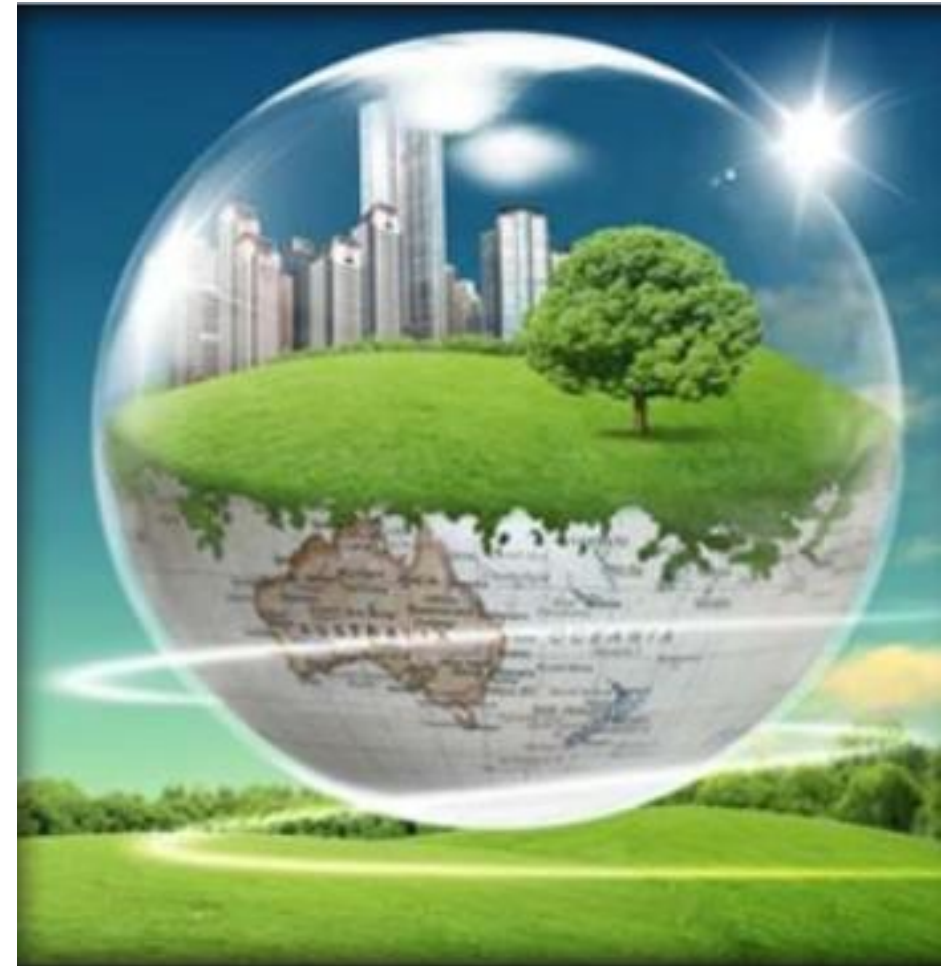


HIDRÓGENO VERDE

DESAFÍOS TECNOLÓGICOS



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Challenges of Hydrogen Technologies

- Production at high pressure, to avoid further compression
- Volume content of O₂ below 1%, for safety reasons
- Safe and light high pressure storage tanks
- Controlled combustión, to obtain zero emissions

