Hydrogen Refilling Station - Roll-out, challenges and key success factors

3rd Symposium, Storing Renewable Energy for Future Mobility, Paul Scherrer Institute

H₂ Energy AG

Zürich, October 26th, 2015
Situation and objectives

• H₂ Energy Inc. is mandated by Coop and CMA to develop and establish the world’s most dense network of hydrogen refilling stations in Switzerland

• Our client is not only focused on HRS infrastructure but is aiming to reduce its overall CO₂ emission to zero by 2023. Therefore the current fleet of private and commercial vehicles need to be replaced by emission free power solutions such as fuel cells or batteries

• The goal is to set-up a nationwide hydrogen infrastructure and secure immediate utilization by FC vehicles and its own FC commercial vehicles

• Switzerland is an ideal European test market for innovations due to:
  – Scientific hub for new technologies
  – High purchasing power
  – Multicultural social and economic environment with three national languages (Italian, French and German)
  – Reliability and high implementation quality
  – High political acceptance (e.g. no Swiss car industry)
Who is the Coop Group?

**Detailhandel**
- coop
- coop city
- coop bau-hobby
- coop @home
- coop mineraloel
- coop prontco
- coop restaurant
- coop vitality
- Inter Discount
- Fust
- microspot.ch
- nettoSHOP.ch
- Schubiger
- top tip
- Lumimart
- Betty Bossi
- IMPORT PARFUMERIE
- CHRIST UHREN & SCHMUCK
- THE BODY SHOP

**Grosshandel & Produktion**
- TRANSGOURMET
  - Schweiz
  - Central and Eastern Europe
  - France
  - PRODEGA GROWA
  - SELGROS cash & carry
  - Transgourmet
  - Transgourmet
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<thead>
<tr>
<th>Total revenues Coop Group, 2014</th>
<th>CHF 28,2bn</th>
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<tbody>
<tr>
<td>Number of retail shops, 2014</td>
<td>Retail: 1'971, OOH 199</td>
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<td>Staff, 2014 (incl. apprentices)</td>
<td>66'125</td>
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</table>

- Market leader organic foods Switzerland and strong focus on sustainability
- Leading Swiss food retailer
- More than 20 retail and online formats, 8 production sites, Transgourmet Group
Who is Coop Mineraloel AG?

<table>
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<tr>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>Revenues Coop Mineraloel AG</td>
<td>CHF 2.7bn</td>
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<tr>
<td>Number of Coop Pronto shops</td>
<td>269</td>
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<tr>
<td>Number of gas stations</td>
<td>212</td>
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<td>Openings 2014 (new shops &amp; stations)</td>
<td>9</td>
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- CMA franchise concept
- 51/49 joint venture with Phillips 66 (Conoco Group)
Hydrogen technology – commercial solution for Coop Group

**Market and technology**
- Demand for alternative drive trains
- Market for hydrogen mobility
- Mature technology

**Politics, public view and regulations**
- Strategy Energy 2050
- Environmental Law Switzerland
- CO₂ reduction targets

• ’Actions speak louder than words’: implementation vision CO₂ neutrality in own organization first
• Increasing value-add in Switzerland (gross national product)

• Demand for future drive trains
• Sustainable business model to meet requirements of future mobility concepts
• Network of ‘sustainable filling stations’
Compliant with Switzerland’s subsidizing policies Coop targets a fully entrepreneurial approach

**Examples**

Germany, Berlin:
- Joint Venture H2 Mobility by Daimler, Air Liquide, Linde, Total, Shell and OMV
- Goal: 400 HRS by 2023, estimated investments: € 400 mill.
- State is funding more than € 1,6 bn for H2 technologies

Japan: 100 HRS, € 290 mill. state funded

California and a few others

➢ **Requirements: cash and time**

Only Coop/Axpo Project know
- Swiss Federal Office of Energy SFOE funding only part of first HRS
- No other subsidies known by now

➢ **Requirements: TRUCKS/BUSSES**
Why availability of hydrogen trucks and/or buses is so vital to successfully establish HRS networks

- 30-50x more hydrogen p.a.
  - 5’000-7’000 kg per truck and year
  - 130-170 kg per car and year

- Optimized utilization of infrastructure
  - Introduction easier
  - Less HRS points needed (tours)
  - Filling cycles can be steered
  - Point-to-point routes need more HRS points
  - Filling cycles with peaks

