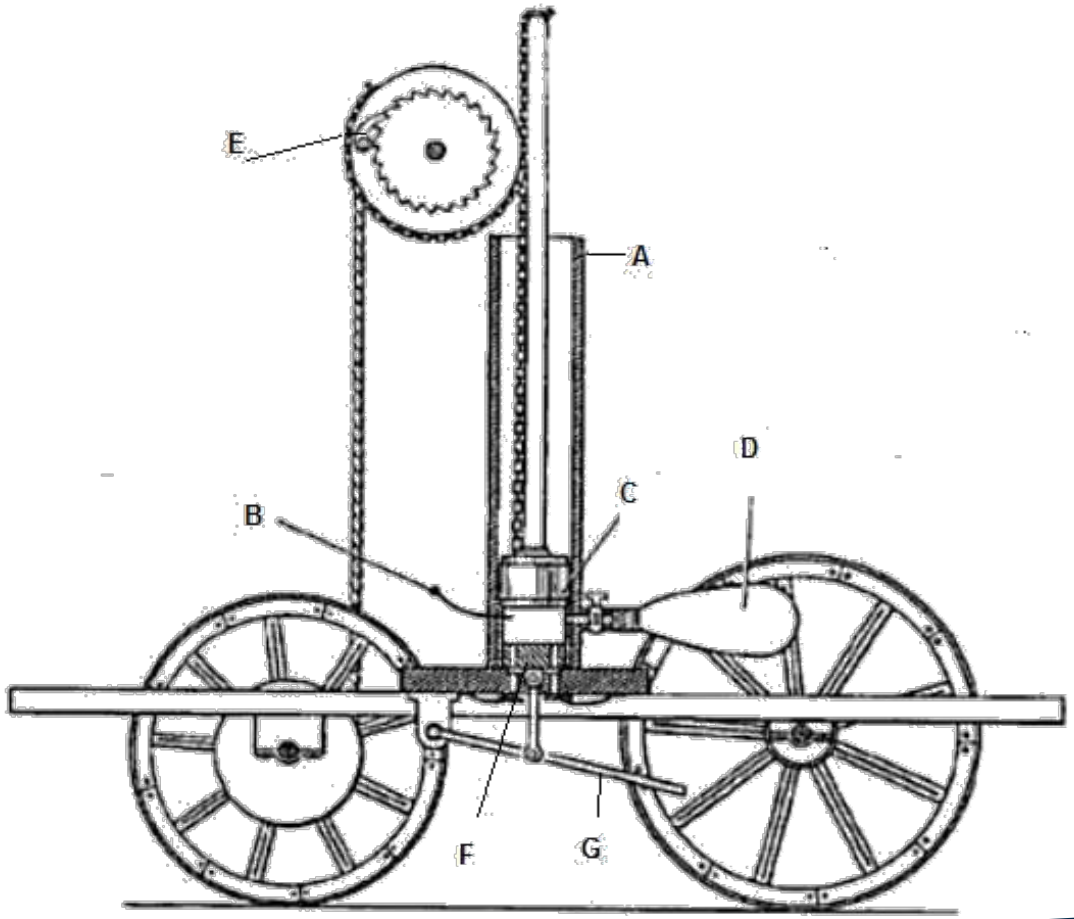
How Connected Hydraulics is Revolutionizing Hydrogen Compression

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

First Combustion Engine ran on hydrogen



https://en.wikipedia.org/wiki/De_Rivaz_engine

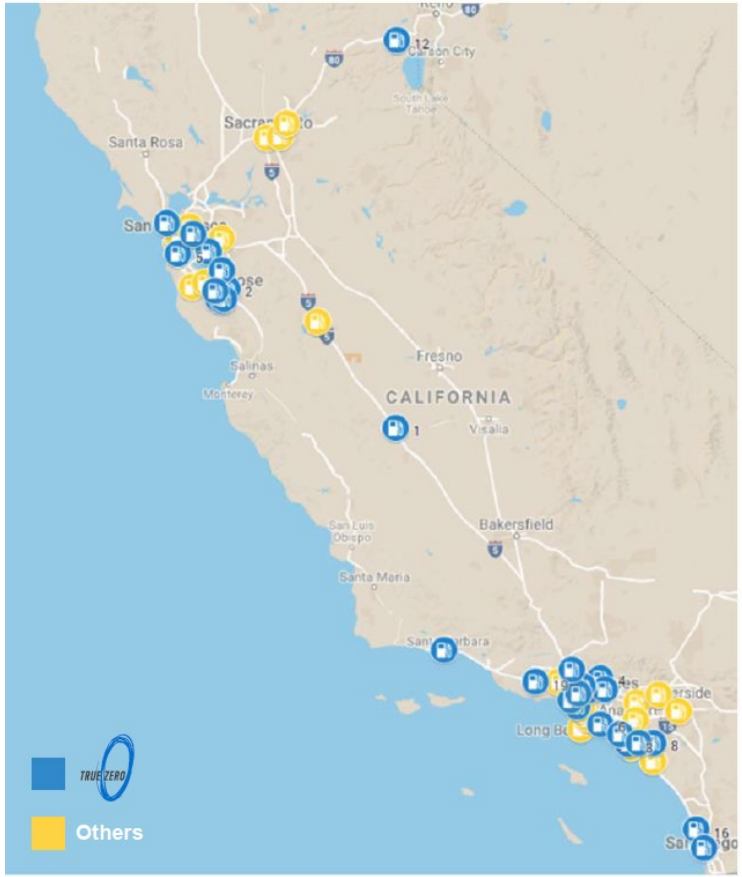
De Rivaz engine

1807
The first wheeled vehicle to be powered by an internal combustion engine running on hydrogen

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

Hydrogen Center of Competence in California, USA



rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

Sustainability @ Bosch

BOSCH

As the largest automotive supplier, we feel responsible to contribute to the decarbonization of the mobility sector

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

Openness for all technologies

Electric heavy trucks for deliveries to cities

Fuel cell

Fuel cells are expected to feature in as many as **20 %** of new electric vehicles by 2030

