Hydrogen Technologies – from the Lab to the Market

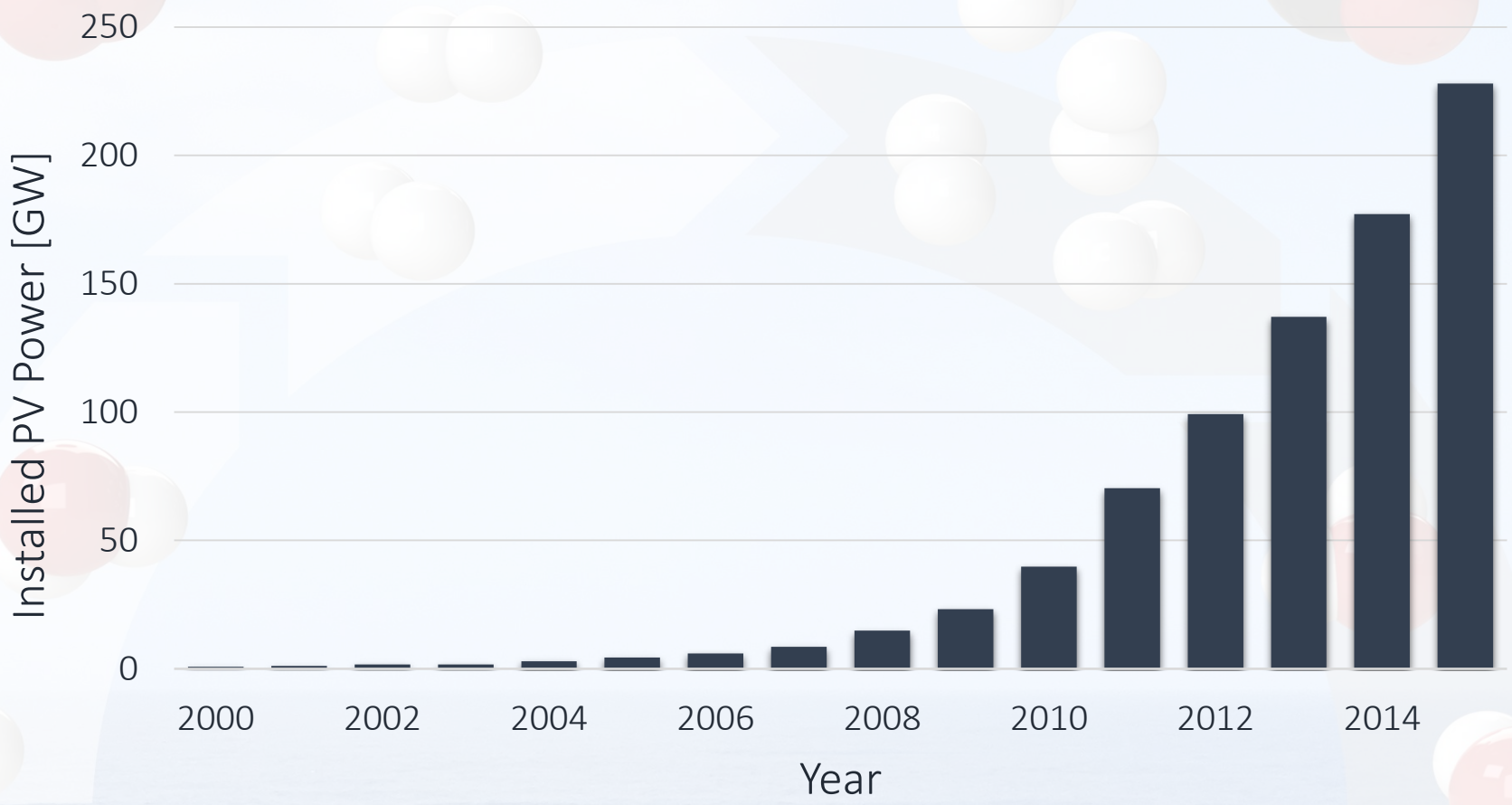
GRZ Technologies Ltd.

