

Upgrading biogas by direct methanation



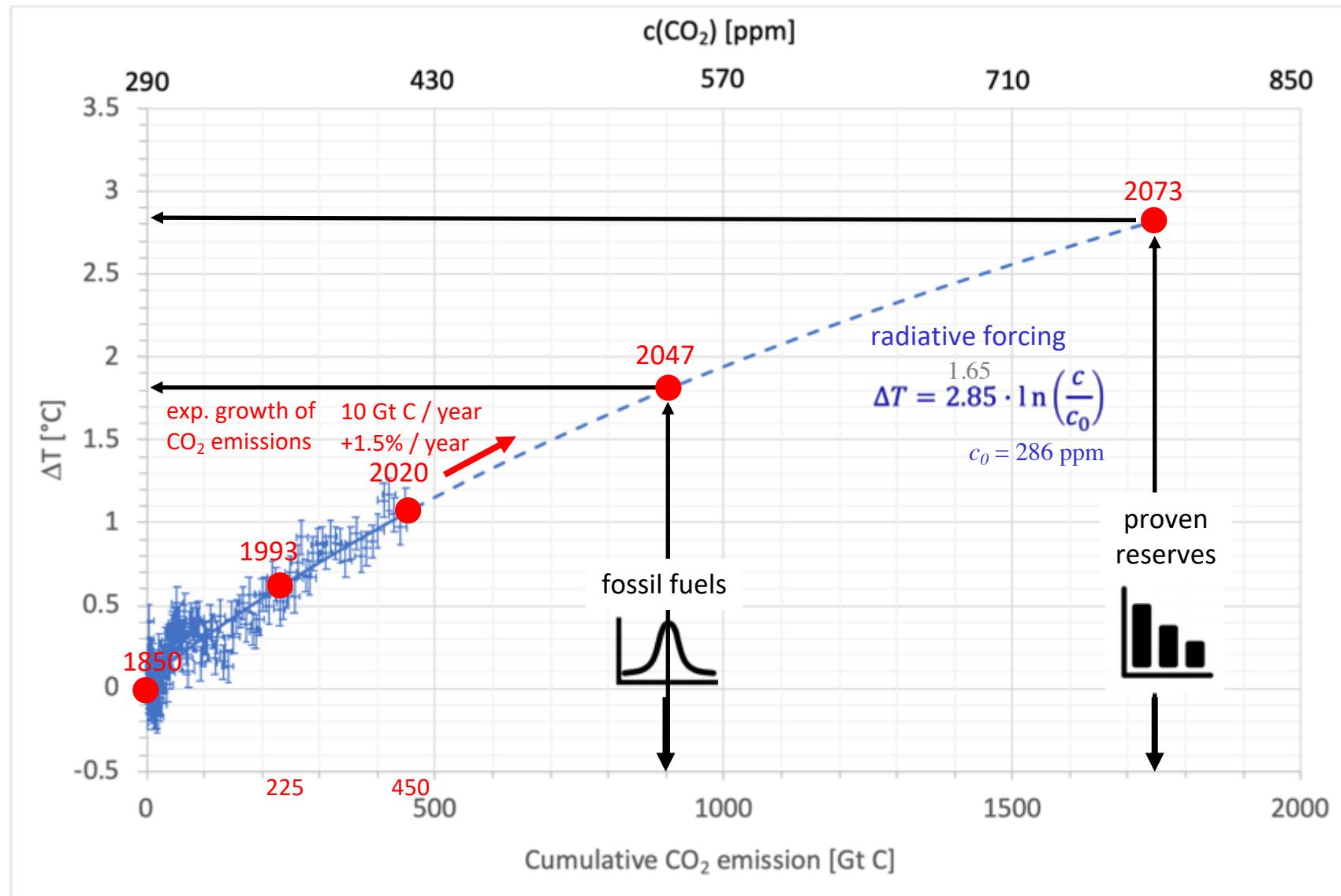
Andreas ZÜTTEL, Prof. Dr.

2e Forum Innovation et Climat
Casino de Montreux, Suisse
vendredi 4 novembre 2022

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CO₂ emissions, global temperature increase und resources

