Hydrogen Supply to Off-Road Applications

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2019 Key Figures

- **NET PROFIT (GROUP SHARE)**: €2.24bn
- **REVENUE**: €21.9bn
- **MORE THAN 3.7 MILLION CUSTOMERS & PATIENTS**
- **PRESENT IN 80 COUNTRIES**
- **INVESTMENT DECISIONS**: €3.7bn
- **~67,000 EMPLOYEES**

Chemical elements and gases:
- **O2** (Oxygen)
- **N2** (Nitrogen)
- **Ar** (Argon and Rare Gases)
- **H2** (Hydrogen)
- **He** (Helium)
- **CO2** (Carbon Dioxide)
- **CO** (Carbon Monoxide)
Air Liquide has nearly 50 years of hydrogen development for industries.
Air Liquide Investments in North America
Air Liquide new investments in North America

1st large scale renewable liquid hydrogen production plant dedicated to the Hydrogen energy markets

- **Investment:** $150 M
- **Capacity:** 30 tons per day (40,000 FCEVs in the West Coast)
- **Location:** North Las Vegas, Nevada
- **Construction:** Began in 2020; operations & delivery in 2022

World’s Largest PEM Electrolyzer to supply ~100% decarbonized hydrogen for Canada and the East Coast Markets

- **Investment:** $40 M (additional investment to existing site with liquefier)
- **Capacity:** >8 tons per day (20 MW PEM electrolyzer)
- **Location:** Bécancour, Québec
- **Construction:** Began in 2019; operations & delivery by year-end
Nevada Construction
Becancour Site
Becancour Site - Aerial view
Hydrogen for Off-Road Applications
Hydrogen supply to a Mine - Demand

Consider a 10,000 tpd production mine
(Source USDOE Industrial Tech Program)

30-40% of site energy is diesel fed
Remainder is split between NG and Electricity

Diesel consumption
Given vehicle operating windows estimated
Hydrogen: 1kg = 2.5gallons diesel equiv

This is equivalent to about **4.5 tpd H2**
Hydrogen supply to a Mining Operation - Production

4.5 tpd H2 Production

SMR - 6-7X smaller than our project in NV (30tpd)
Note: this is 40-50X smaller than a large scale, industrial SMR

Electrolyzer - 10MW - 0.5X our Quebec project

Onsite or Offsite production?
Onsite may make sense for long duration, very large mines
Offsite for smaller operations
Hydrogen supply to a Mine - Supply

4.5 tpd H2 Supply

Liquid Delivery - on road
~1 trailer deliveries per day

Gaseous - on road
~ 9 trailer deliveries per day

Gaseous - pipeline
Small offtaker - is there an existing Pipeline? Very Unlikely
Hydrogen supply to a Mine - Storage

4.5 tpd H2 Consumption x 2-3 days backup
= 9-13.5 tons of storage

Liquid storage
- Spheres
- Horizontal tanks (4.5 ton storage each)

Gaseous storage
- HP cylinders

Gaseous - pipeline
- No (very limited) storage needed
Typical H2 Stations - in the field and in development

**Offroad (warehousing)**
- Current US:
  - 1 tpd, liquid
  - 4 dispensers

**LDV**
- Current CA: collocated at gasoline stations
  - 0.8 tpd, gaseous and liquid supply, some with onsite production
  - 4 dispensers, 350 and 700 bar

**HDV**
- Planned US: 10+ tpd, liquid supply, some with onsite production
  - 4-8 dispensers
Hydrogen supply to other off-road usages

**Sourcing the hydrogen**
- <1000 miles for liquid on road
- <300 miles for gaseous on road

Potential for onsite? Scale drives this decision

**Supply - Liquid or Gas**

**Dispensing - Permanent or Mobile**
Hydrogen supply to other off-road usages

**Military**
Base Operations vs Mobile and Deployed Operations

**Agriculture**
- Much more distributed energy usage
- More seasonal variation in usage
- Likely candidate for mobile fueling options

**Construction**
- Huge range in scale and duration of projects
Hydrogen supply to off-road usages

Project Scale and Duration drives decisions on

- Liquid vs gas
- Onsite or offsite production
- Permanent vs temporary/mobile infrastructure

Technology exists in each case, solutions are ready for deployment
Thank you!