Electric cars are at home in the city

Battery

At least **20 %** of all new vehicles will be exclusively battery-electric by 2030

+6 % greater range per battery charge thanks to Bosch SiC[1] semiconductors

More economical and more ecological for frequent long hauls

Combustion engine

At least **67 %** of all new vehicles in 2030 will still run on diesel or gasoline, with or without hybrid

Diesel's CO_2 footprint is **15 %** better than gasoline's

New diesel engines have practically stopped emitting nitrogen oxide

Efficient over long and short distances

Hybrid

-15 % less consumption with Bosch 48-volt system

By 2030, at least **31 %** of all new vehicles will feature a hybrid powertrain

Important part of future mobility mix

Renewable synthetic fuels

-100 % CO_2 Renewable synthetic fuels are a carbon-neutral option for combustion engines

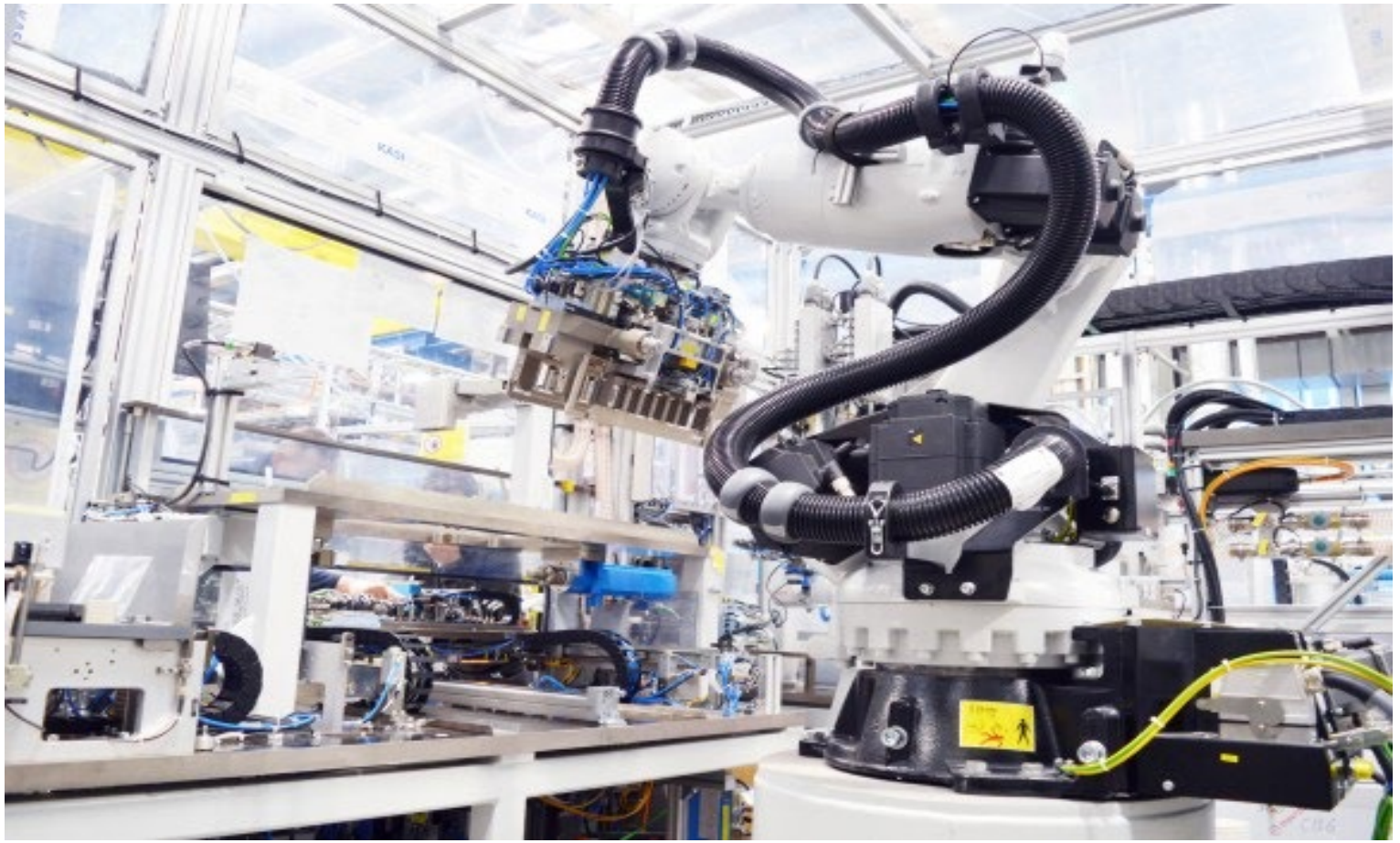
Roughly **50 %** of the vehicles that will be around in 2030 have already been sold – most of them have a gasoline or diesel engine

We believe in openness to technology and that hydrogen is needed to meet this goal