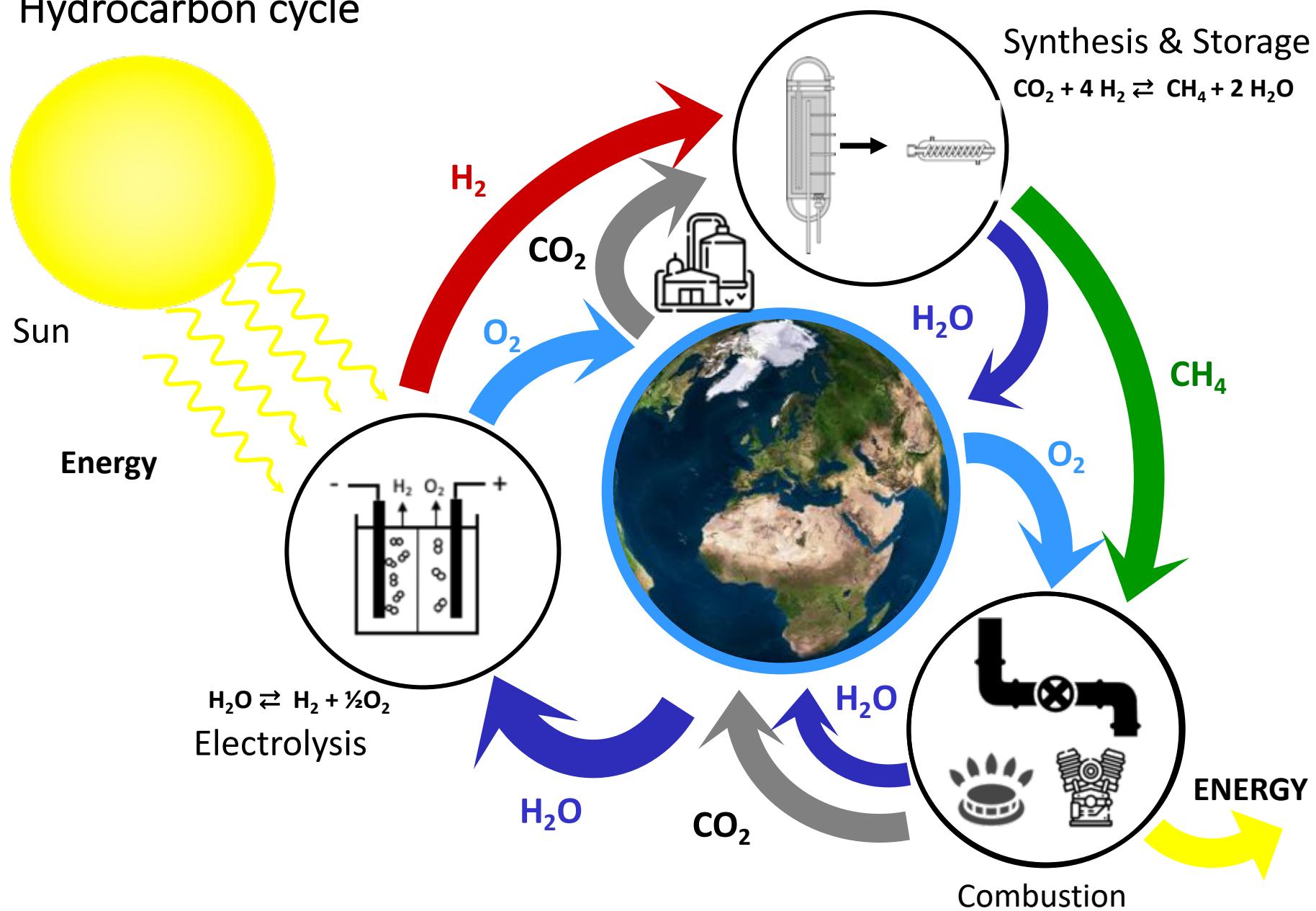
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Ref.: <http://www.globalwarmingequation.info/global%20warming%20eqn.pdf> and Ollila, A. (2014), "The potency of carbon dioxide (CO₂) as a greenhouse gas", Development in Earth Science, Vol. 2, pp. 20-30, available at: www.seipub.org/des/paperInfo.aspx?ID=17162