ITBA Hydrogen production at high pressure

2002 - Test at 970 bar



2005 - Test at 970 bar



2009 Electrolyser in Base Esperanza, Antartica

- Max Production of H_2 : 1 Nm³/h
- Max Power: 5 kW - Operating pressure: 30 bar



2010 Electrolyser at UNC for wind-interface studies

30 bar, 0.8 m³N/h

Today it is in Chaco



2011 Electrolyser at Pico Truncado, Santa Cruz

3 Windmills donated by Germany

ITBA Electrolyser - 200 bar, 4 m³N/h

1st Hydrogen Service Station in Argentina



2013 Electrolyser at ITBA

150 bar, 0.5 m³N/h

6 months borrowed to Energy Systems

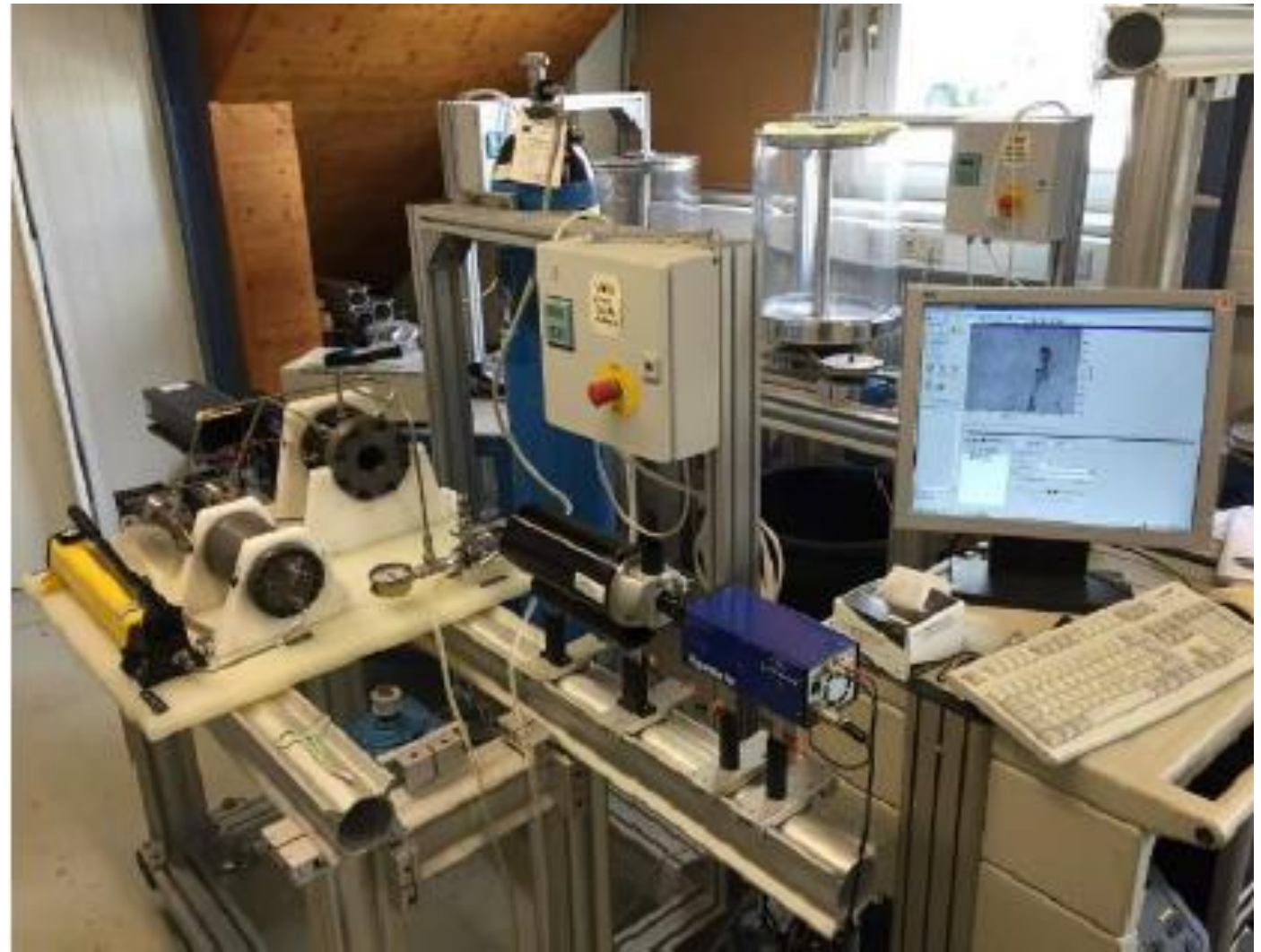
It is being optimized at ITBA for research



2016
ITBA Optical Electrolyser
at KIT. Up to 500 bar

Study of bubbles
detachment and
behaviour, at high
pressure electrolyser

High pressure
electrolysis is the
key for Green H₂



Felix Frey, ITBA-KIT Master Thesis, 2016

2016 - H2 purity: comparison of results

Company	Casale Chemical s	ErreDue	Hydrogen Systems	Norsk Hydro	Teledyne	ITBA
Max pressure [bar]	10	6	10	30	7	200
H ₂ production [Nm ³ /hr]	10	20	10	10	11	1-5
Electric consumption [KW/Nm ³ H ₂]	N/A	6	4,2	4.8	6,1	5
Purity [%vol.]	99,8	99,7	99,999(*)	99,8	99,999(*)	99.7
Origen						

(*) Using postproduction purity enhancers

KIT/ IKET high pressure catalytic converter to be tested at ITBA.

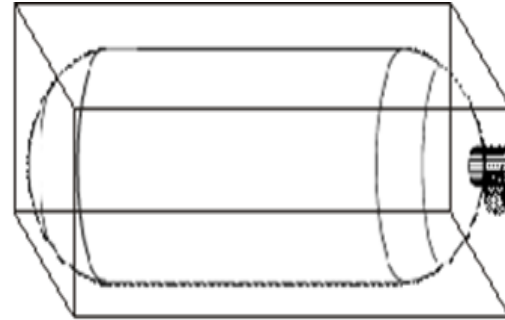
2019 - ITBA tested the KIT catalytic converter up to 120 bar



ITBA innovative high pressure H2 storage

Conventional steel tank

- heavy
- expensive
- unsafe



Coiled tank

- Material Al 6063 T6
- Tube length 200 m
- Inner diameter 5 mm
- Empty weight 27 kg
- Storage capacity 2,7 Nm³ at 700 bar
- Hydraulic test 1050 bar
- Not affected by hydrogen damage
- High heat transfer capacity
- Safe due to slow flow through small breaks
- Unrestricted shape

H2 compressibility at 25°C	
bar	kg/m3
1	0,1
350	28,3
700	47,0
1050	60,5
1400	70,7



Conversion Diesel bus → Otto hybrid bus

- Diesel engine → Otto fueled with H₂
- Controlled burn → zero NO_x emission
- Innovative tank for H₂ at 700 bar
- Engine coupled to electricity generator
- Bus powered electrically
- Regenerative brake system



Diesel engine, OM 904LA.III/22,130 kW

H₂-electric bus without fuel cells: greener and cheaper

