



# Hydrogen Supply to Mining Operations

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# 2019 Key Figures



**~67,000**  
EMPLOYEES



PRESENT IN  
**80** COUNTRIES



MORE THAN  
**3.7** MILLION  
CUSTOMERS &  
PATIENTS



REVENUE  
**€21.9bn**



NET PROFIT  
(GROUP SHARE)  
**€2.24bn**



INVESTMENT  
DECISIONS  
**€3.7bn**



OXYGEN



NITROGEN



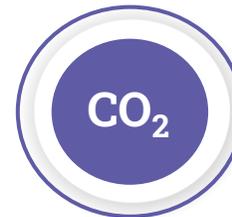
ARGON  
AND RARE  
GASES



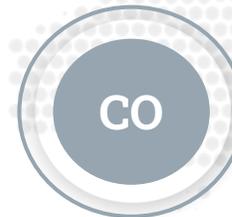
HYDROGEN



HELIUM



CARBON DIOXIDE



CARBON  
MONOXIDE

# Air Liquide has nearly 50 years of hydrogen development for industries

## Production & Supply chain

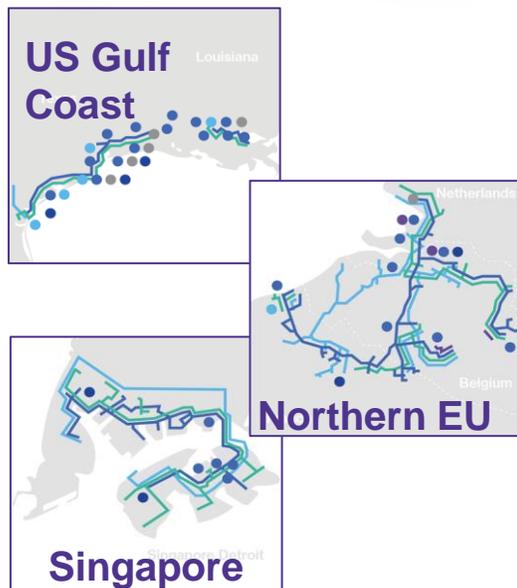
### Production



### Supply chain



## Distribution Networks



- Hydrogen
- Oxygen
- Nitrogen
- Synthetic gas
- Hydrogen and/or carbon monoxide facility and hydrogen source
- Oxygen and nitrogen facility
- Cogeneration facility
- Synthetic gas facility

## Markets Segments

### Process industries

Oil & Gas



Steel, Glass



Electronics



### Transportation

Space



## Key Figures

14 Bm<sup>3</sup>/yr

1,850 km H<sub>2</sub> pipeline

46 large H<sub>2</sub>/CO plants

40 electrolyzers in operation

2 B€ sales



## Air Liquide Investments in North America



# Air Liquide new investments in North America



## Nevada



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

- Investment: **\$150M**
- 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: **\$40M** (additional investment to existing site with liquefier)
- Capacity: **>8 tons per day (20 MW PEM electrolyzer)**
- Location: **Bécancour, Québec**
- **5** Construction: **Began in 2019; operations & delivery by year-end**

## Bécancour



Public - Oct. 2020

# Nevada Construction



# Becancour Site



# Becancour Site - Aerial view



# Hydrogen for Mining Applications



H<sub>2</sub>Only

EMERGENCY SHUT-OFF

CA 504785  
MC-27461-P  
US DOT 1048755

h<sub>2</sub> EAVY-DUTY PROGRESS PC  
BY TOYOTA HYDROGEN FUEL CELL

NO SMOKING  
FLAMMABLE GAS  
HYDROGEN GAS  
ODOR

Sale \$  
Kilograms  
Price per kg



# Hydrogen supply to a Mining Operation - Demand

What would a hydrogen based ground fuel infrastructure look like at a large mine site

In a given year, a large mining site consumes  
(Source IG Consultants, 2017 Study)

**37M liters of diesel per year**

Hauling Trucks

Excavators, Dozers, Loaders

Aux Equipment - generators, pumping, etc.

Rail Operations

This is equivalent to about **12tpd H<sub>2</sub>**



# Hydrogen supply to a Mine - Production

## 12tpd H2 Production

SMR - similar to our project in NV (30tpd)

Note: this is 1/8th the size of large scale, industrial SMR

Electrolyzer - 40MW - 2X our Quebec project

Onsite or Offsite production?

# Hydrogen supply to a Mine - Supply

## 12tpd H2 Supply

Liquid Delivery - on road

~3 trailer deliveries per day

Gaseous - on road

~ 25 trailer deliveries per day (!)

Gaseous - pipeline

Small offtaker - is there an existing pipeline?



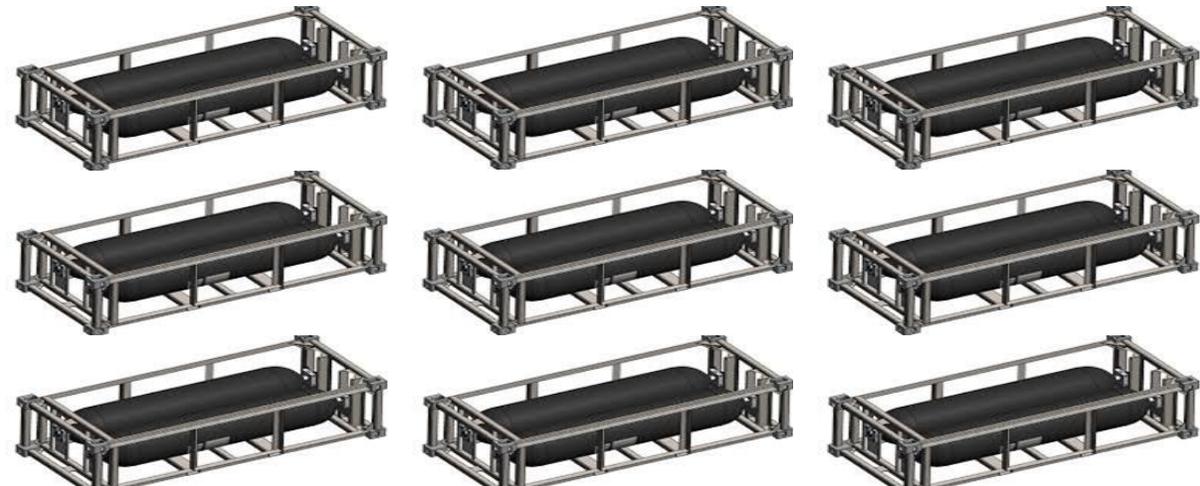
# Hydrogen supply to an Airport - Storage

12tpd H2 Consumption x 2-3 days backup  
= **20-30 tons of storage**

Liquid storage  
Sphere(s)

Gaseous storage  
HP cylinders

Gaseous - pipeline  
No (very limited) storage needed



# Hydrogen supply to an Mine - Dispensing

## 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 a Mine

## **The challenge is scale**

Production, supply and distribution - proven at scale

Applications - vehicles in service and under development

Dispensing infrastructure - leverage existing



CLEAN  
MOBILITY  
by  Air Liquide

**Thank you!**

 Air Liquide