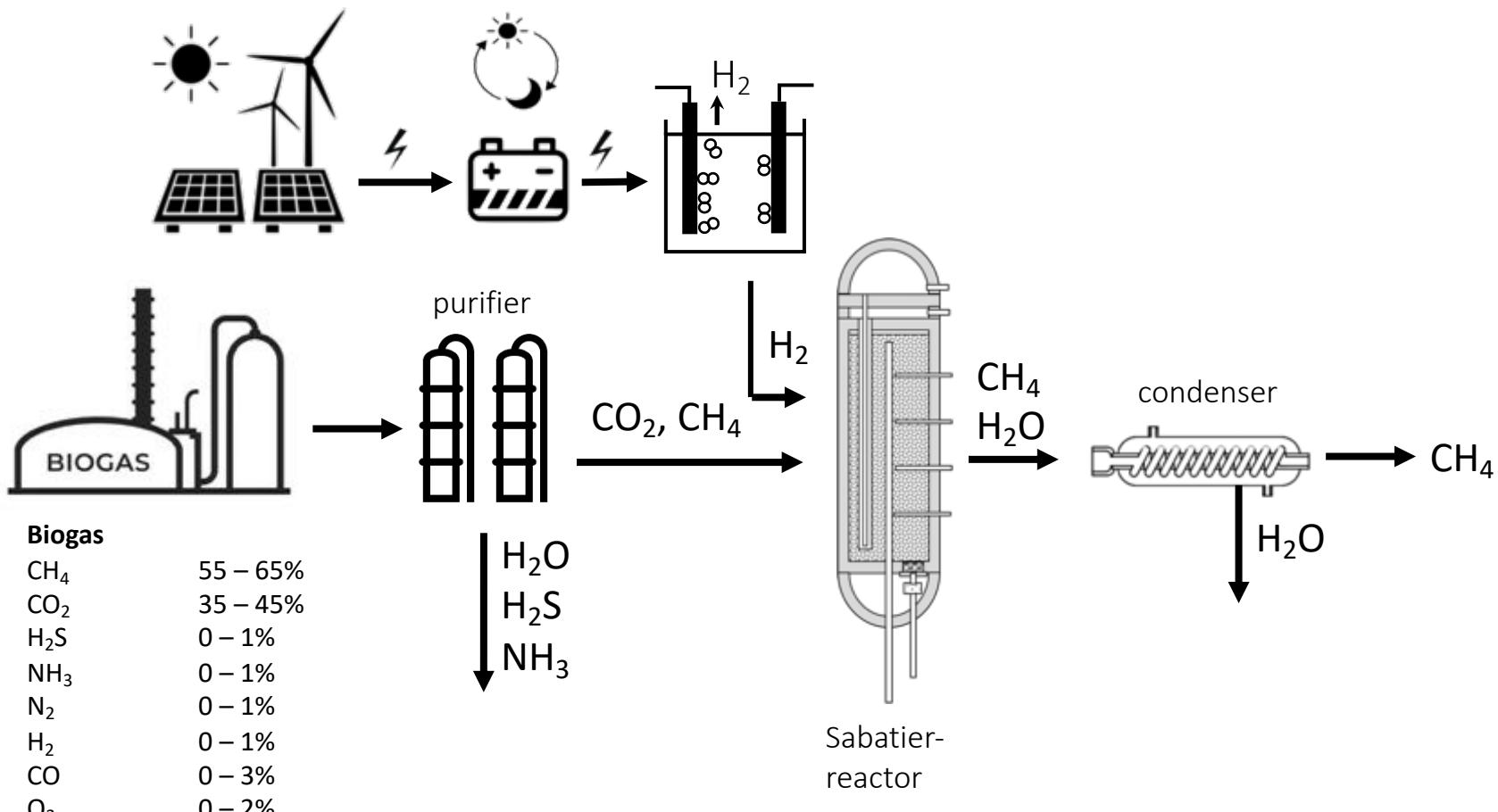
Hydrocarbon cycle

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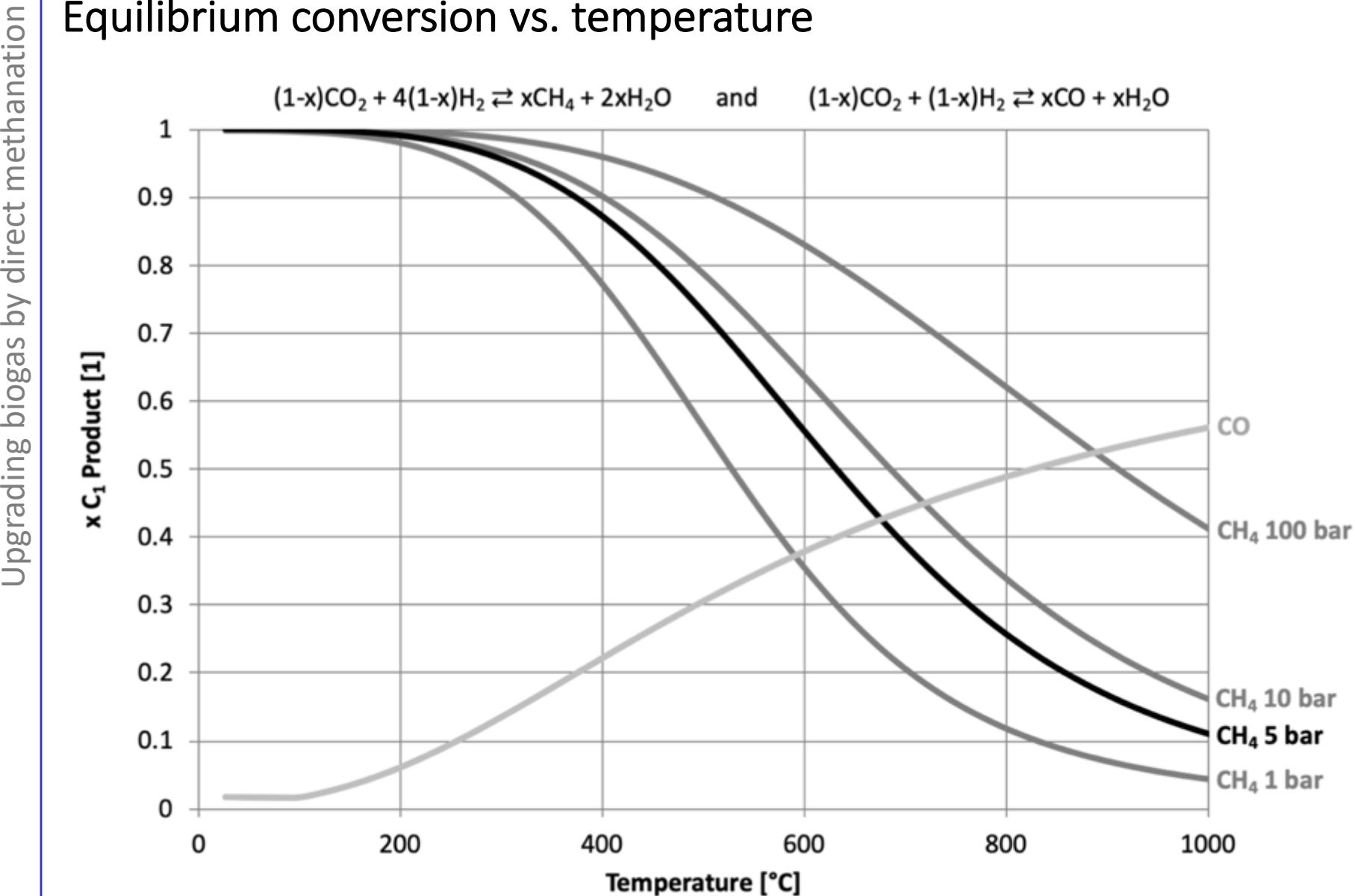


Ref.: Andreas Züttel , Arndt Remhof , Andreas Borgschulte and Oliver Friedrichs, "Hydrogen: the future energy carrier", Phil. Trans. R. Soc. A (2010) 368, pp. 3329–3342; <https://doi.org/10.1098/rsta.2010.0113>

