



# NIKOLA MOTOR INTRODUCTION & HD STANDARDS DEVELOPMENT NEEDS



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**EVP, TECHNOLOGY, H2 & FC**

# PRESENTATION OVERVIEW

- **NIKOLA OVERVIEW**
- **HD HYDROGEN INFRASTRUCTURE**
- **HD INTERFACE DEVELOPMENT, VALIDATION TO STANDARDIZATION NEEDS**
- **SUPPORTING THE GTR #13**





# NIKOLA MOTOR'S WORLD-CLASS PARTNERS.

Nikola has partnered with some of the best industry leaders in the world. These partnerships enabled Nikola to come to market and make its' Zero Emission vision become reality.



**WABCO**

**MAHLE**



nel•



**PRATT  
MILLER**



- OVER 8,000 TRUCKS ON ORDER
- SINGLE CUSTOMER 800 TRUCK ORDERS FROM ANHEUSER-BUSCH INBEV
- TOTAL COST OF OWNERSHIP LEASE (TCO) INCLUDING H2 FUEL, FC TRUCK





## NIKOLA TWO™

- 100% ZERO TAILPIPE EMISSIONS
- 100% ELECTRIC DRIVE
- HYDROGEN POWERED
- 750 km - 1,200 km RANGE
- AUTONOMOUS CAPABILITIES
- 2,000 FT. LBS TORQUE
- 1,000 HORSEPOWER
- 125kW-250 kWh BATTERY
- 240 kW FUEL CELLS
- 80kg Hydrogen Storage



