ENERGY TRANSITION AND MOBILITY AT THE 2020 TURNING POINT

EPFL | VALAIS WALLIS | Empa

Andreas ZÜTTEL

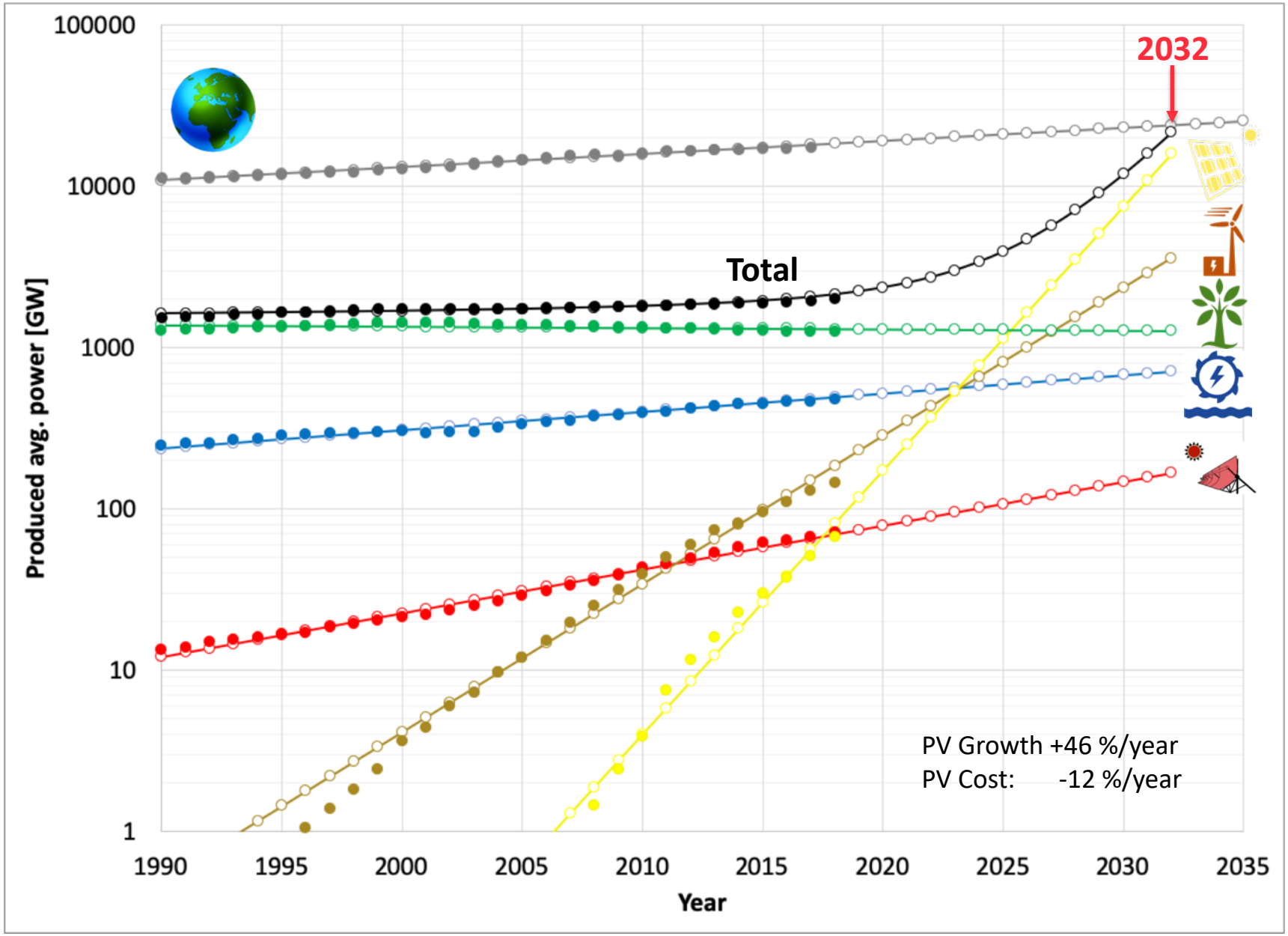
Annual seminar

Energy For Motion On line | 12.11.2020

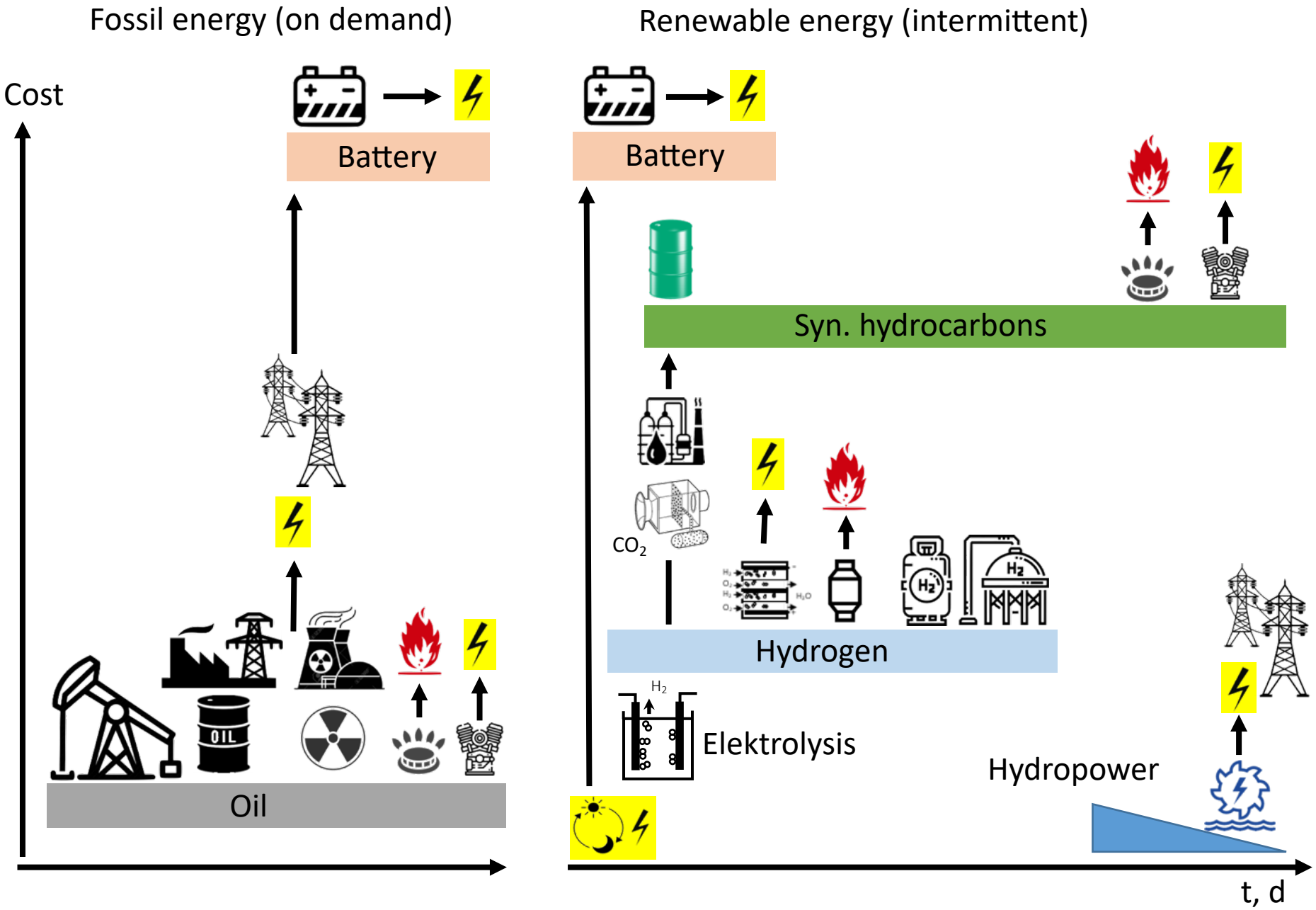
POLITECNICO MILANO 1863
DIPARTIMENTO DI ENERGIA

ENERGY FOR MOTION
Department of Excellence 2018-2022

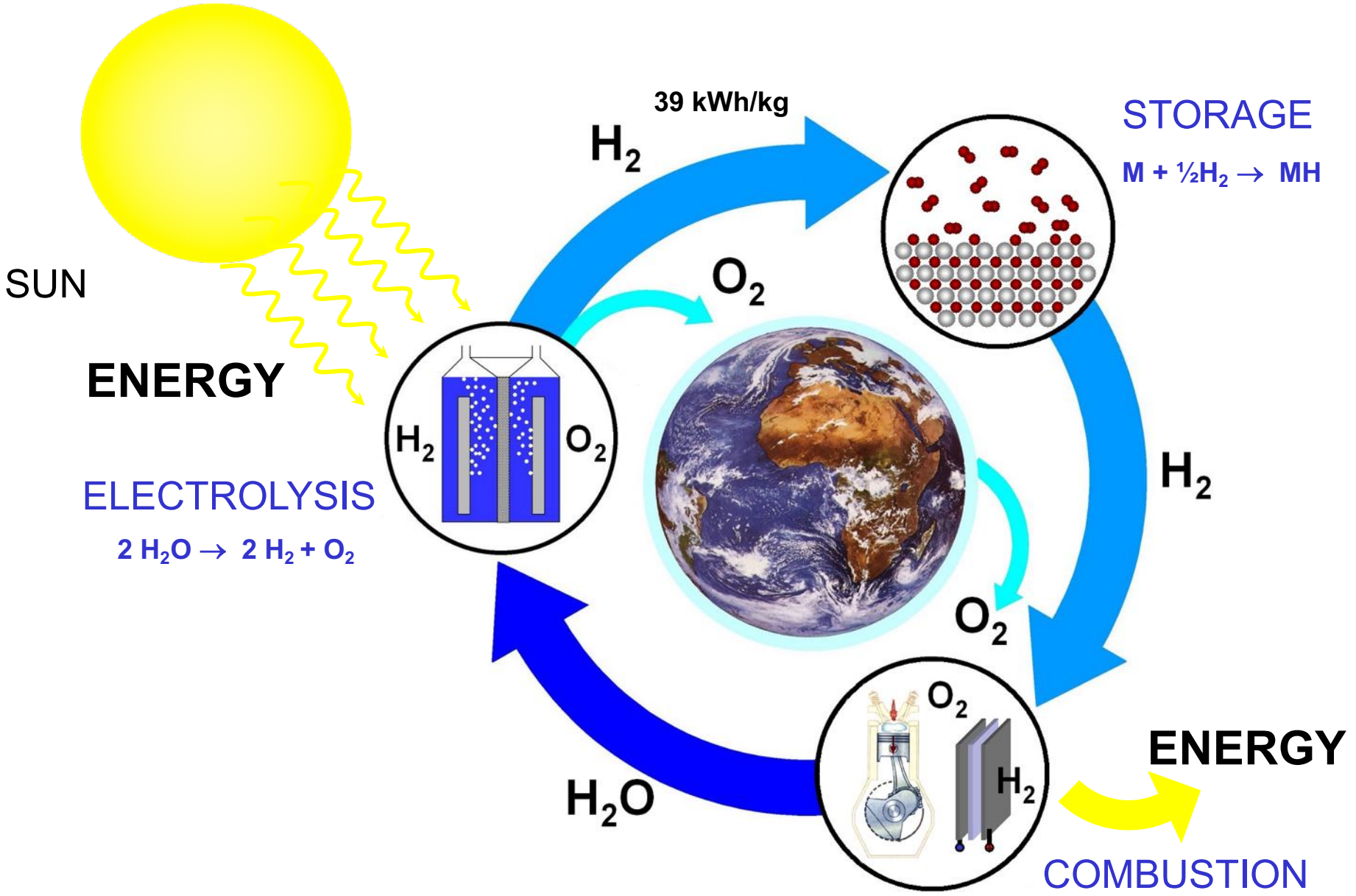