Upgrading biogas by CO₂ reduction to Methane



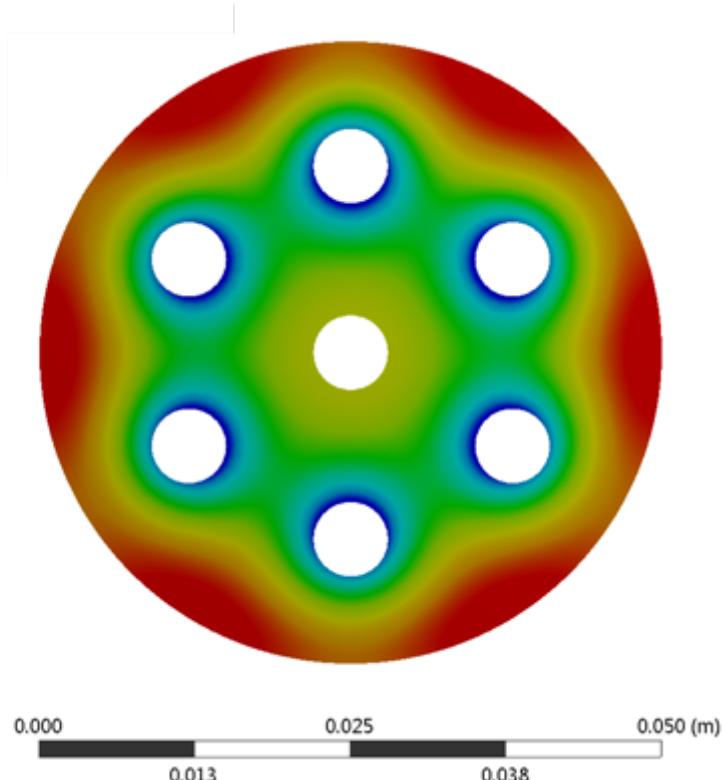
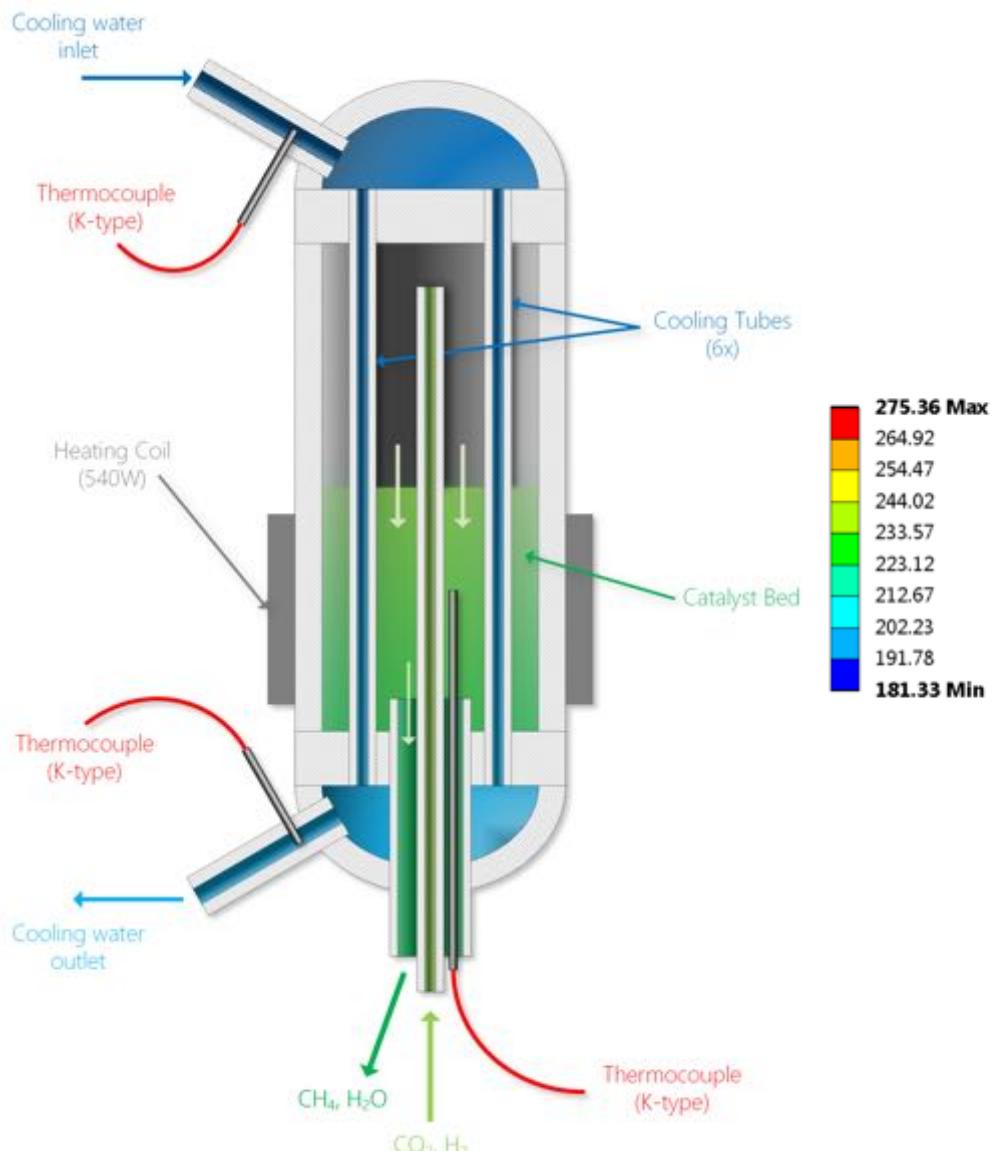
Equilibrium conversion vs. temperature



Ref.:René Bautz; Gilles Verdan, Andreas Züttel, "Installation Power-to-Gas Novatrice", AQUA & GAS No3 (2021), pp. 48-53

