to refill (disconnecting)
Development of energy storage demo complex in Chemicum

Installed:
- \( \text{H}_2 \) generator + Storage (600L 300bar + 600L 35bar)
- 1kW PEM fuel cell x1 + inverter
- 300W PEM fuel cell x3 + inverter
- 5kW PEM fuel cell x1 + inverter (temporarily removed for other purposes)
- Central microgrid inverter 30kW
- 80kWh Battery bank (Lead Acid “solar” 3000 cycles @ 80% DoD 60% capacity remains)
- Inverters for battery research
- 60kW Solar array with 8 separate inverters
- \( \text{H}_2 \) refuelling nozzle

Planned
- Li-ion battery bank

Future plans:
- \( \text{H}_2 \) compressor
- \( \text{H}_2 \) storage \(~2\text{m}^3\) @ 300Bar (~50 kg hydrogen)
- Electrolyzer with capacity 20kg/24h = 10 m\(^3\)/h = ~40-50kW
- Expanding solar field
Solar Panels

<table>
<thead>
<tr>
<th>Panel</th>
<th>Monokristall</th>
<th>Polükristall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>300W</td>
<td>285W</td>
</tr>
<tr>
<td>OCV</td>
<td>39,7V</td>
<td>38,7V</td>
</tr>
<tr>
<td>SSC</td>
<td>9,7A</td>
<td>9,42A</td>
</tr>
<tr>
<td>Nom.Current</td>
<td>9,26A</td>
<td>9A</td>
</tr>
<tr>
<td>Efficiency</td>
<td>18,44</td>
<td>17,52</td>
</tr>
<tr>
<td>Dimensions</td>
<td>1640<em>992</em>35</td>
<td>1640<em>992</em>40</td>
</tr>
</tbody>
</table>

184W/m²

1. 5kW inverter 19 Polycrystal panels
2. 5kW inverter 19 Monocrystal panels
3. 10kW inverter 36 Monocrystal panels
4. 10kW inverter 36 Monocrystal panels

1. 6kW inverter 20 Polycrystal panels
2. 10kW inverter 36 Monocrystal panels
3. 10kW inverter 36 Polycrystal panels
Solar Panels
# Electrolyzer

<table>
<thead>
<tr>
<th>AEM / elektrolüüser</th>
<th>ActaSPA 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>Anion Exchange Membrane</td>
</tr>
<tr>
<td><strong>H2 capacity</strong></td>
<td>1000nL/h</td>
</tr>
<tr>
<td><strong>Working pressure</strong></td>
<td>35 BAR (without compressor)</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>4.8kW</td>
</tr>
<tr>
<td><strong>Water consumption</strong></td>
<td>0.4L/h</td>
</tr>
<tr>
<td><strong>Puhtus</strong></td>
<td>&gt;99.999%+vesi (&gt;99.97%)</td>
</tr>
<tr>
<td><strong>Toitepinge</strong></td>
<td>100-240VAC 1 ph</td>
</tr>
</tbody>
</table>

4.8kW electrolyser 1nM3/h @ 35at = 2.8kWh storage
Fuel Cell

Main Powergrid

40 kWh LiFePO4 Battery

50 kWh Lead Acid Solar battery
3000 tsükült 60%

H₂ storage 600L = 58 kWh energy

Solar 10 kW
Solar 10 kW
Solar 10 kW
Solar 10 kW
Solar 5 kW
Solar 5 kW
Solar 5 kW
Solar 5 kW

Research Charger

Input 400V 3ph Bypass

Output 400V 3ph 30 kW

4.8 kW Electrolyzer
1 m³/h @ 35 atm = 2.8 kWh energy
## PEMFC 1kW

<table>
<thead>
<tr>
<th>PEMFC</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>Proton Exchange Membrane</td>
</tr>
<tr>
<td>H₂ consumption</td>
<td>780L/h</td>
</tr>
<tr>
<td>Working pressure</td>
<td>0.5 BAR</td>
</tr>
<tr>
<td>Nominal Voltage</td>
<td>28.8V @ 35 A</td>
</tr>
<tr>
<td>Power</td>
<td>1kW</td>
</tr>
<tr>
<td>Working Temperature</td>
<td>50°C</td>
</tr>
<tr>
<td>Cooling</td>
<td>Air Cooled</td>
</tr>
</tbody>
</table>
Solar irradiation to electricity
Lead Acid Battery Pack

Central Inverter
Electricity to Hydrogen
Low pressure storage (35bar)
High Pressure hydrogen storage 300bar
H2 refuelling nozzle
Software to control and monitor

<table>
<thead>
<tr>
<th>Battery voltage [V]</th>
<th>Autonomy [hh:mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>382</td>
<td>34:03</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Battery current [A]</th>
<th>Capacity [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>51</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hydrogen flow rate [l]</th>
<th>Hydrogen capacity [m3]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>19.722</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL</th>
<th>INV1-5kW</th>
<th>INV2-10kW</th>
<th>INV3-10kW</th>
<th>INV4-10kW</th>
<th>INV5-6kW</th>
<th>INV6-10kW</th>
<th>INV7-10kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.58 kW</td>
<td>0.5 kW</td>
<td>0.46 kW</td>
<td>1.04 kW</td>
<td>1.08 kW</td>
<td>0.48 kW</td>
<td>0.98 kW</td>
<td>1.04 kW</td>
</tr>
<tr>
<td>61.90 kWh</td>
<td>5.7 kWh</td>
<td>5 kWh</td>
<td>11.5 kWh</td>
<td>11.8 kWh</td>
<td>5.4 kWh</td>
<td>10.9 kWh</td>
<td>11.6 kWh</td>
</tr>
</tbody>
</table>
Acknowledgements

• This work was partly supported by the EU through ERDF under projects TK141 “Advanced materials and high-technology devices for energy recuperation systems” (2014-2020.4.01.15-0011) and NAMUR ”Nanomaterials - research and applications” (3.2.0304.12-0397), and by the Estonian Research Council (institutional research grant Nos. IUT20-13 and 20065PR).

• Special thanks to Auve Tech for funding fuel cell development and integration to Iseauto
Thank you for your attention