Swiss-US Energy Innovation Days, August 22nd, 2018

Dr. Noris Gallandat, Claudio Ruch, Prof. Andreas Züttel

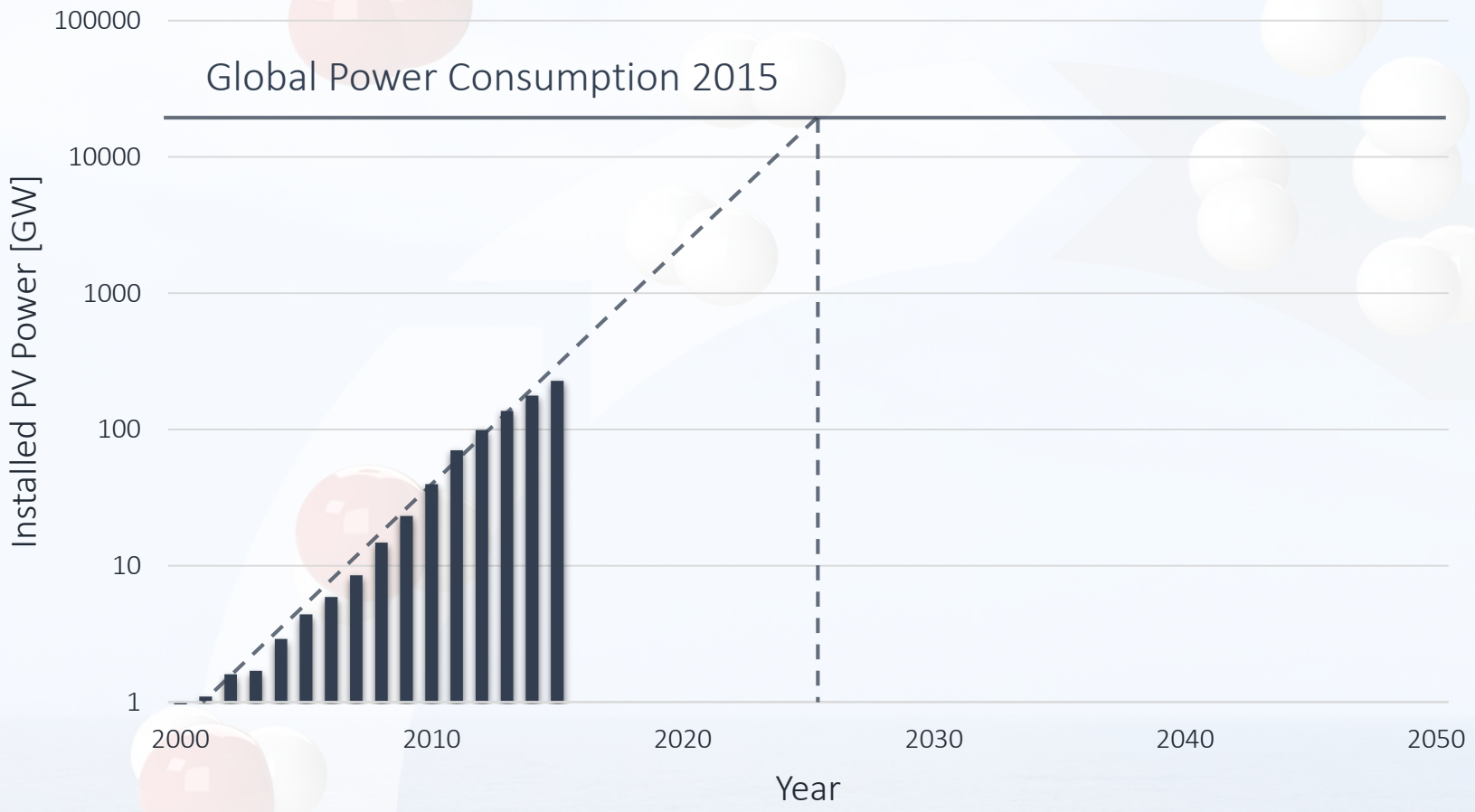
GRZ Technologies

Development of Solar Power (I)



[1] IEA PV trends 2016

Development of Solar Power (II)