GLOBAL PRODUCED RENEWABLE ENERGY



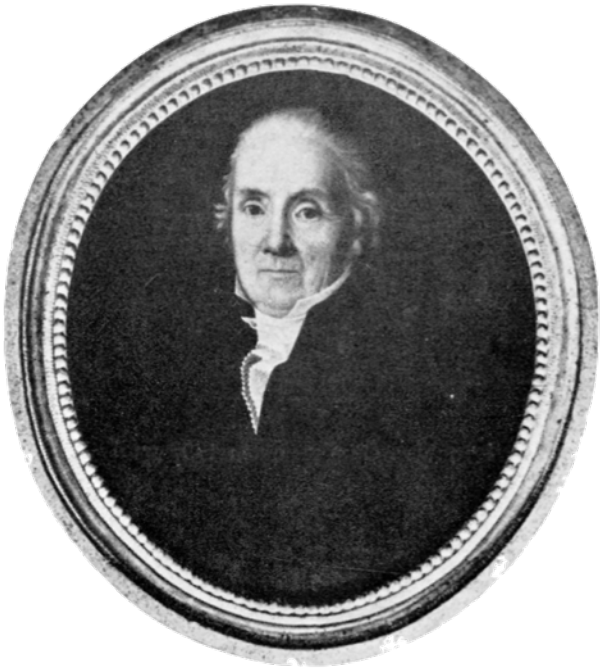
FOSSIL VS. RENEWABLE ENERGY



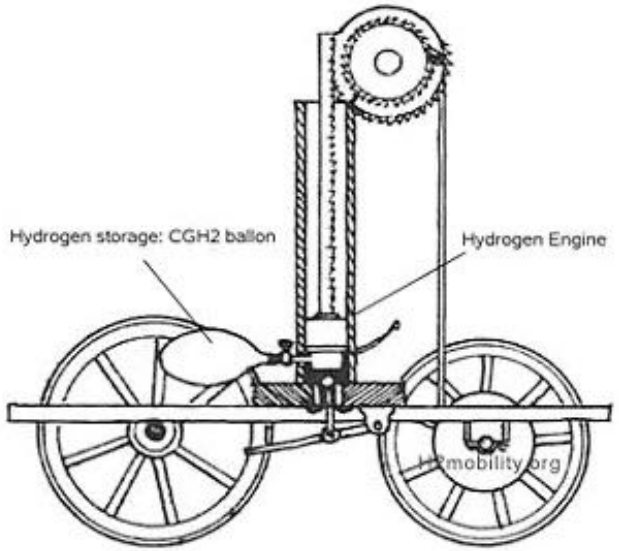
HYDROGEN CYCLE



1st Hydrogen Car

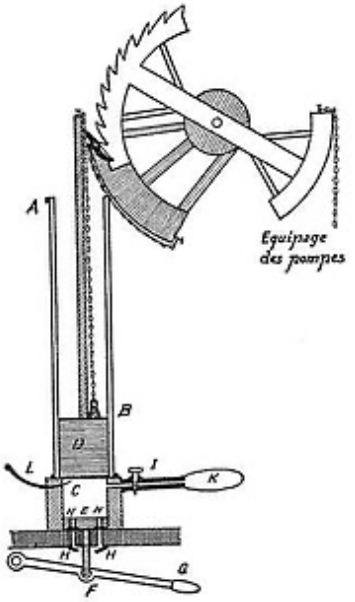


François Isaac de Rivaz (* December 19, 1752 in Paris, † July 30, 1828 in Sion, CH) was a French politician, chancellor, member of parliament and entrepreneur.



In 1813, de Rivaz attempted a large handcart powered by his engine. He was able to achieve 25 firings of H_2/air mixture in a row that had to be triggered individually by hand. The car, which was loaded with four people or a load of 700kg, was able to drive a full 26m at a speed of 3 km/h.

This trip is considered the first trip as a motor vehicle with an explosion or gas engine in the history of technology.