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

Our strength

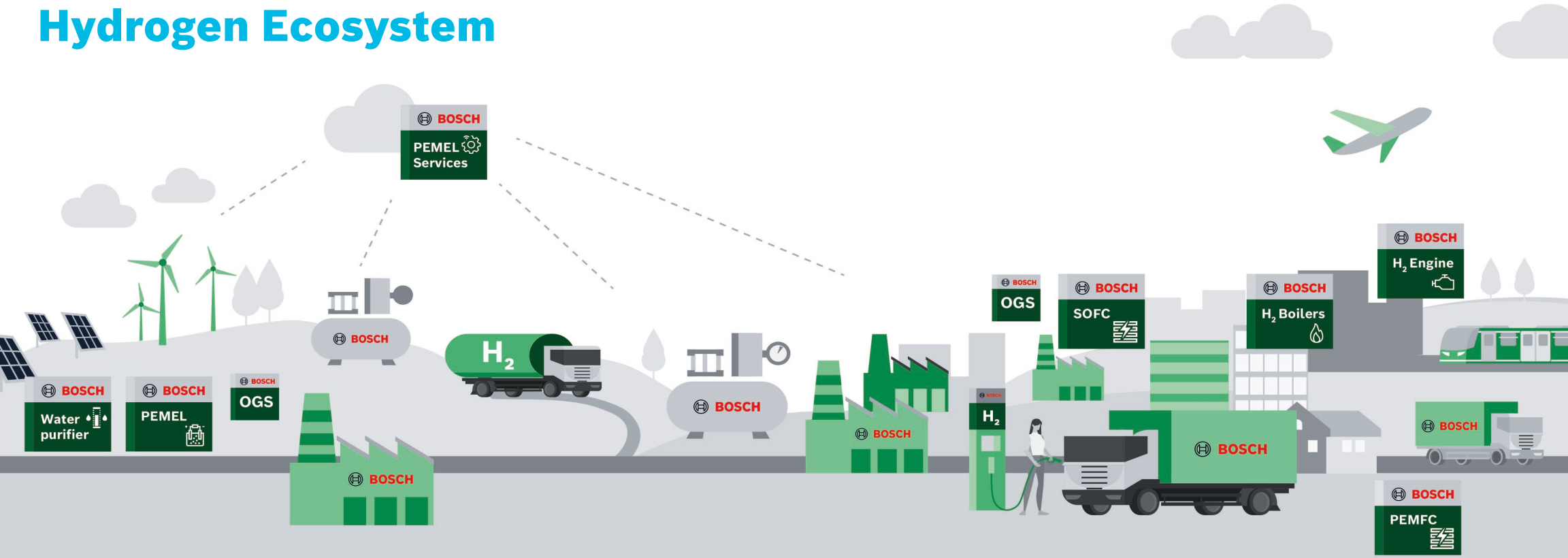


We want to make hydrogen successful by using our mechanical engineering power

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

Hydrogen Ecosystem



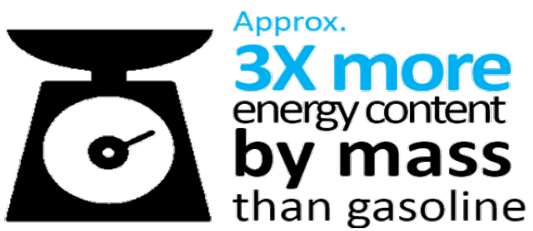
Production **Storage & Distribution** **Usage**

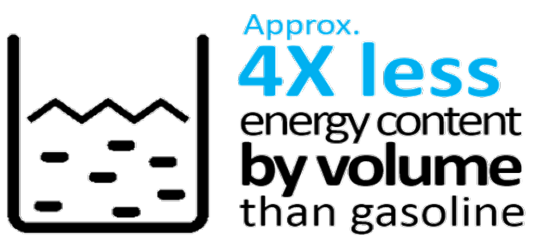
rexroth
A Bosch Company

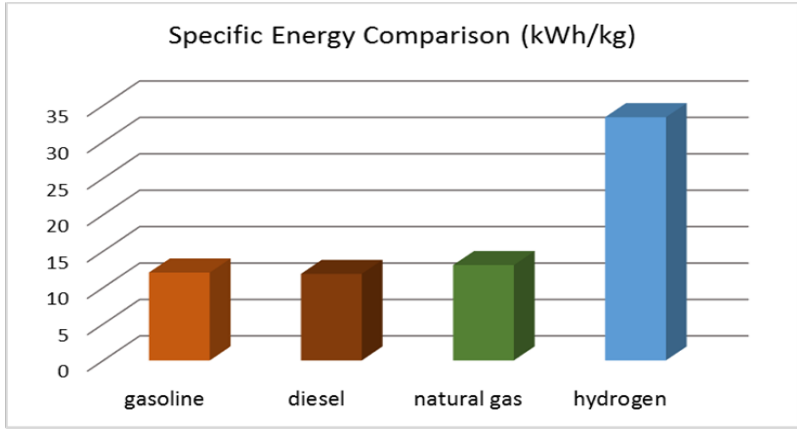
How Connected Hydraulics is Revolutionizing Hydrogen Compression

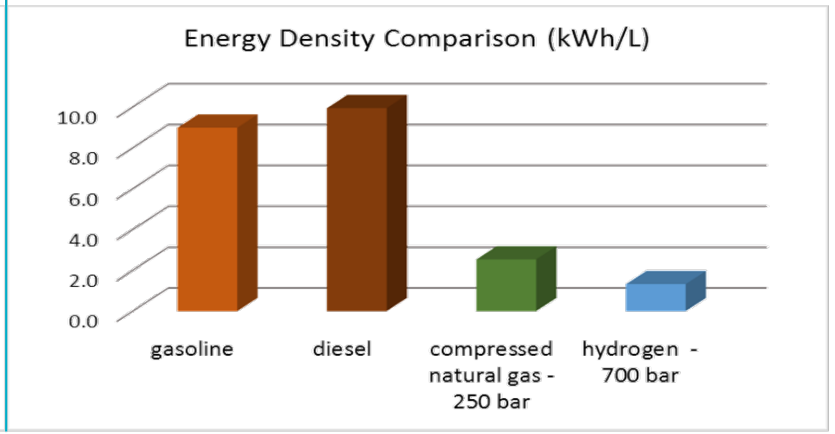
Why to compress the hydrogen?