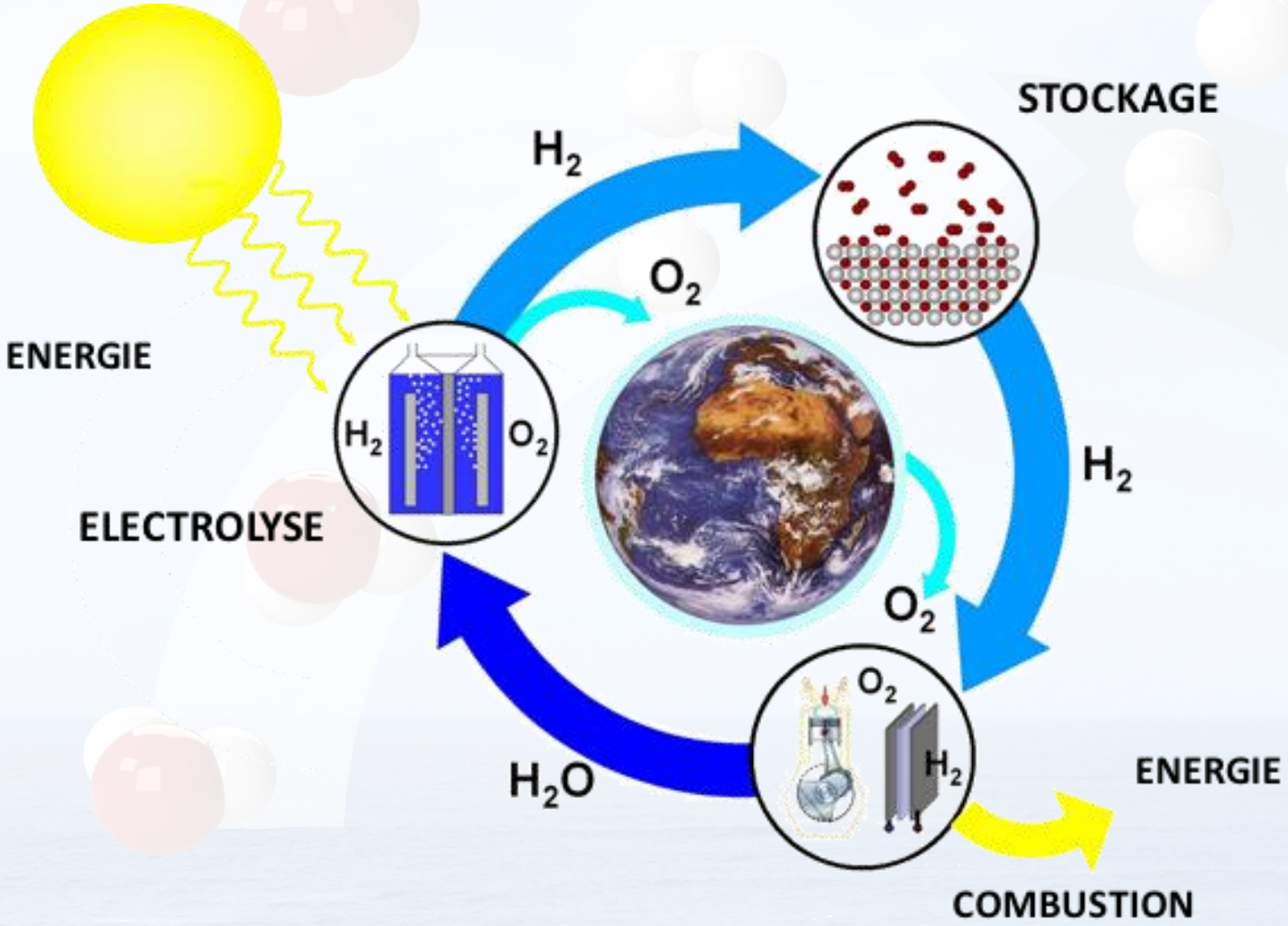


Should the current trend continue, the installed peak PV power will equate the global power consumption of today (incl. oil, gas, coal) *in less than 10 years.*

This creates a huge opportunity for energy storage technologies.