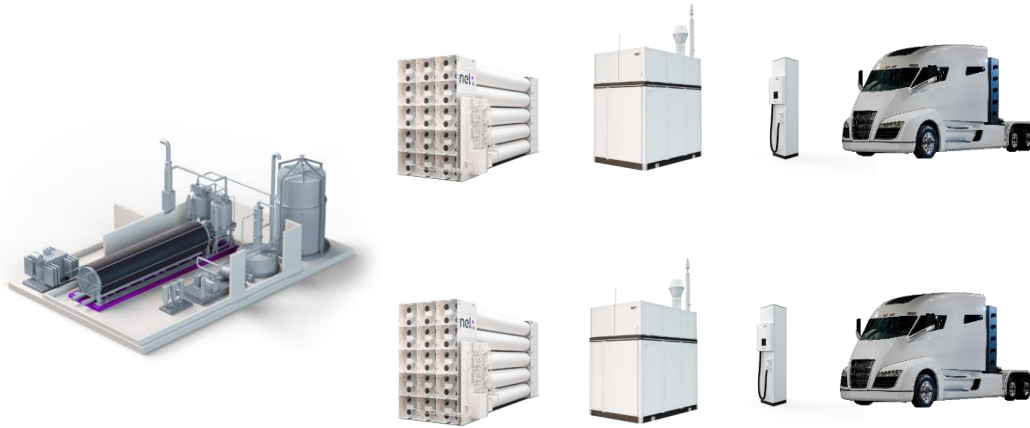
# H2 FUELING FROM ELECTROLYSIS

HYDROGEN GENERATION  
WITH RENEWABLES + GRID  
WITH LOW COST ELECTRICITY



## Development Stations 2019

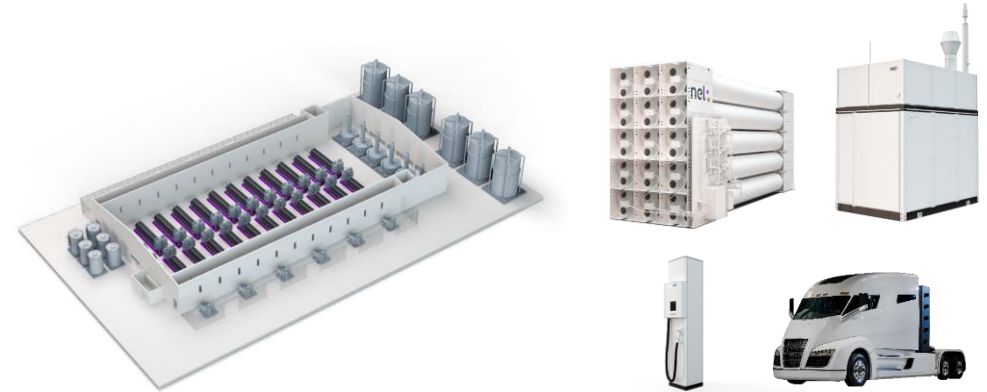
1,000kg hydrogen per day



*Dual fueling lines*

## Commercial Stations → 2023+

8-32 tons hydrogen per day



## NEL H2 STATIONS FOR NIKOLA:

- **NEL ALKALINE ELECTROLYSIS “TRIED AND TRUE” TECHNOLOGY, HIGH EFFICIENCY (20 YEAR+ LIFETIME)**
- **NEL 70 MPA HYDROGEN FUELING FOR BOTH LIGHT DUTY AND HEAVY DUTY**

# NIKOLA HYDROGEN STANDARD STATIONS RETAIL FOR HD & LD

- “Standard” Modular 4-8 Ton/day station for sale of retail hydrogen for Nikola and other customers
- Scalable up to 32 ton/day H2 (for truck Depot, etc.)
- SAE J2601 H70 Light Duty
  - Limit to 60g/s
  - J2799 IrDa Unidirectional
- H70 HF Heavy Duty Dispensers
  - Under Development
  - Goal: 180g/s + (TBC)
  - Goal: 10 Minute, 80kg Fill
  - Bidirectional Communications





# WHY 70MPa FOR 40 TON SEMIS?

## SHORT REVIEW OF POSSIBLE TECHNOLOGIES FOR FAST FUELING & 1000KM+ RANGE-COMMERCIAL TRANSPORT



- 35MPa: Reliable, cheaper H<sub>2</sub> Technology, however not enough range (Roughly 1/2 70MPa)
- 50MPa: Reliable, cheaper H<sub>2</sub> Technology, however not enough range, not yet standardized (Roughly 3/4 70MPa)
- LH<sub>2</sub>: Reliable, cheap, energy dense, range possible, however there are boil-off considerations (3%/day) and not enough liquefiers in World to supply in 5-10 years without massive investment
- LOHC: Liquid Organic HC: Cheaper, Energy Dense, unproven technology, not feasible for onboard vehicle use at this time.
- ✓ 70MPa HD: Reliable, Energy Dense (saves 500kg), enables range, however costlier, new fueling hardware and protocol needs to be developed for fast fueling: 80kg in 10 minutes.



# 70 MPA HD FUELING: DEVELOPMENT NEEDS



- 70 MPa Hydrogen Fueling protocol: 10+ minutes +NFPA Leak Checks (~12 min.),
- H2 Simulation + Fueling Lab Testing needs
- New HD H70 high flow nozzle, break-way and hose assembly
- Hydrogen Storage H70 Receptacle Check Valve
- SIL rated, Bi-direction communication
- New compressor for high flow 180g/s+
- New station cooling capacity for T40 HF
- New High Capacity H2 Station Storage Vessels @50MPa (much greater than 40kg)

# 70 MPA HD –H2 INTERFACE- COMPONENTS VALIDATION/STANDARD

New Validation Testing/ information to support SAE HD Fueling timeline:

- H70 high flow nozzle (freezing, etc.) (new ISO/ SAE)
- Break-way (pull tests, etc.) (new ISO/ CSA)
- Hose (bending, burst tests, etc.) (new ISO/ CSA)
- H70 Receptacle & Check Valves- (new ISO/ SAE)



# CONCLUSION



- **NIKOLA MOTOR BRINGING TO MARKET BOTH A FUEL CELL HD TRUCK AND ELECTROLYSIS H2 STATIONS WITH KEY TECHNOLOGY PARTNERS**
  - **NIKOLA SHOWING FUEL CELL PROTOTYPE TRUCK AND FUELING STATION IN ARIZONA ON APRIL 16-18 (NIKOLA WORLD)**
  - **THERE ARE NEEDS FOR NEW FUELING HARDWARE AND DATA PROJECTS FOR 70MPA HD**
  - **STANDARDIZATION IN ISO/ SAE NEEDED FOR HIGH FLOW HD COMPONENTS**
- WORKING WITH THE GTR #13 TEAM TO ACCELERATE NEXT REVISION TO INCLUDE REQUIREMENTS FOR HD VEHICLE SAFETY**