High energy by mass, low energy by volume









Only nuclear energy is higher

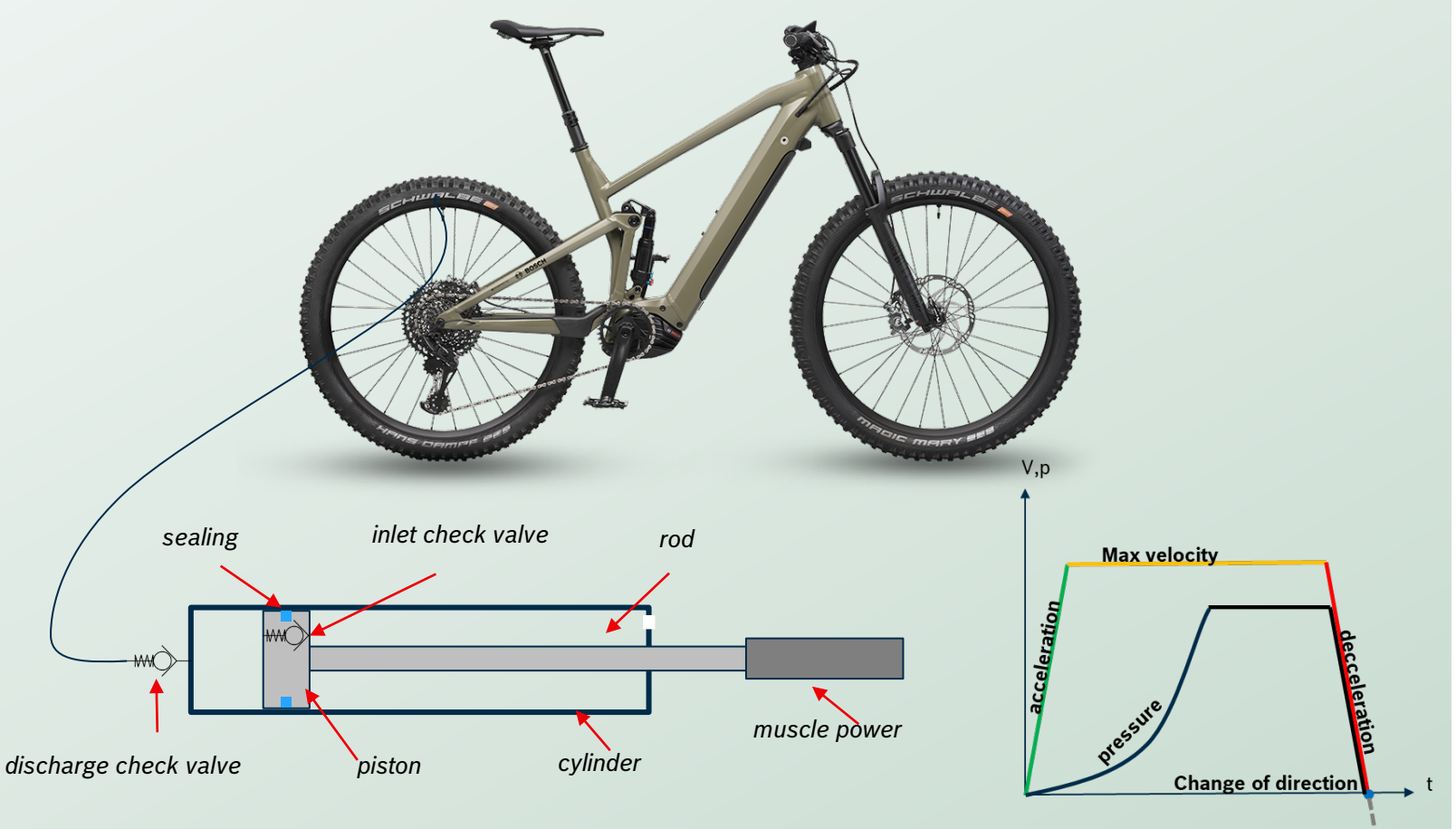
Density similar to styrofoam

Source: https://www.energy.gov/eere/fuelcells/increase-your-h2iq

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

What are the challenges?



Main Requirements

- Reliable
- Efficient
- Scalable

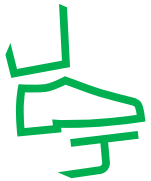
Soft Requirements

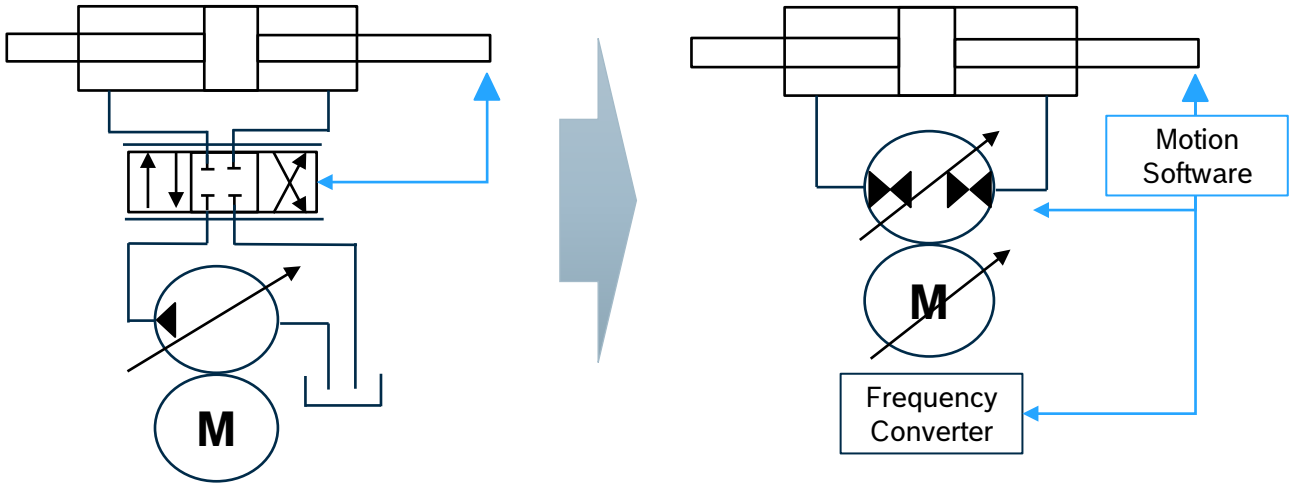
- Noise
- Space
- Maintenance

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

How can Connected Hydraulics mastering this challenges?