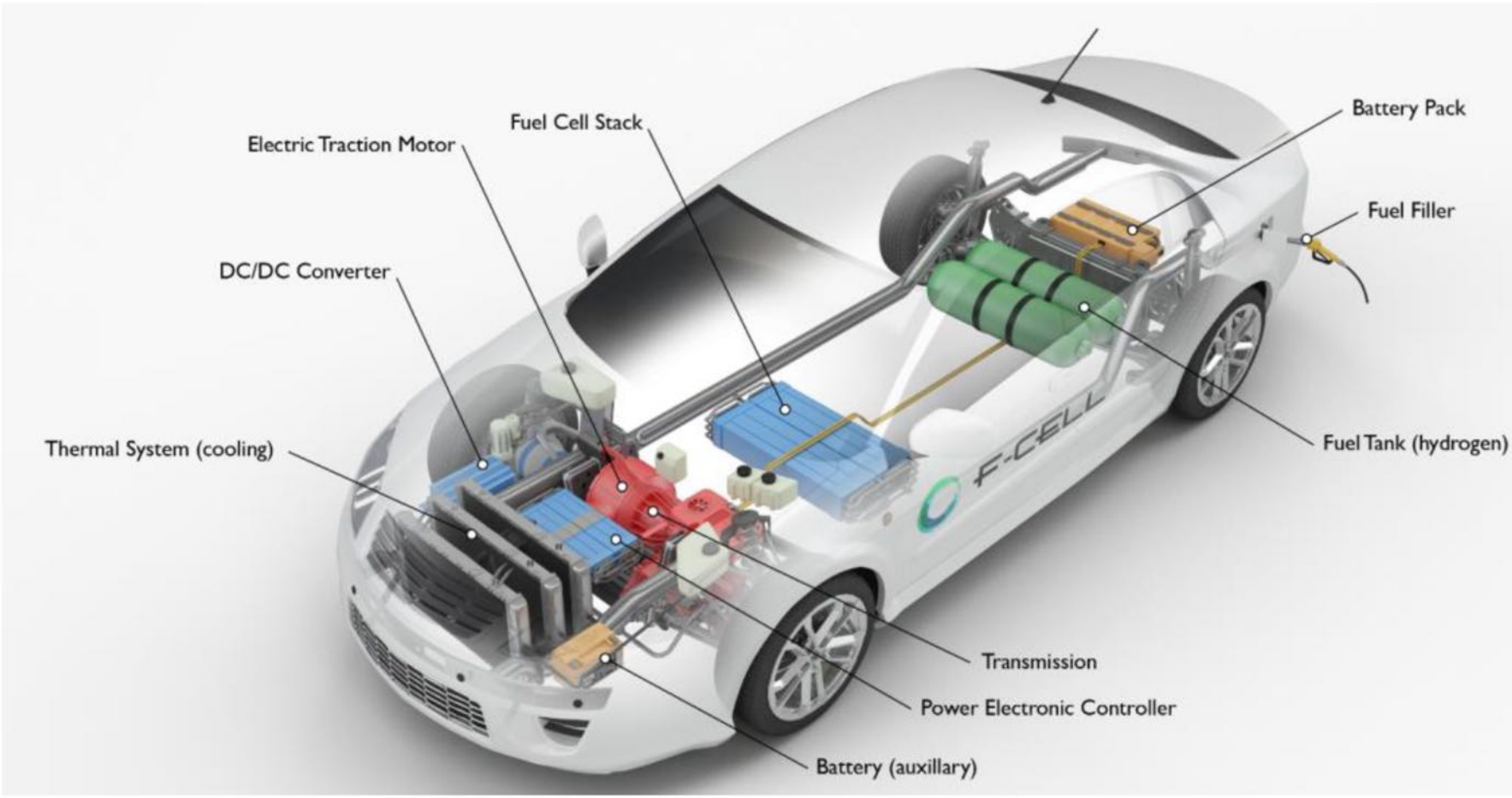
COMPRESSED HYDROGEN STORAGE

Toyota Mirai

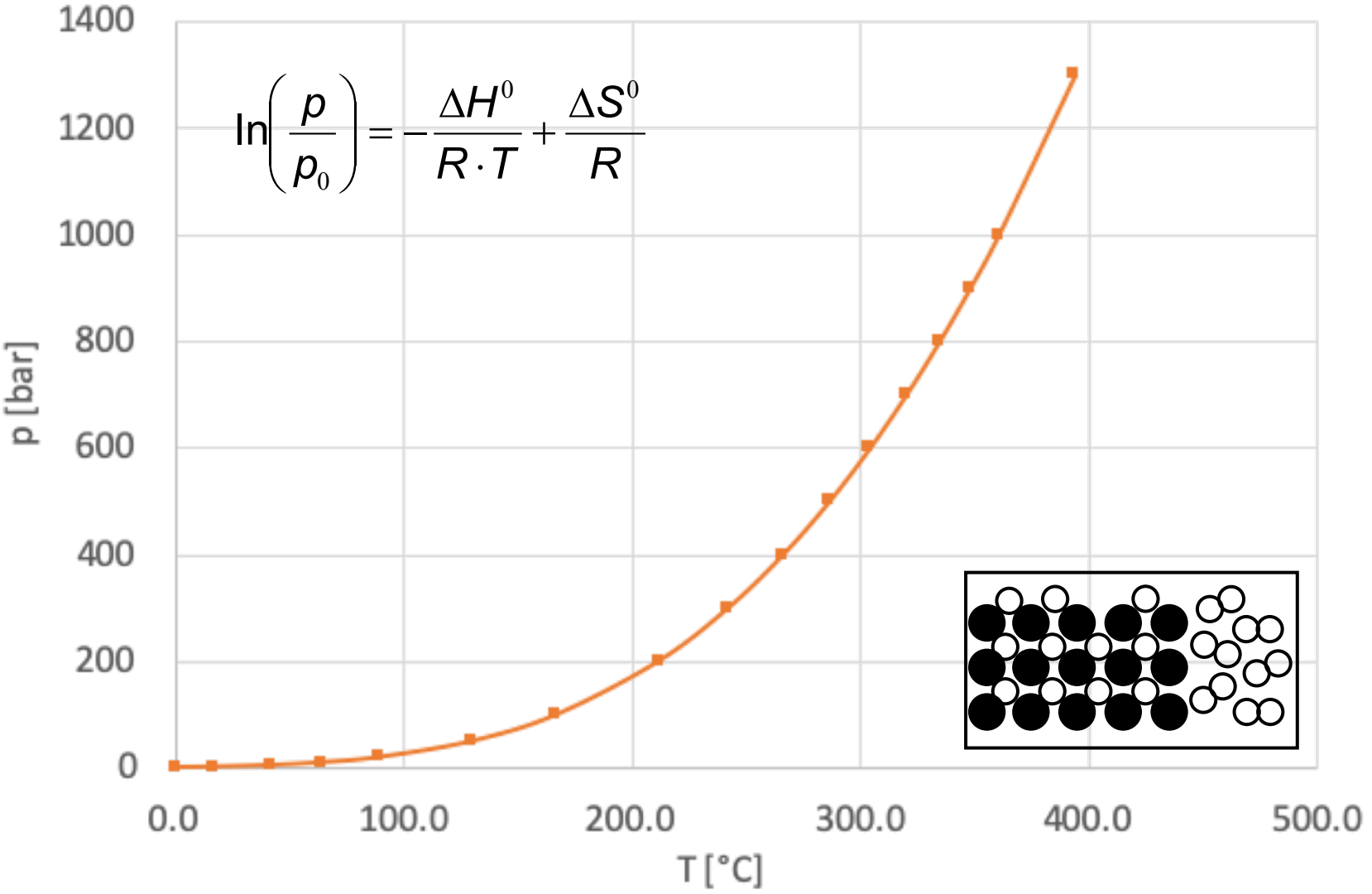
Honda Clarity

Hyundai NEXO

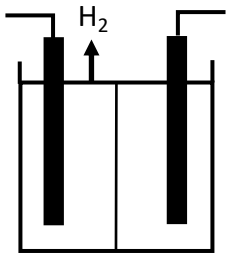
Hyundai Motor XCIENT fuel cell heavy-duty truck