[1] IEA PV trends 2016
[2] IEA Key World Energy Statistics 2016

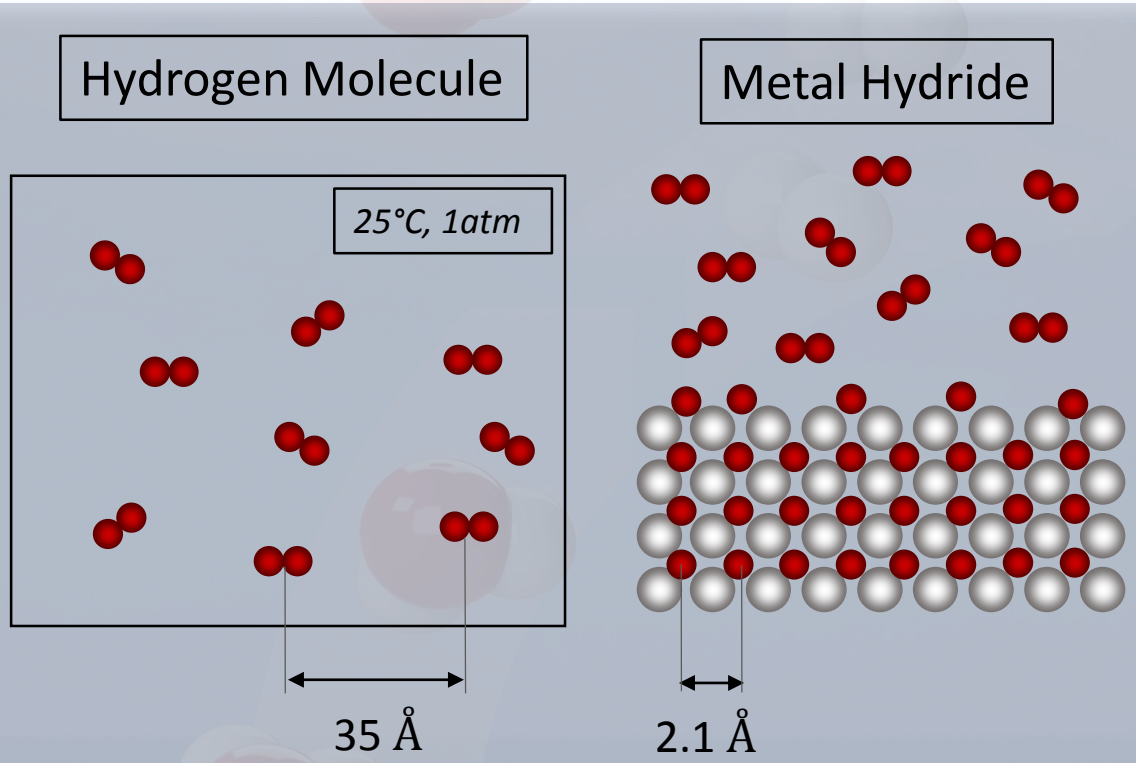
Energy Storage in Hydrogen



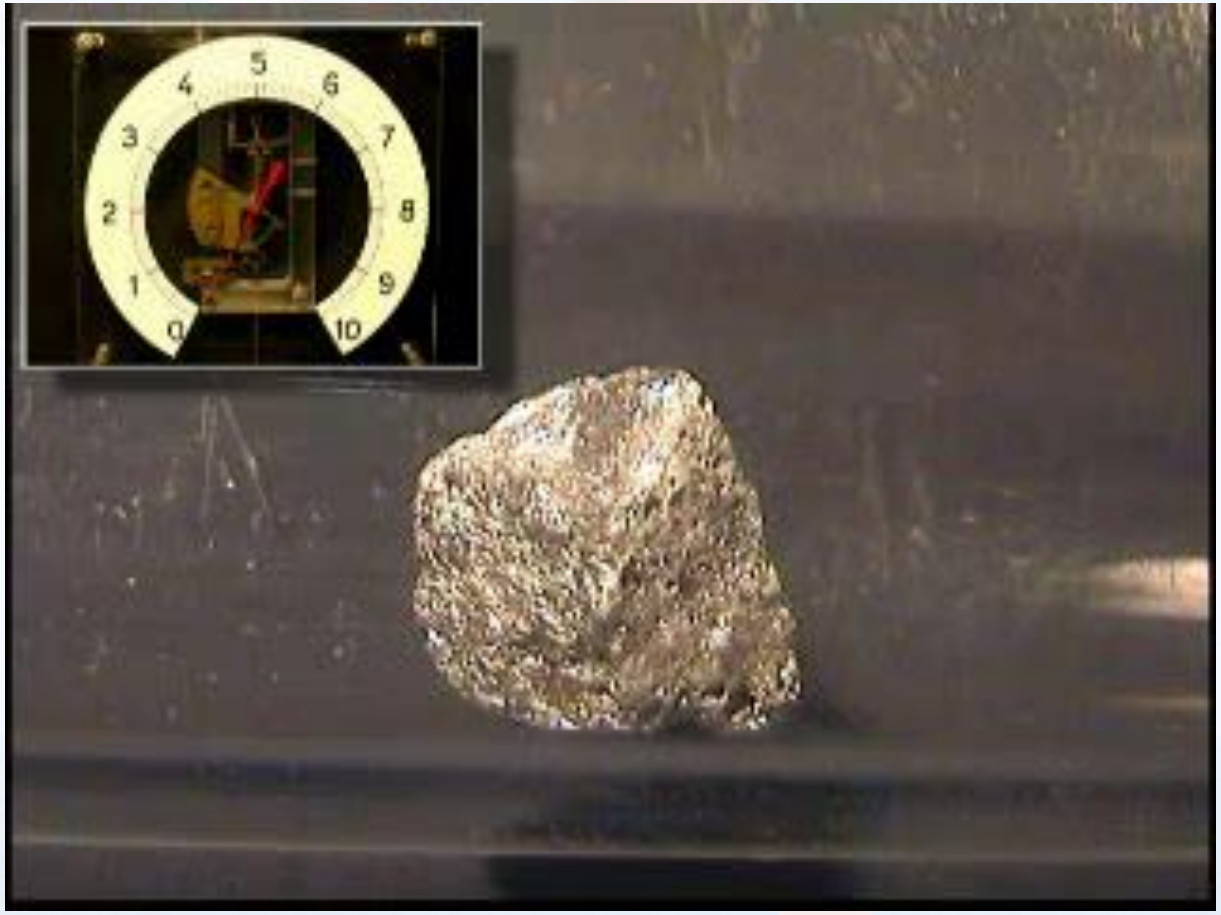
Energy storage in hydrogen is a three-step process:

1. Electrolysis
2. Storage
3. Combustion

Metal Hydrides: Concept

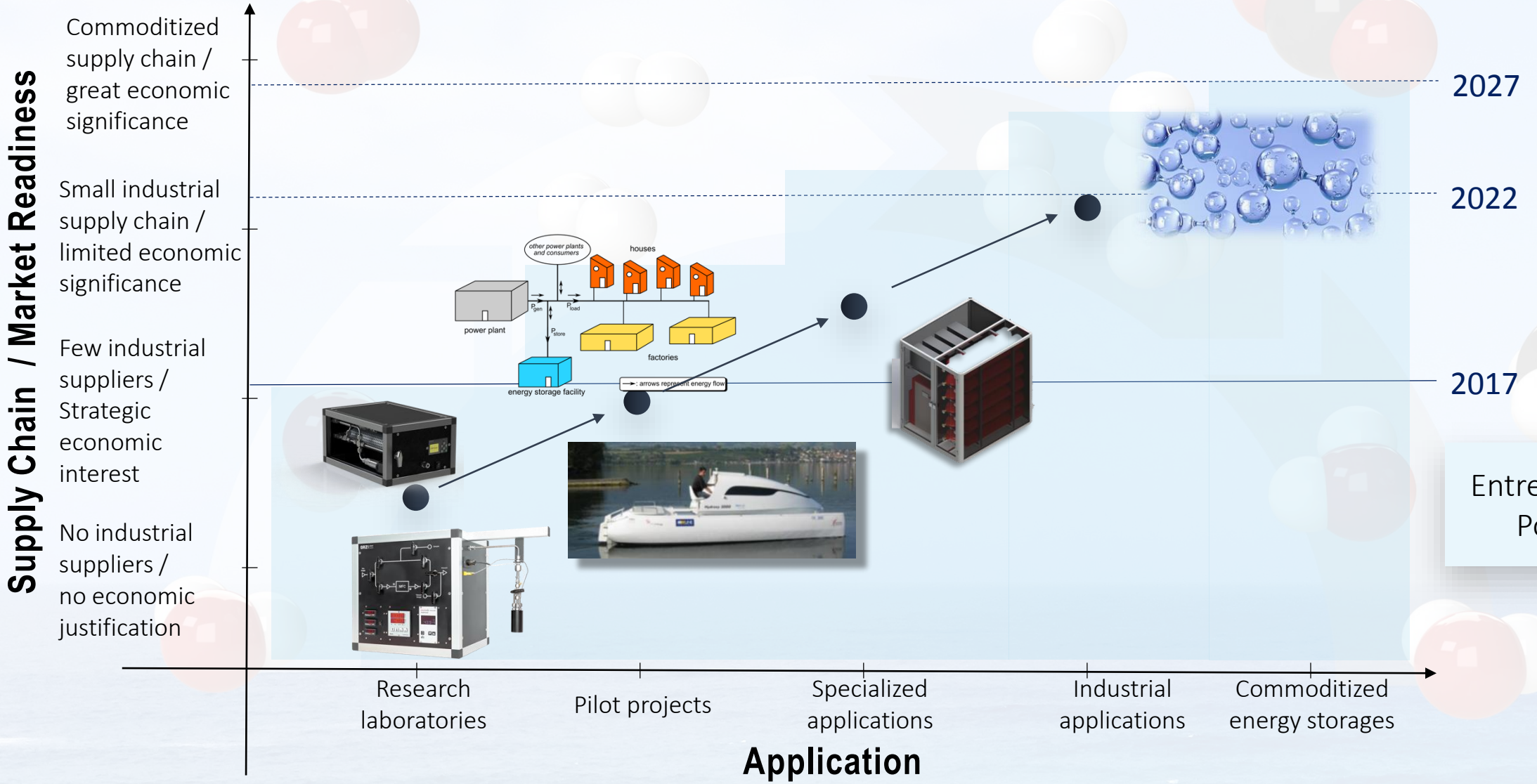


Factor 16.6 in Distance = Factor 2300 in Volume



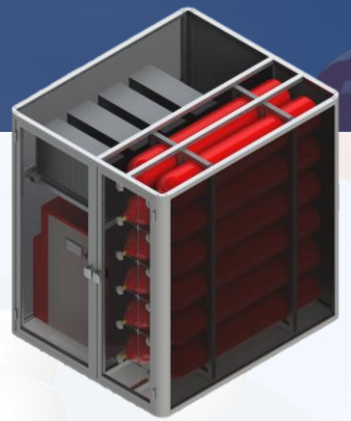
Ph. Mauron, M. Bielmann, A. Züttel EMPA, Switzerland

Business Strategy: Seize Potential where it is



Entrepreneurial Potential

Business Strategy



Commercial Storage Unit

Pilot Projects

Laboratory Products

2017 2018 2019 2020 2021 2022

Business success: AGAS Mano & HyCo

AGAS Mano

- **A**dvanced **G**as sorption **A**nalysis **S**ystem
- Integrated data analysis system
- First sales: December 2017
- **IP:** FTO and Patent for sample holder

HyCo

- Metal hydrides hydrogen compressor for the safe use of pure (6,0) hydrogen in the laboratory
- Safe & Fast
- First sales: January 2018
- **IP:** FTO and Patent on operating principles

Pilot Project: Dix Hut

- First fully autonomous mountain hut
- Altitude: 2928 m
- Storage capacity H_2: 3 MWh
- Realization: August 2019

Thank you for your attention

BR2 Technologies

the ark

VENTURE KICK

EPFL INNOGRANTS

venturelab

swissnex network

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE | VALAIS WALLIS

TOP 100 STARTUP AWARD

Team

BR2 Technologies

ETH Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Berkeley UNIVERSITY OF CALIFORNIA

ABB

Claudio Ruch

- Msc. Sc. ETH
- Experienced in energy Industry
- Responsible for business strategy

Fridolin Holdener

- Entrepreuneur
- Background in hydrogen and cryogenics
- Responsible for production