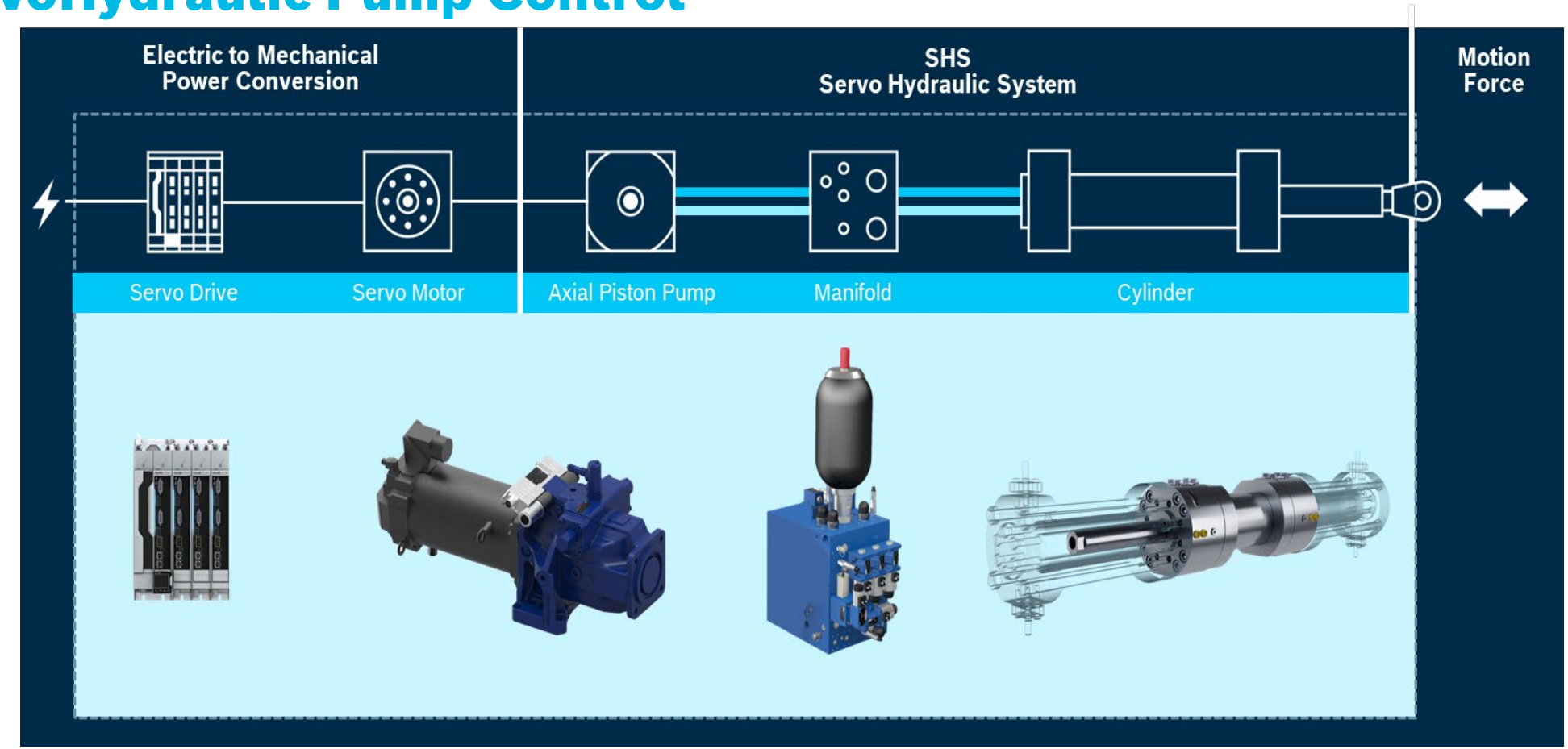


- *Strong – robustness with hydraulics*
- *Smart – controllability with software*
- *Efficient – efficiency with electrics*