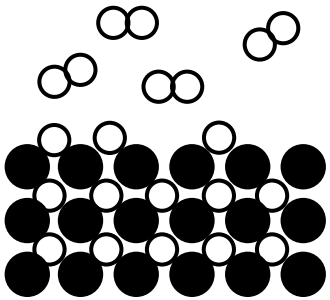
METAL HYDRIDE PRESSURE VS. TEMPERATURE



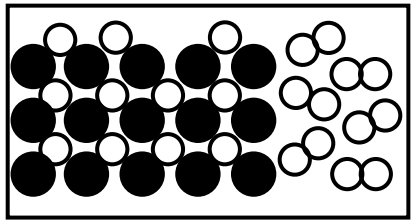
METAL HYDRIDE COMPRESSOR



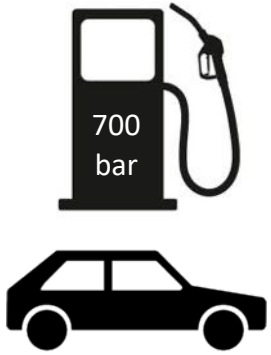
H_2 production
p = 30 bar



H_2 Storage in MH:
10 < p < 30 bar, at RT



MH compression
700 bar, 5 kg H_2



H_2 in car's 700 bar tank

grz TECHNOLOGIES

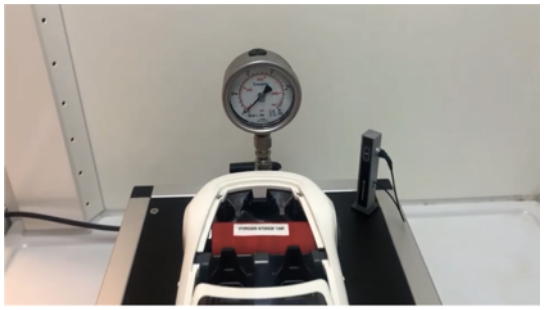
HYUNDAI

Burckhardt Compression
Compressors for a Lifetime™

MESSER
Gases for Life

www.grz-technologies.com

FUELING A MODEL CAR WITH MH COMPRESSOR



HYDROGEN MOBILITY

Francois Isaac de Rivaz

Hindenburg (1937)

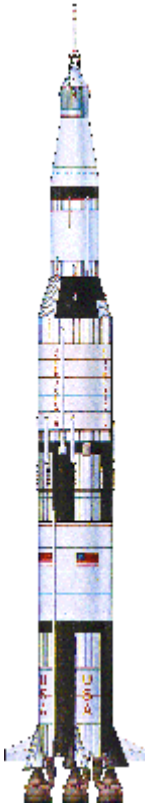
Karl Kordesch: Austin A40 (1966)

Tupolev 155 (1988)

Ch. Bach: Hy.move (2009)

Necar 1 (1994)

NuBus, 250kW (2002)



Saturn (1963)

Space Shuttle (1981)

Necar 4 (2002)

Hyundai hydrogen car FCEV (2018)

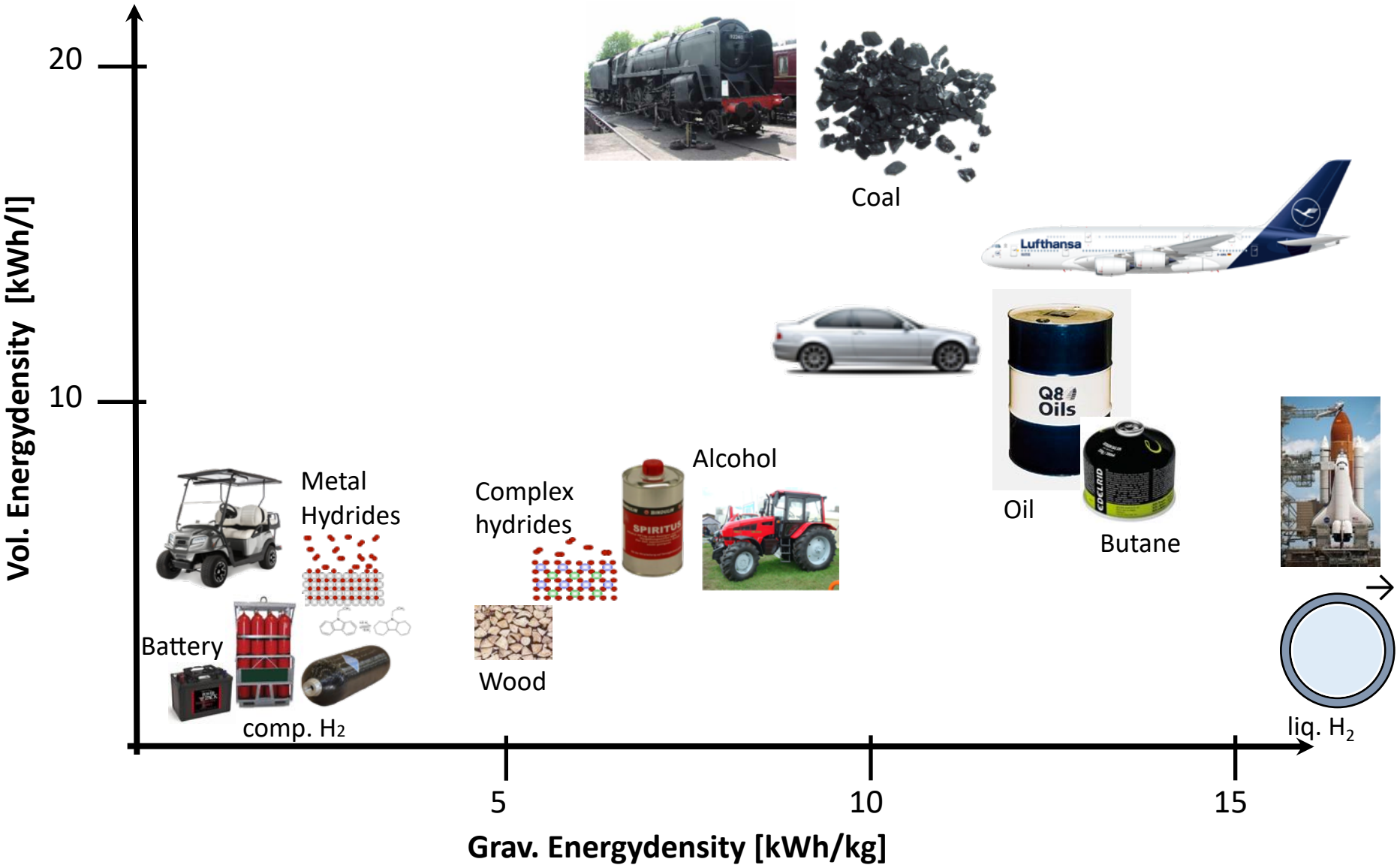
BMW (1978)