UNI FR UNIVERSITÉ DE FRIBOURG UNIVERSITÄT FREIBURG

AT&T Bell Laboratories

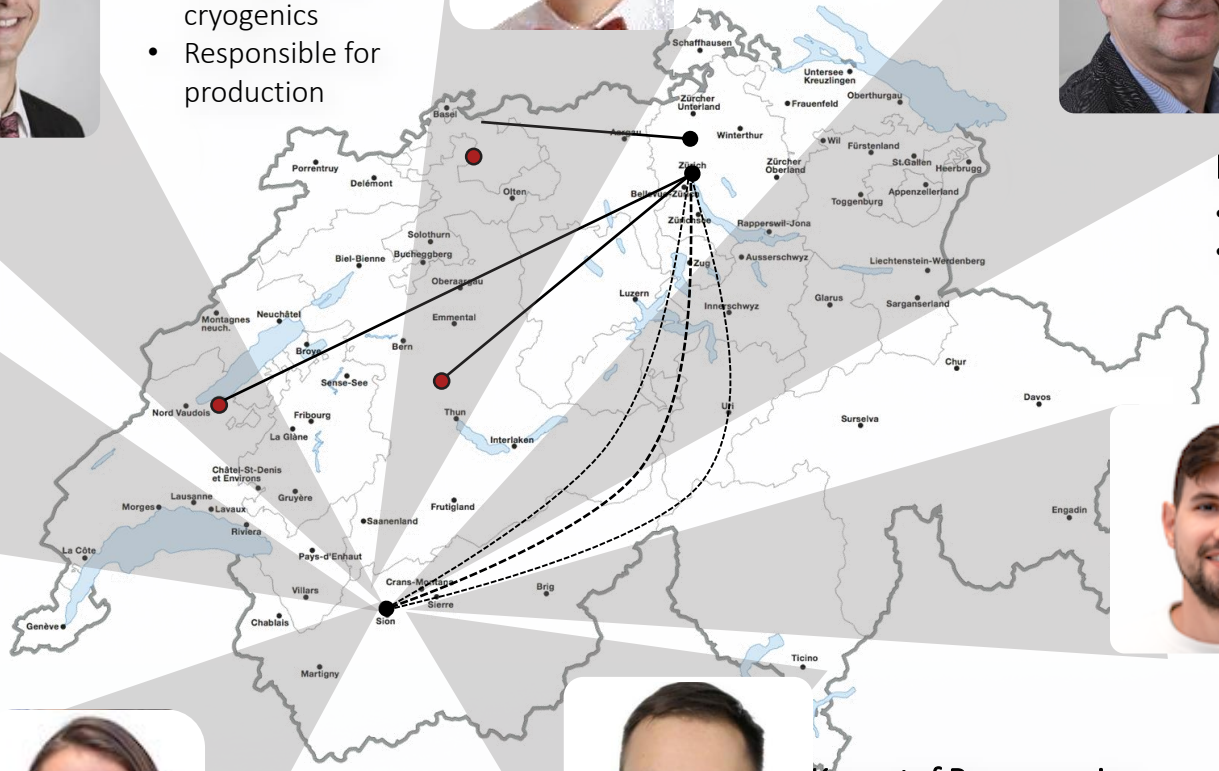
EMPA Materials Science & Technology

VU VRIJE UNIVERSITEIT AMSTERDAM

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE | VALAIS WALLIS

Prof. Dr. Andreas Züttel

- > 20 years of research in hydrogen
- Worldwide network in the research community



Dr. Noris Gallandat

- PhD Georgia Tech
- Specialized in thermal management
- Responsible for R&D and operations

ETH Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Georgia Tech

EMPA Materials Science & Technology

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE | VALAIS WALLIS

Mathias Beguin

- Electronics Eng.
- Responsible for electronics and software development

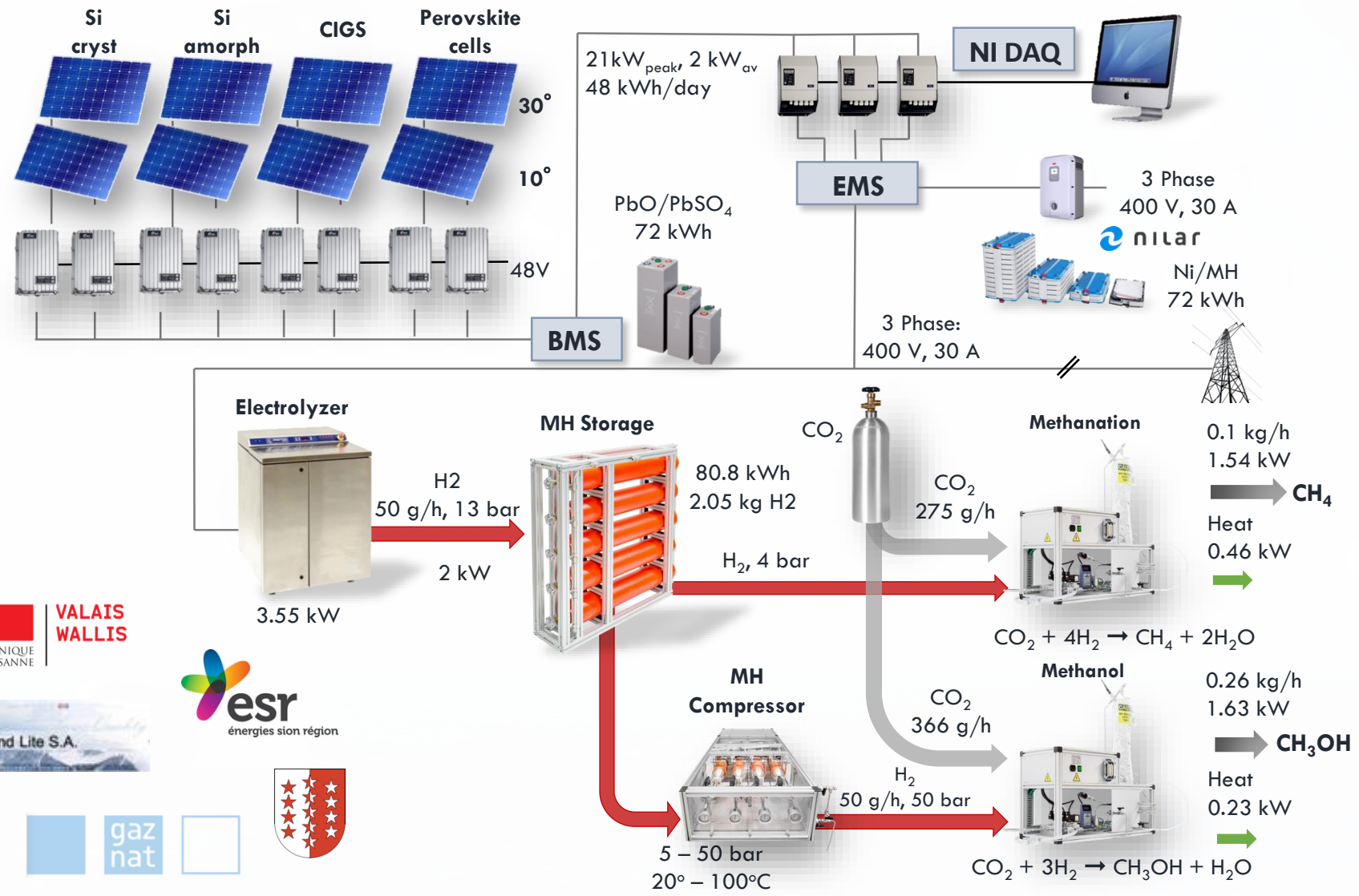
Pamela Canjura

- Chem.Eng. Msc. Student EPFL
- Intern

Krzysztof Romanowicz

- Mech. Eng.
- Responsible for mechanical design

Small-Scale Demonstrator Sion



- Full Solar to Synthetic Hydrocarbons conversion displayed in a single installation
- Many components developed in-house gives a high flexibility and modularity of the installation
- Intermediate size allowing testing of new materials and components under real conditions at moderate costs