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

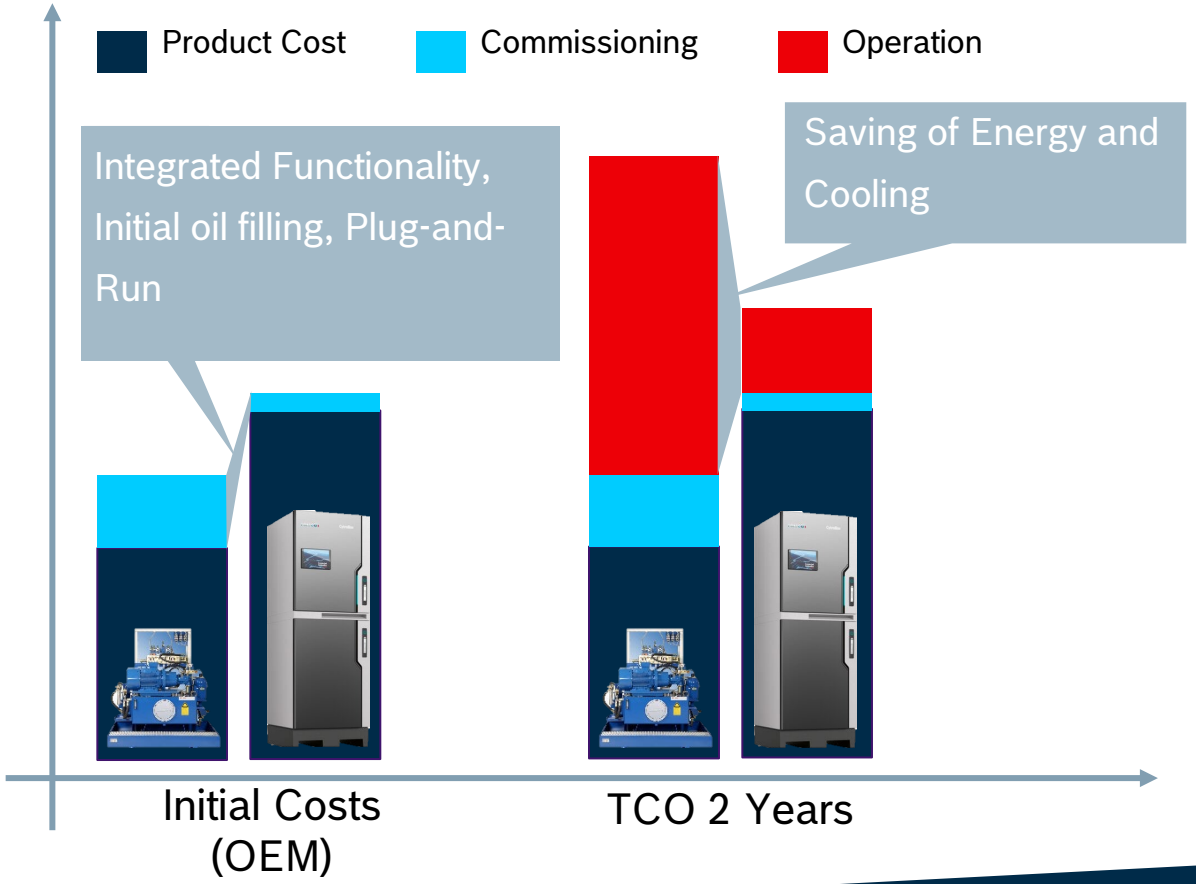
ServoHydraulic Pump Control



rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

TCO Advantage of Connected Hydraulics



Example: Hydrogen Refuelling Station

Compression to 700bar	80kg/h
Valves controlled hydraulics	85kW
Pump controlled hydraulics	23kW
Energy Price	$0.25/kWh
Annual savings pump controlled:	**-73%**
10h/day	**$57k**

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

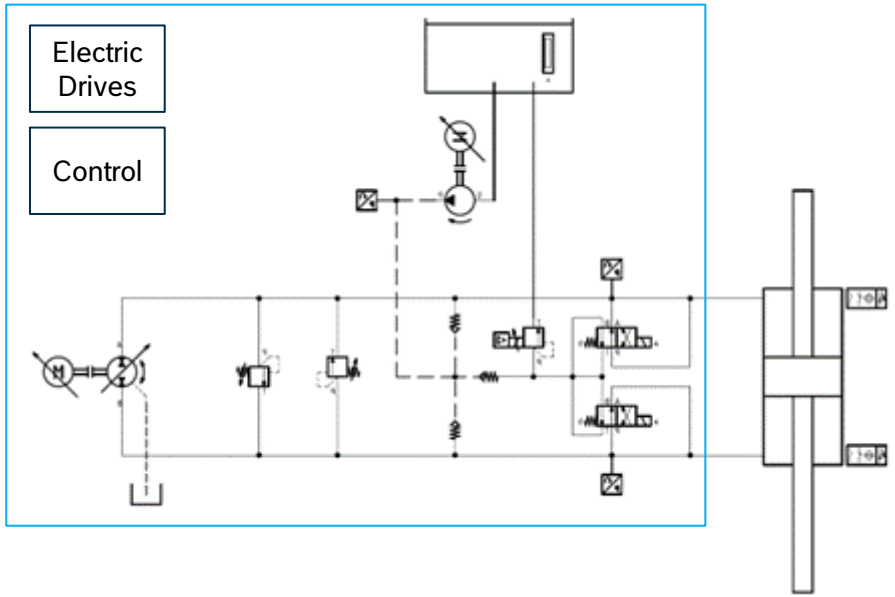
CytroForce – Technical data

Force range (kN)	≤ 200
max. stroke (mm)	≤ 500
max. velocity (m/s)	0,8
End position accuracy (mm)	~ 0,5
Working pressure (bar)	≤ 315

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

CytroCore for Hydrogen – Technical data



Power range (kW)
75 nominal & 110 peak

max. flow rate (l/min)
≤ 227

Working pressure (bar)
≤ 315

Tank volume (l)
26

Size (m×m)
0,7 x 0,7

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

CGV – Technical data

Force range (kN)
60 – 2.500

max. stroke (mm)
≤ 1000

max. velocity (m/s)
0,8

End position accuracy (mm)
~ 0,5

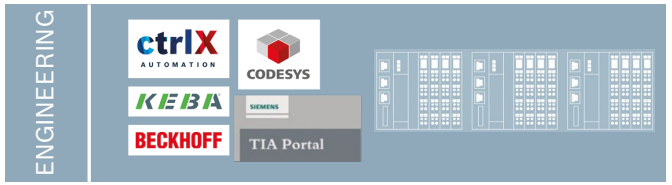
Working pressure (bar)
≤ 315

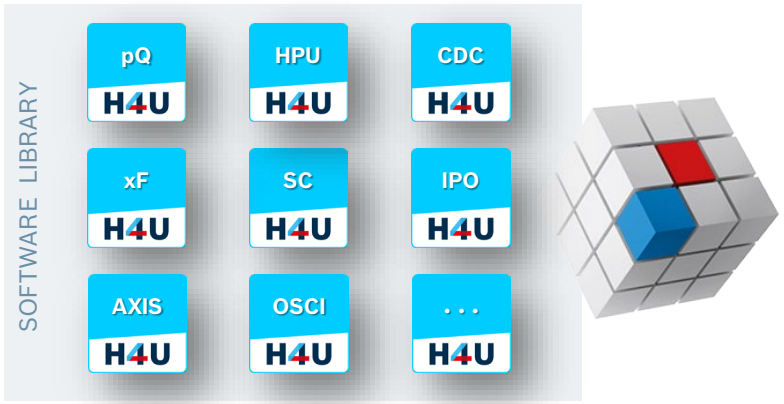
rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

Modular Software Platform

HYDRAULICS FOR YOU
THE INTELLIGENT MOVE





H4U.app CDC
Compressor Drive Control for Hydrogen

Operation mode control	
Operation limits calculation	✓
Supported functions	
Start-Up, cooling & monitoring	✓
Kinetic Buffering	✓
Model-based Actual Value Generation	✓
Compressor Actuator	✓
HPU Extension	✓