Ratrac (2004)

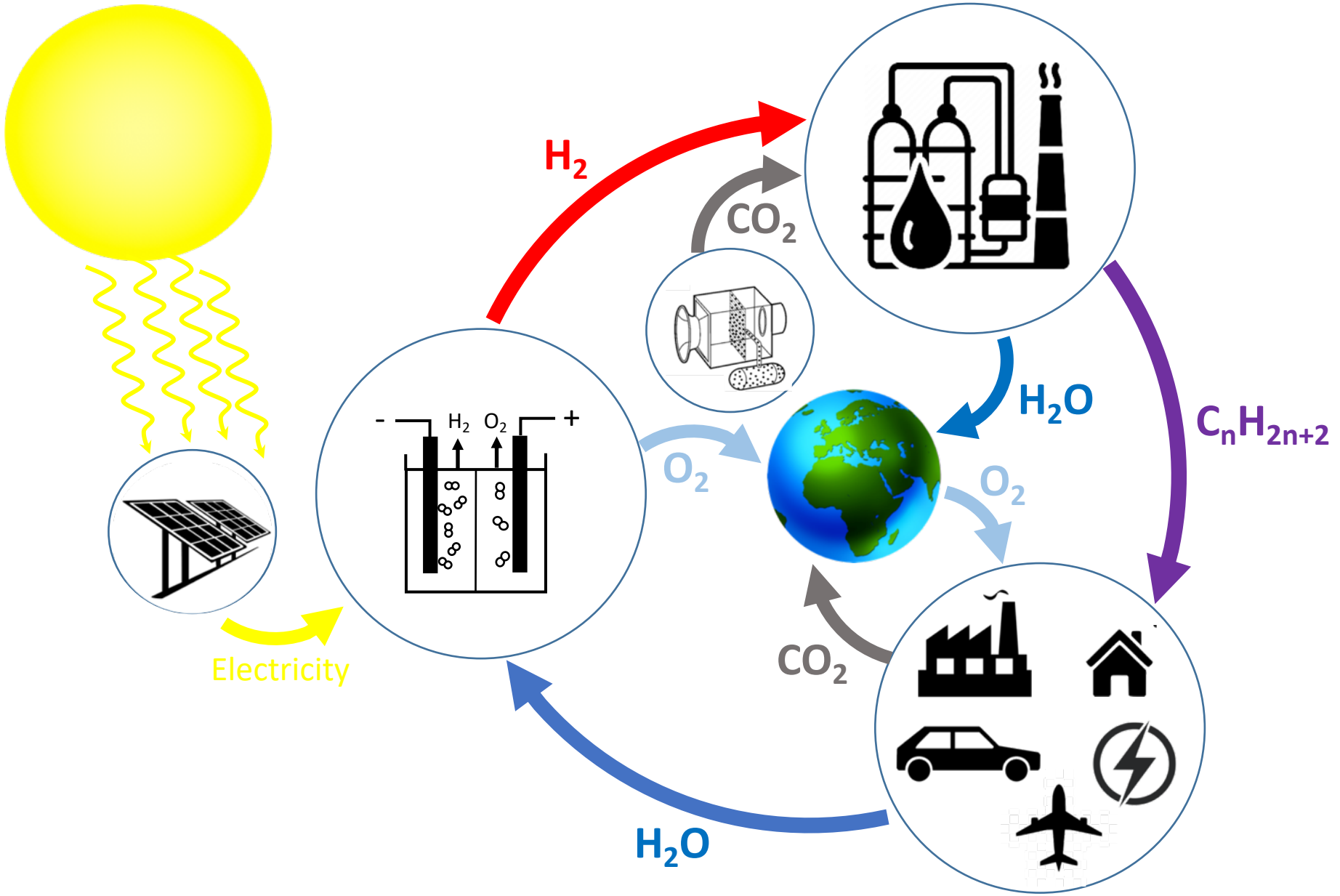
Toyota Mirai (2014)

Coradia iLint (2018)