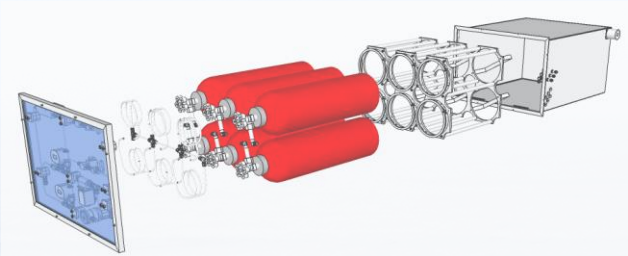
Hydrogen Storage in Hydrides

FC HyMove

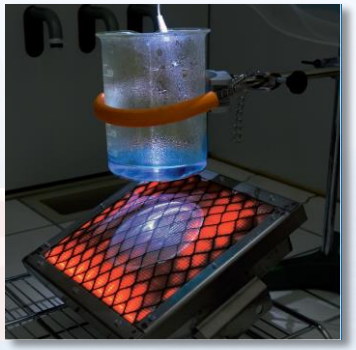
FC canal boat, MH storage
2.5 kg H_2, 1.0 mass%

FC vehicle MH storage
0.5 kg H_2, 1.2 mass%

IC snow truck, MH storage
5 kg H_2, 1.0 mass%

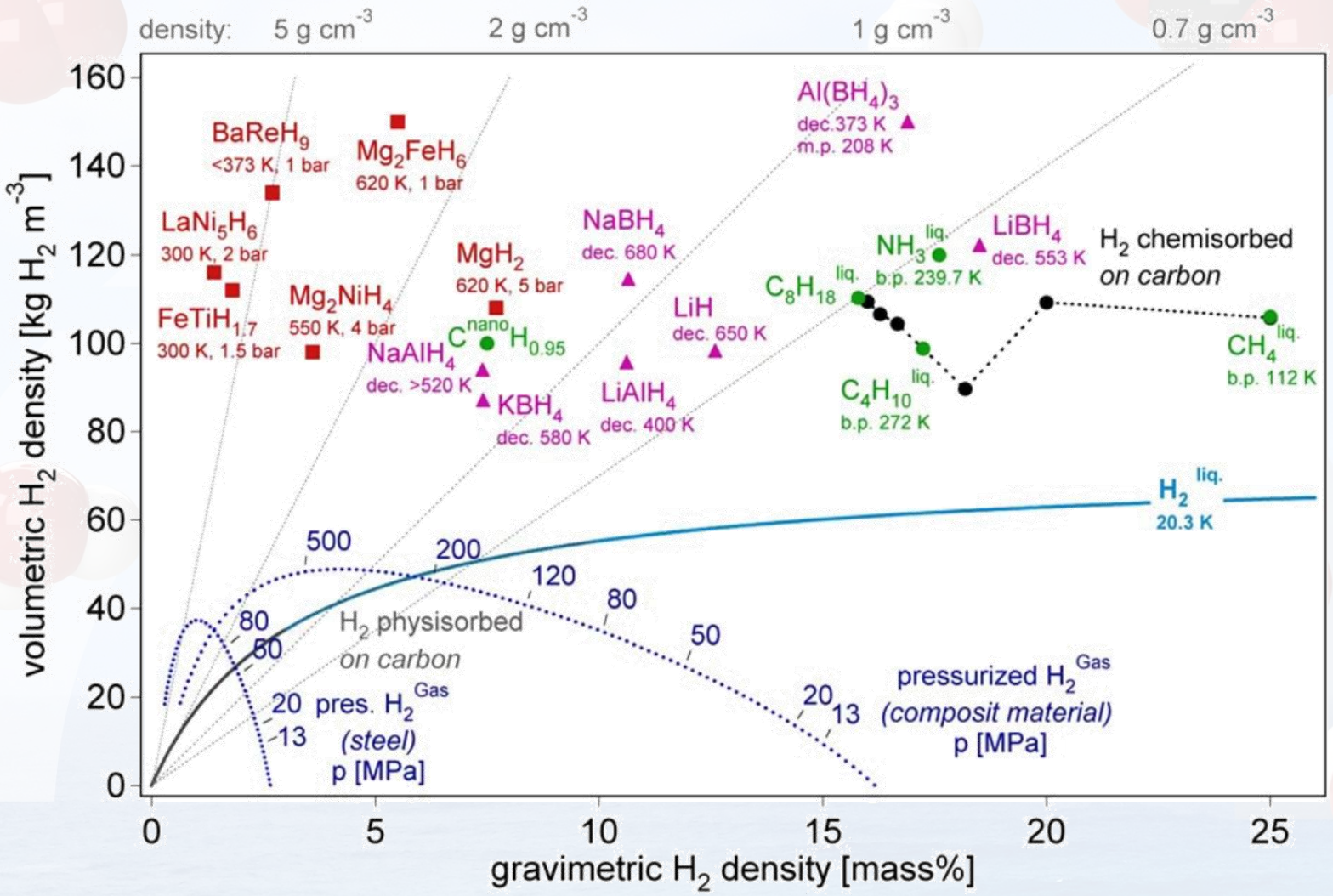


SELF: Autonomous Living Unit

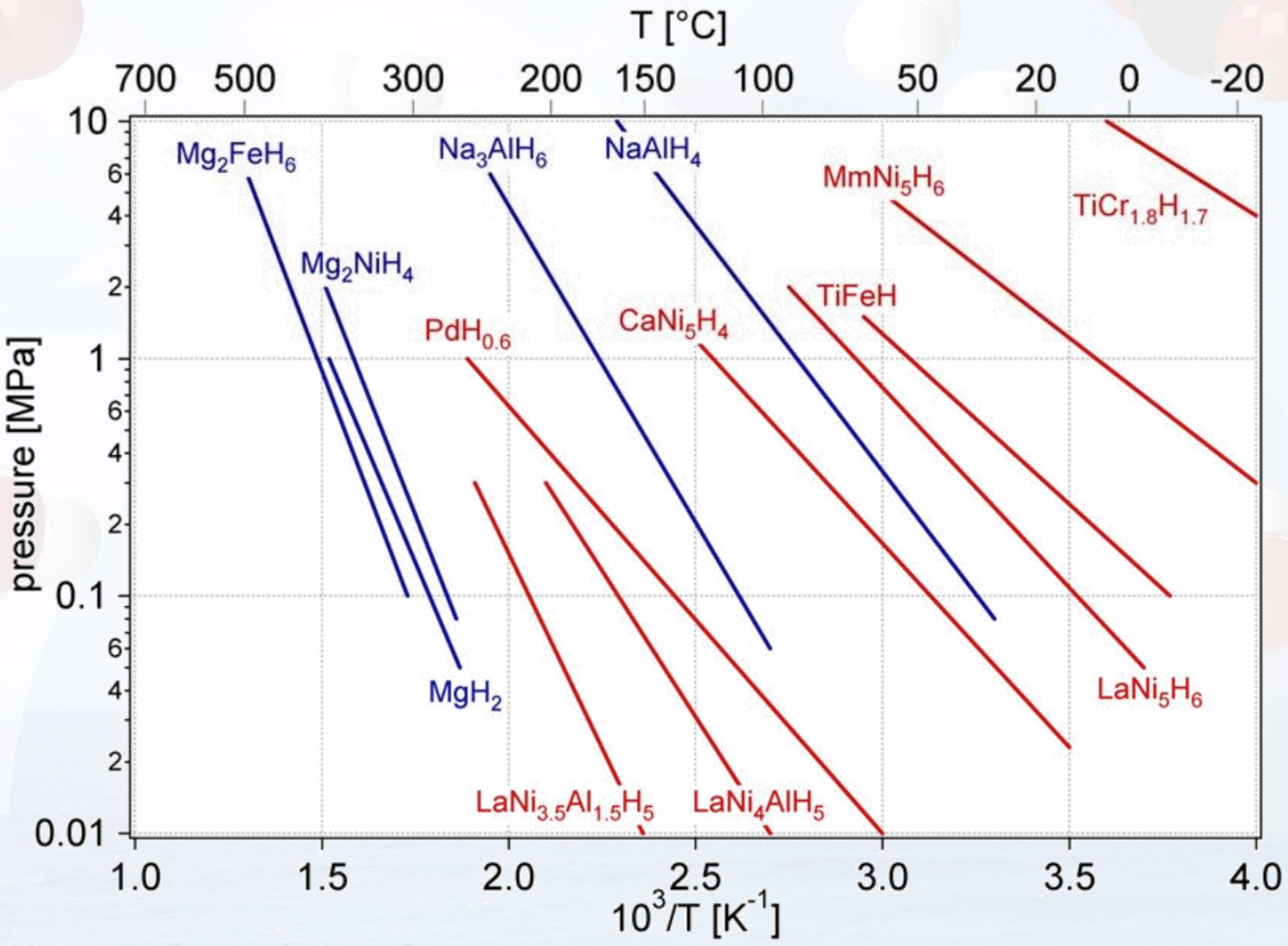


H_2 cat. heater

Metal Hydrides vs. Complex Hydrides



Van’t Hoff Plots



Case Study: Autonomous House

- Highly reduced volume (factor 25)
- 100% safe inside building

http://www.umweltarena.ch/uber-uns/energieautarkes-mfh-brutten/

Conventional H_2 Storage:

- Unsafe: placement outside house
- Large volume increases cost

Case Study: Tesla Model S

Tesla Model S 85

- Battery Pack: 85 kWh, 540 kg
- Density: 0.16 kWh / kg
- Estimated volume: 570 L
- Estimated price: USD 20-25k

MH Storage TODAY (as built)

- 2.05 kg H_2, 81 kWh, 255 kg
- Density: 0.32 kWh / kg
- Volume: 206 L
- COGS (Prototyping): < USD 20k
- No optimization carried out yet

MH Storage FUTURE

- Design optimization: 20% weight reduction, 50% volume reduction (within 12 Months)
- New materials: 50-80% weight reduction (until 2022)

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