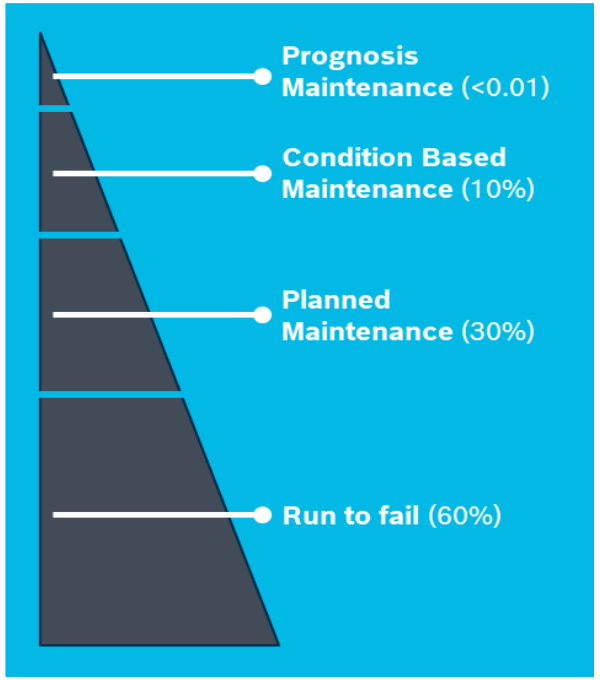
rexroth
A Bosch Company

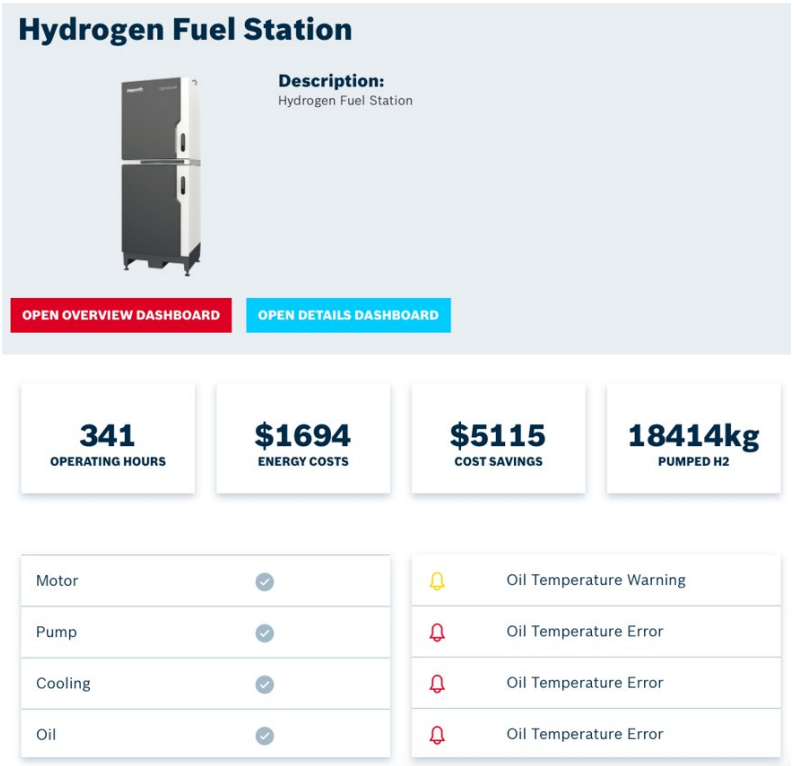
How Connected Hydraulics is Revolutionizing Hydrogen Compression