ENERGY DENSITY OF FUELS

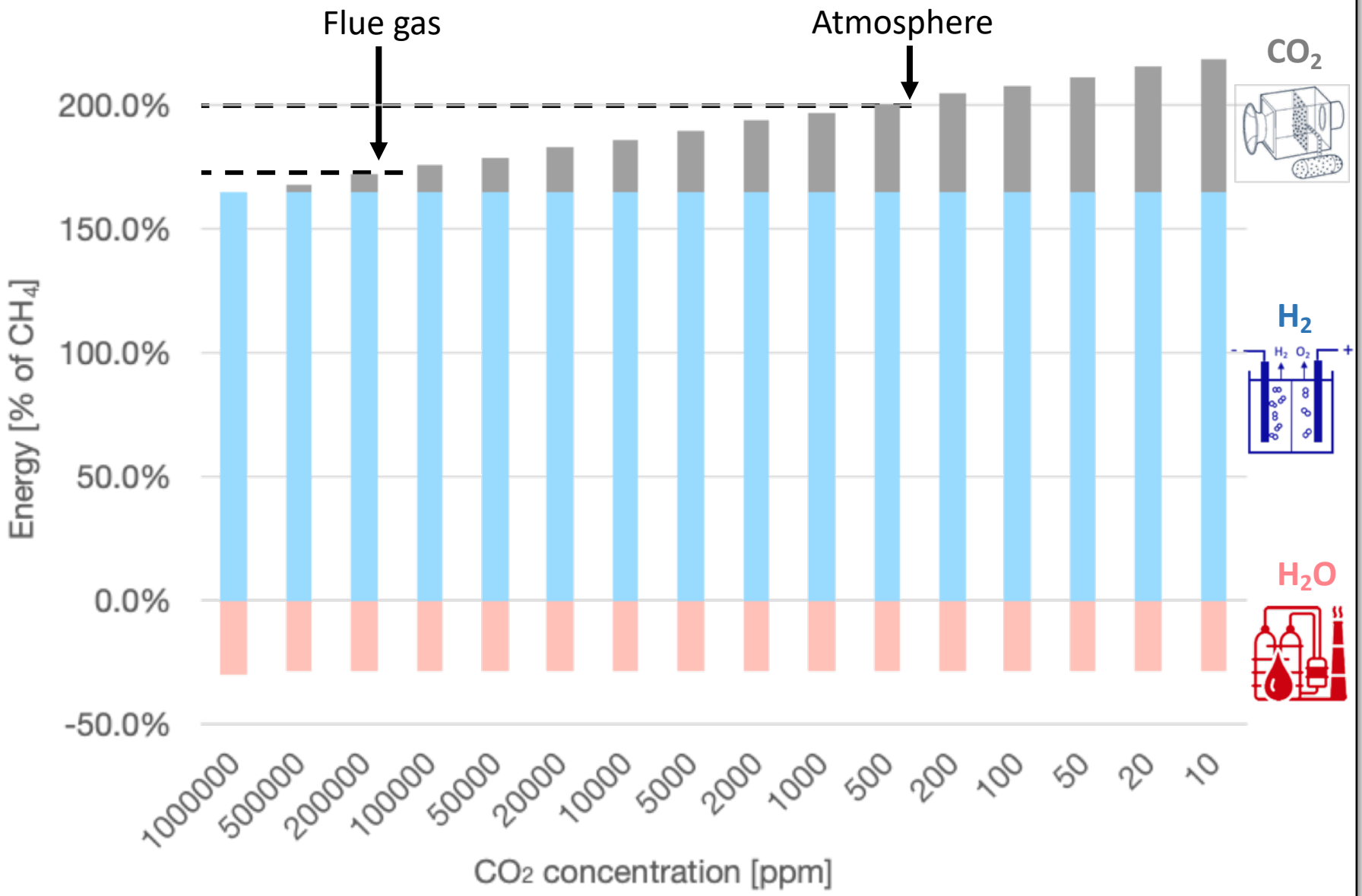


SYNTHETC HYDROCARBONS

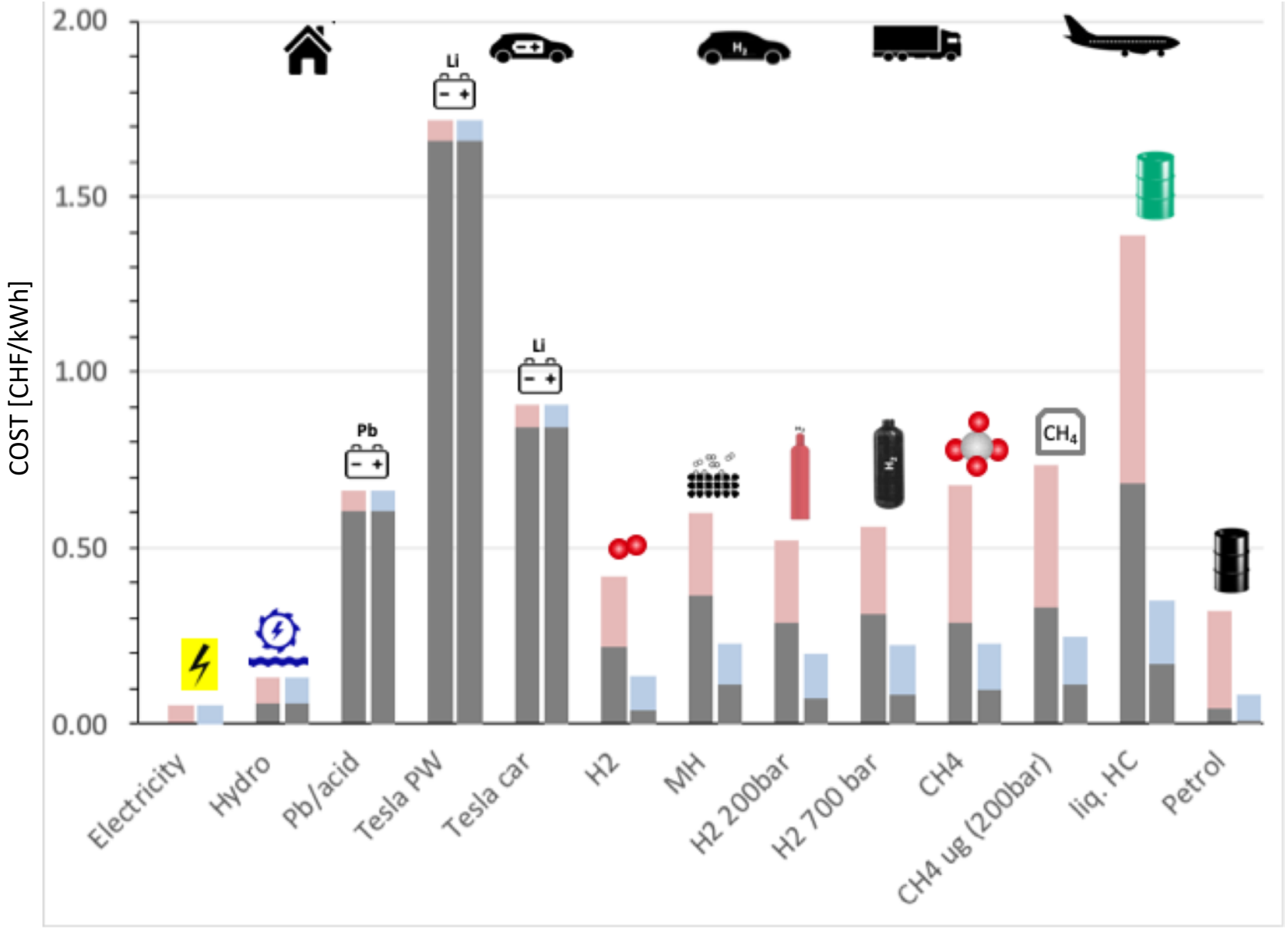


TECHNICAL ENERGY DEMAND FOR SYN. METHANE

$CO_2 + 4H_2 \rightleftarrows CH_4 + 2H_2O$



COST FOR SYSTEM, ENERGY & ELECTRICITY



COMPARAISON

	FIAT 500	FIAT 500e	Hyundai NEXO	TESLA MODEL S
Drive	ICE	e-motor	e-motor	e-motor
Weight	940 kg	1355 kg	1855 kg	2100 kg
Consumption	3.8l / 100km	18 kWh / 100km	1 kg H_2 / 100km	20 kWh / 100km
Storage	Petrol tank	Li Battery 42 kWh	H_2 Tank 700 bar	Li Battery 82 kWh
Range	500 km	500 km	666 km	450 km
Energy costs	5.7 Fr./100 km	16 Fr./100 km	12 Fr./100 km	18 Fr./100 km
Vehicle costs	12.7 Fr./100 km	46 Fr./100 km	58 Fr./100 km	66 Fr./100 km
Travel expenses	18 Fr./100km	62 Fr./100km	70 Fr./100km	84 Fr./100km