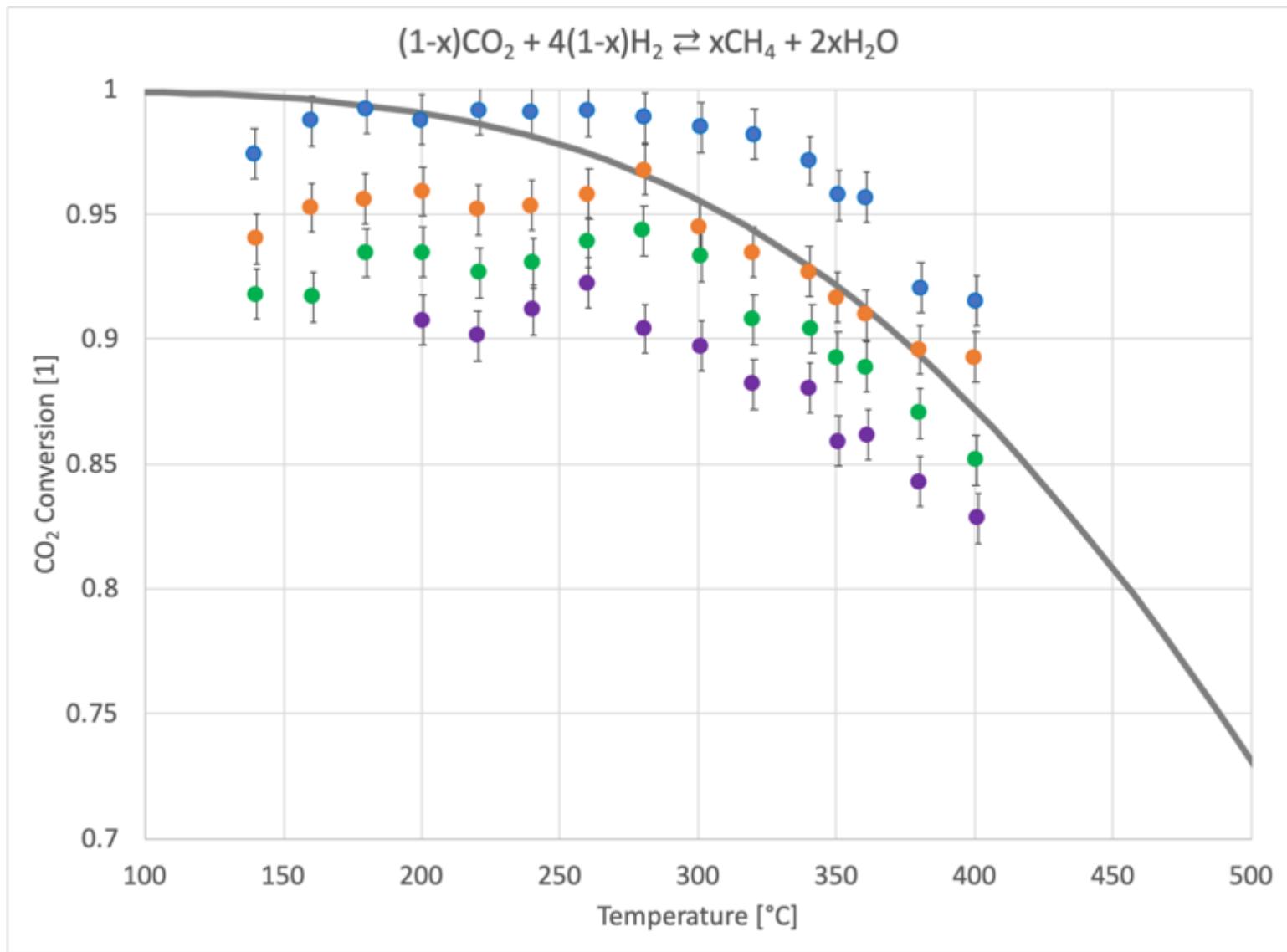
Methane reactor (2 kW)

Upgrading biogas by direct methanation



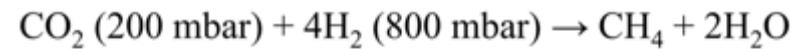
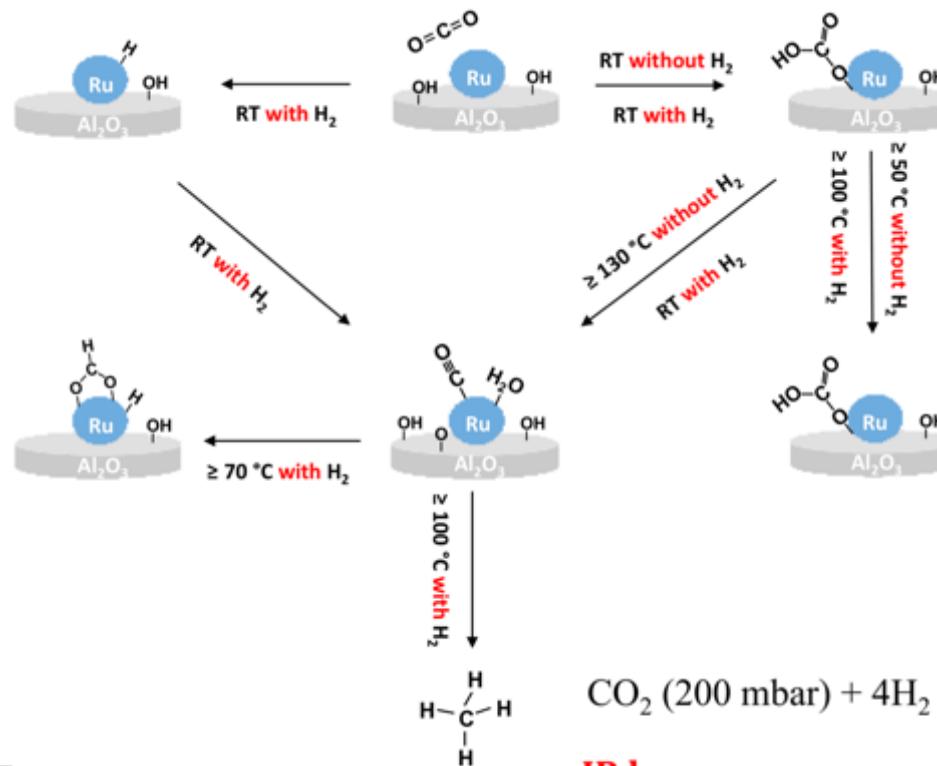
Ref.: Noris Gallandat, Robin Mutschler, Vincent Vernay, Heena Yang, Andreas Züttel, "Experimental Performance Investigation of a 2kW Methanation Reactor", Sustainable Energy Fuels, 2 (2018), pp. 1101 - 1110