Digital Service to reduce downtime and optimize maintenance

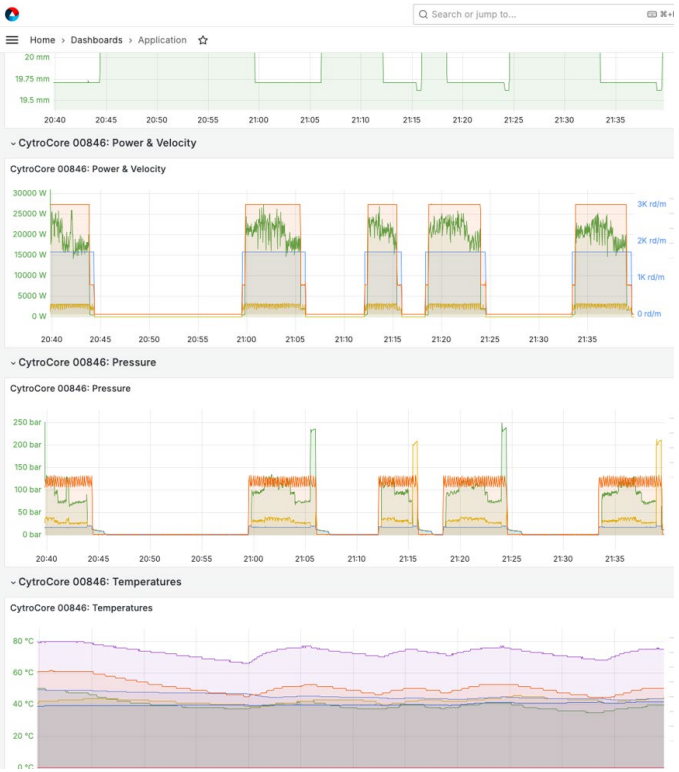
CytroConnect Solutions

Today´s Reliability Strategy





Dashboard

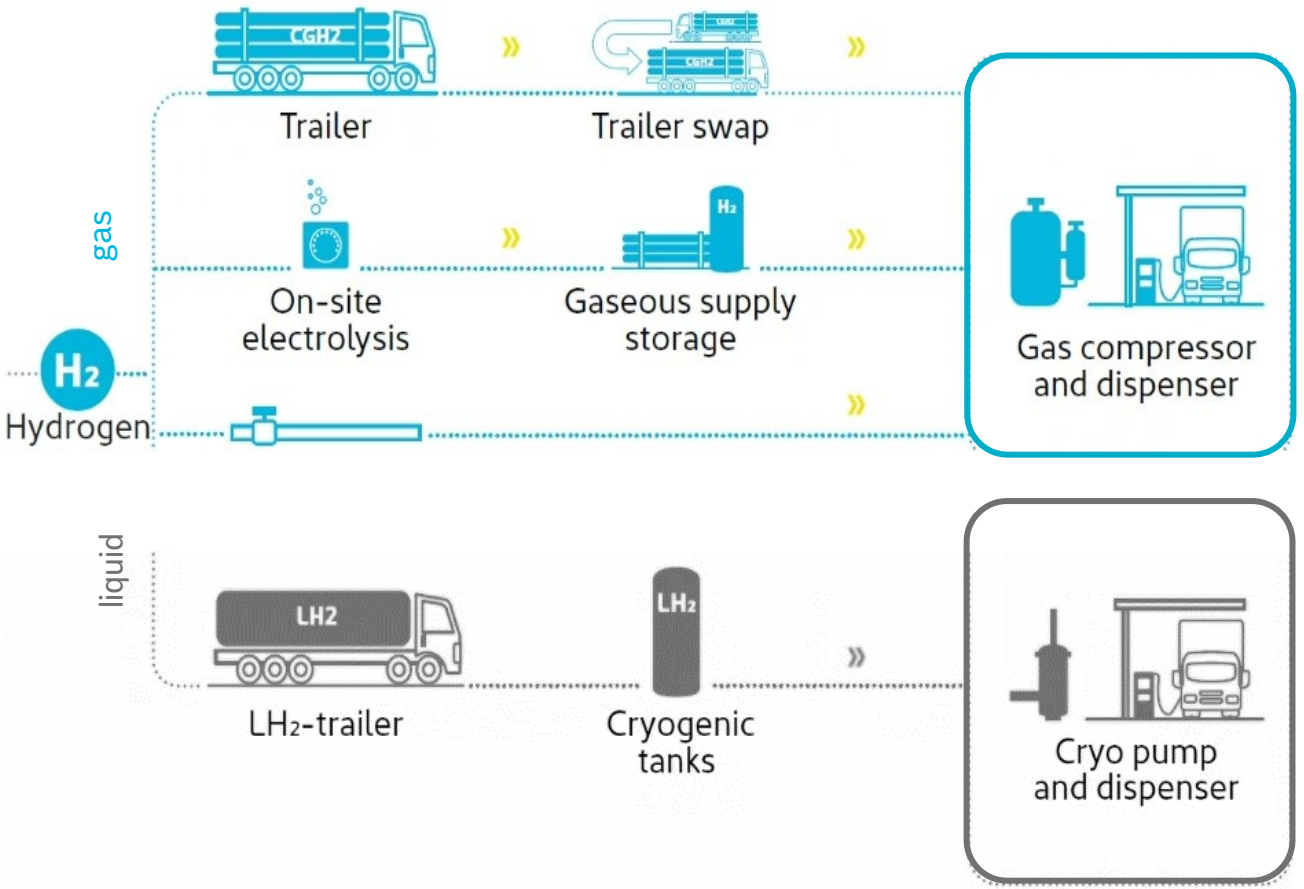


Oscilloscope

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

New Generation of CryoPumps

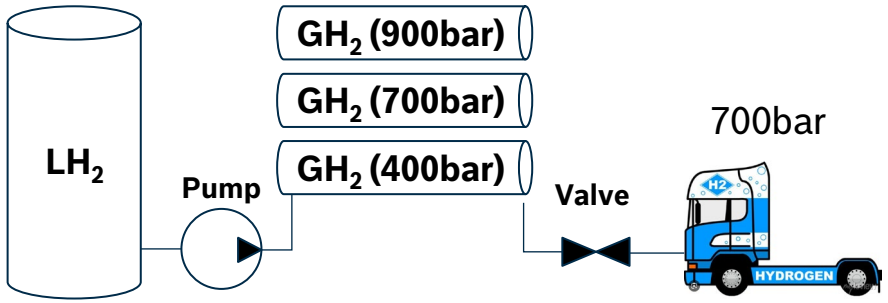


rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

New Generation of CryoPumps

Storage Bank – Fill Control by Valve



Direct Fill – Fill Control by Pump

New generation of CryoPumps

fill a heavy duty truck in 10min

No need for storage banks

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

Summary

Connected Hydraulic Portfolio

CytroConnect Solutions

HYDRAULICS FOR YOU
THE INTELLIGENT MOVE

Main Requirements

- *Reliable*
- *Efficient*
- *Scalable*

Soft Requirements

- *Noise*
- *Space*
- *Maintenance*

Benefits

With our Connected Hydraulics technology and experience, we enable YOU to make your refueling station more economic.

H2 Community

Let's together make hydrogen successful ☺

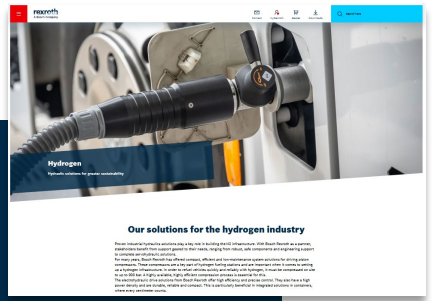
rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

rexroth
A Bosch Company

How Connected Hydraulics is Revolutionizing Hydrogen Compression

Further Information



WEBSITE

Hydrogen @ Bosch Rexroth

VIDEO

Innovative solutions for hydrogen refueling stations

VIDEO

Efficient solution for the compression of hydrogen

PRESS INFO

Distributing and refueling hydrogen more economically

CONTACT

Andreas Günder
Director Hydrogen
Center of Competence

rexroth
A Bosch Company

22 – 26 APRIL 2024

ENERGIZING A SUSTAINABLE INDUSTRY

Products and solutions at #HM24

hannovermesse.com

WORLD. LEADING. INDUSTRYSHOW.

HANNOVER MESSE

Hall 6 - Booth D26