- Less expensive technology
  - 350 bar
  - Easier to compensate non available filling station
  - Educated professional drivers
  - 700 bar
  - Stable and easy to use technology
Our implementation and multiplication plan only works in cooperation with third parties

**Initial action**: establishing 3-5 hydrogen filling stations by Coop Mineraloel AG and securing value chain for renewable hydrogen

- Procuring Coop Hydrogen Trucks in order to generate immediate demand
- Extension of hydrogen network by CMA and other players
- Introduction of first passenger cars by OEMs
- Establishing nationwide network with 15-30 hydrogen filling stations
- OEMs offering H₂ trucks
- OEMs offering H₂ passenger cars
- HRS suppliers to deliver technology
- OEMs offering competitive H₂ technology
- HRS competitors
Issues can be derived from specific situation of third parties

Vehicle OEMs
- Slow ramp-up passenger cars
- No trucks available!

HRS technology suppliers
- Cost still unacceptably high (market not yet established, very few vendors, etc.)
- Technical solutions not yet fully balanced with end user needs
- Exposure to Swiss authorities

Competitive HRS operators
- Not yet existent
Divided interests of major OEMs for car and truck markets

Estimated revenues for Switzerland (in CHF mill., 2014)

Volkswagen Group

1'700

Cars: 75
Trucks: 110

Daimler Group

500

Cars: 110
Trucks: 90

Top 5 countries for HCV* manufacturing

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<th>2006</th>
<th>2014</th>
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* ‘Cars’ is the dominant segment for both OEMs
* Volkswagen and Daimler have a combined Swiss market share for heavy trucks of about 60%
* Both have a car and a truck division, managed separately and independently
* The two markets (cars and trucks) have different consumer patterns
  - Cars: design, technology, innovation
  - Trucks: cost in order to fight Chinese competitors

* HCV: heavy commercial vehicles, trucks > 6 to.
Alternative drivetrains for commercial trucks not a priority for key OEMs yet

Worldwide HCV market, 2014
In '000 units

- China: 985.0
- US: 377.4
- EU: 297.0
- India: 237.3
- ASEAN: 168.1
- Brazil: 164.7
- Russia: 116.0
- Japan: 77.1
- Central America: 65.5
- Eastern America: 48.1
- South America: 43.0

• 70% of worldwide truck market in very cost sensitive markets (filled bars)
• TCO is also main criteria in remaining 30% of all countries (industrial countries)
• Investments for innovation and improvements mainly for two aspects
  – Lowering TCO
  – Fulfilling emission targets
• Hydrogen drivetrains not a priority ...
• ... UNLESS ...
... unless they are more cost efficient than conventional drivetrains (combustion engines)...

... which already now is the case on a holistic TCO view by Swiss truck operators

100% = TCO_t (today)

100% = +/-100% of TCO_t

Road tax*
17% 8%

Mainten.
11% 15%

Depr.
8% 3%

Overhead

3%

Wages
43% 43%

Fuel
18% 26%

100% = TCO_t

Projected cost reduction for fuel cell system, in percent

Cost level for combustion engine

* Including insurance and interests

... and will be even enforced with technology developments and lower unit cost for the future

100%

30-35%

Today in 3-5 years End game
A Swiss HRS network could break even with a population of at least 80’000 fuel cell vehicles

Example development market penetration Toyota Prius

- It took Toyota approx. 4-5 years to produce and market 80’000 units p.a. (cumulative)
- This example was based on a global and existing worldwide infrastructure
- Toyota targets worldwide fuel-cell car sales of 30’000 a year by 2020
- In order to break-even in Switzerland a population of at least 80’000 are needed
- CMA cannot have idle capacity sitting around for more than 5 years and therefore needs demand driven by the Coop owned commercial fleet → TRUCKS
Build-up of hydrogen refilling network is faced with three major challenges

- Value chain matching customer needs
  - Onsite vs. delivered
  - Storage technology, etc.
- Redundancy of system
- Service and maintenance

**Technical**

**Commercial & economic**

**Regulation and politics**

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**Demand**
- Vehicles *(TRUCKS)*
- Hydrogen

**Supply**
- Customer attraction
- Marketing
- Pricing

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- General acceptance
- Authorities and Swiss finish
- Subsidies
- Tax
Key Success Factors

• Credible Vision - focus on purely sustainable energy

• Conviction, endurance and flexibility

• Strong partners and excellent team members

• Holistic approach highlighting all aspects of the hydrogen value chain