CO_2 Conversion as a function of temperature

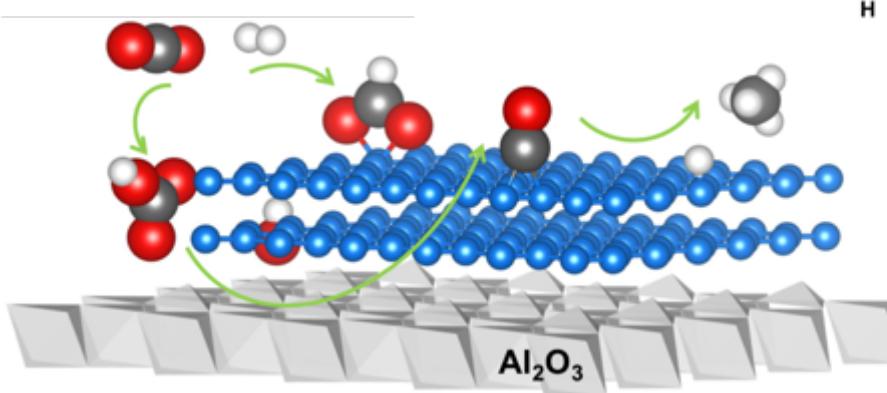


Ref.: Andreas ZÜTTEL, Noris GALLANDAT, Gilles VERDAN, René BAUTZ, "CO₂ Neutral Synthetic Methane Production", Sustainable Future – Powered by Gas, 2021 World Gas Conference, to be submitted