Railway 12 Fr/100km 2 Cl. (1/2)

14th Int. SYMPOSIUM HYDROGEN & ENERGY

Sapporo, Japan (2020)

15th Emmetten, Switzerland

16th Sendai, Japan

17th Harbin, China

1st INT'L SYMPOSIUM

Combined with

14th INT'L SYMPOSIUM
HYDROGEN & ENERGY

January 5th -10th, 2020
Hotel Monterey Edelhof Sapporo,
SAPPORO, JAPAN

Hydrogenomics

https://www.hydrogenomics.jp/
Contact: secretary@hydrogenomics.jp

SUBJECTS

- Hydrogenomics (Densification, Localization, Migration, Activation, Advanced Meas./Simulation)
- Hydrogen Production
- Hydrogen Storage
- Hydrogen Applications
- Theory and Modeling
- Fuel Cells
- Batteries
- Synthetic Fuels
- Functional Mater.

ORGANIZER

Prof. Dr. Shin-ichi ORIMO, Tohoku University, Sendai

STEERING COMMITEE

Shin-ichi ORIMO, Tohoku University
Taro HITOSUGI, Tokyo Institute of Technology
Katsuyuki FUKUTANI, University of Tokyo
Andreas ZÜTTEL, EPFL, Switzerland

KEYNOTE and INVITED SPEAKERS

Keynote
Andreas ZÜTTEL, EPFL, Switzerland Hans-Joachim FREUND, MPI-Berlin, Germany
Anibal Javier (Timmy) RAMIREZ-CUESTA
Oak Ridge National Laboratory, USA Masaru TSUKADA, Univ. Tokyo, Japan
Invited
Ryotaro ARITA, Marcello BARICCO, Craig BUCKLEY, Martin DORNHEIM, Jianping GUO, Ikutaro HAMADA, Bjørn HAUBACK, Michael HIRSCHER, Craig JENSEN, Genki KOBAYASHI, Michel LATROCHE, Katsutoshi NAGAOKA, Chikashi NISHIMURA, Minoru OSADA, Astrid PUNDT, Hiroyuki SAITOH, Katsuya SHIMIZU, Petra SZILÁGYI, Min ZHU (in alphabet order)

PROGRAM

LOCATION

Hotel Monterey Edelhof Sapporo
Nishi 1-1, Kita 2 Jyo, Chuo-ku,
Sapporo, Hokkaido, 060-0002, Japan
+81-11-242-7111
http://www.hotelmonterey.co.jp

Conference fee
¥0,000; incl., Proceedings, Coffee Breaks, Dinner, Conference Dinner, Poster Sessions, Excursion

TIMELINE
Registration and Abstract Submission:
Planned to be September, 2019

15th INT. SYMPOSIUM HYDROGEN & ENERGY

23. - 28. January 2022
Seeblick Höhenhotel,
Emmetten, Switzerland

http://hesymposium.ch/

SUBJECTS

- Hydrogen production
- Hydrogen storage
- Fuel Cells
- Batteries
- Synthetic fuels
- Theory & modelling
- Applications

ORGANIZER

Prof. Dr. Andreas ZÜTTEL, Mrs. Ivana SUTER
Ecole Polytechnique Fédérale de Lausanne (EPFL)
Institut des sciences et ingénierie chimiques (ISIC),
CH-1015 Lausanne, Switzerland

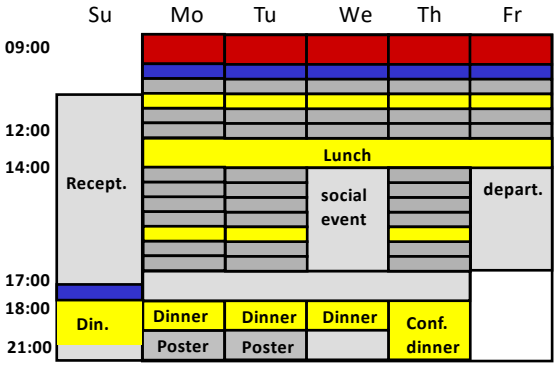
STEERING COMMITEE

Craig JENSEN, Hawaii, USA
Shin-Ichi ORIMO, Japan
Min ZHU, China
Andreas ZÜTTEL, Switzerland

INVITED SPEAKERS

Henning ZOZ, Germany
Noris GALLANDAT, Switzerland
Shin-Ichi ORIMO, Japan
Craig JENSEN, Hawaii, USA
Min ZHU, China
Hans GEERLINGS, The Netherlands
Jinqiu ZHANG, China
Robert SCHLÖGL, Germany
Klaus LACKNER, USA
Jens NORSKOV, Denmark
Ib CHORKENDORF, Denmark
Hannes JONSSON, Iceland

PROGRAM



LOCATION

SEEBLICK HÖHENHOTEL***
Hugenstrasse 24, CH-6376 Emmetten, Switzerland
T: +41 41 624 41 41, e: info@hotelseeblick.ch
U: http://www.hotelseeblick.ch

REGISTRATION

Conference fee CHF 1200
incl. conference facilities, internet, proceedings and social event, excursion, coffee breaks, lunch, dinner, conference dinner, beverages at poster sessions.

Registration online:
http://hesymposium.ch/
Registration and abstract submission:
before 1st October 2020

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Institute of Chemical Sciences and Engineering (ISIC)
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