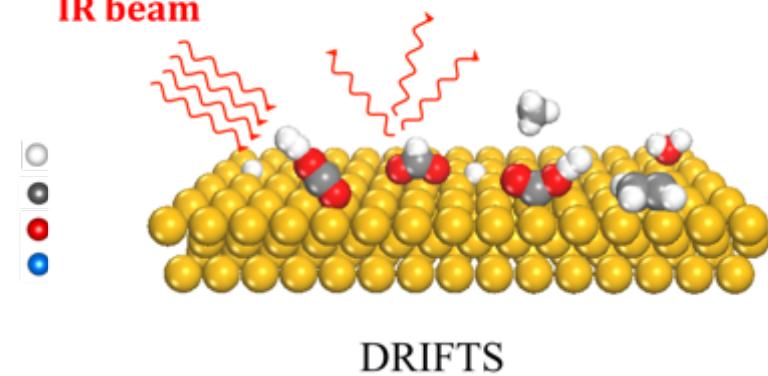
CO_2 reduction reaction mechanism



IR beam



IR beam

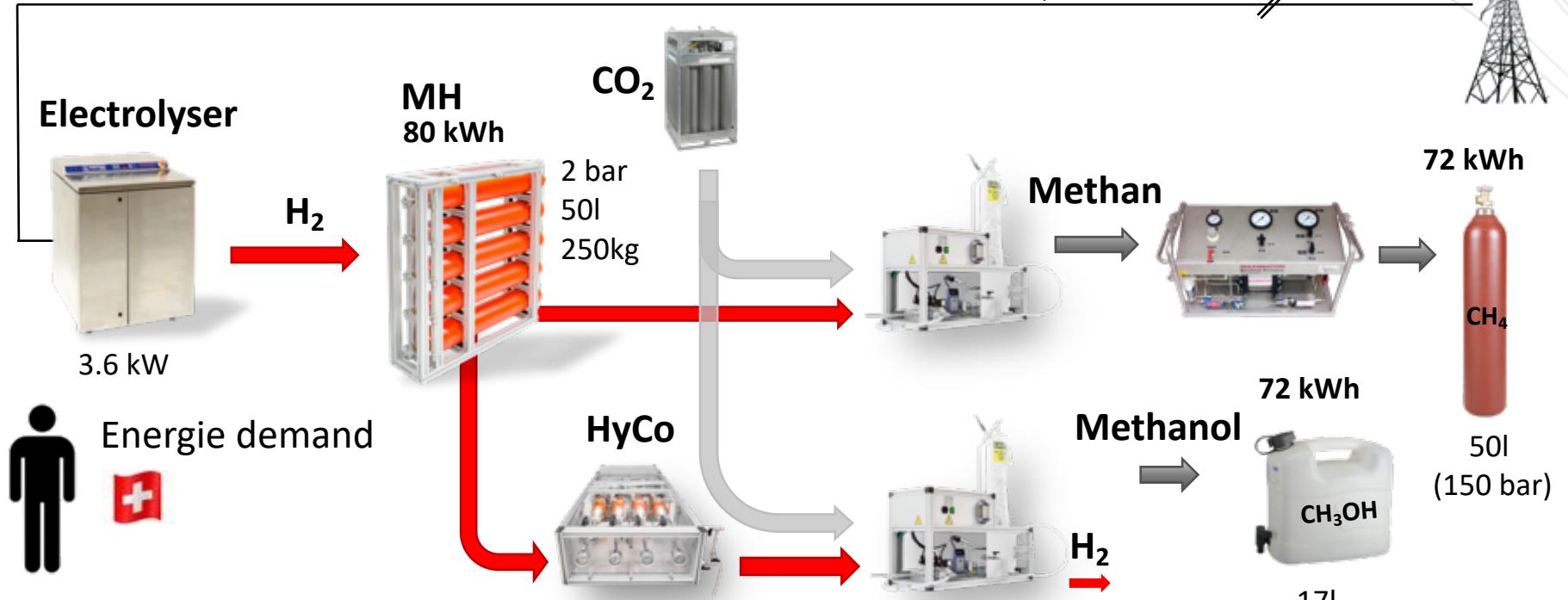
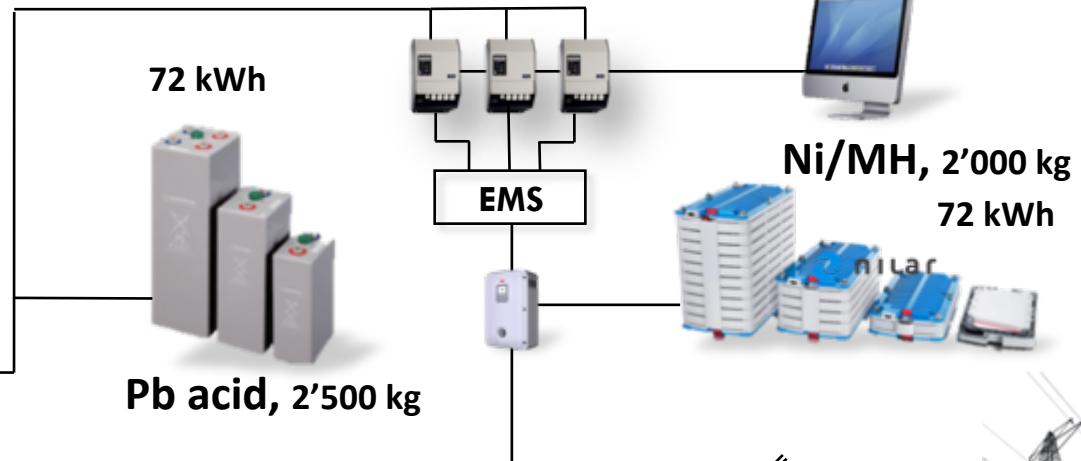
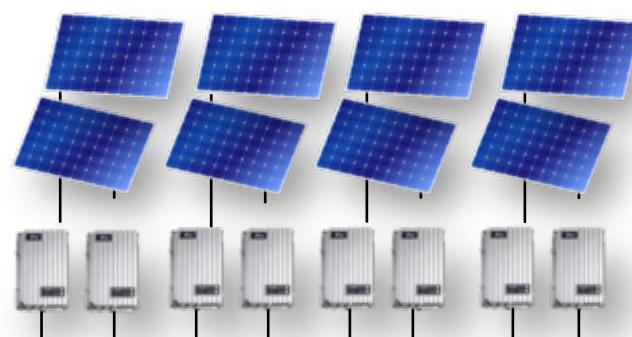


Ref.: Kun Zhao, Ligang Wang, Marco Calizzi, Emanuel Moioli, Andreas Züttel, "In situ Control of the Adsorption Species in CO_2 Hydrogenation: Determination of Intermediates and Byproducts", J. Phys. Chem. C 122:36 (2018), pp. 20888–20893

Small Scale Demonstrator Sion (SSDS)

URL: ssds.epfl.ch

120 m² 28'800 kWh/Jahr

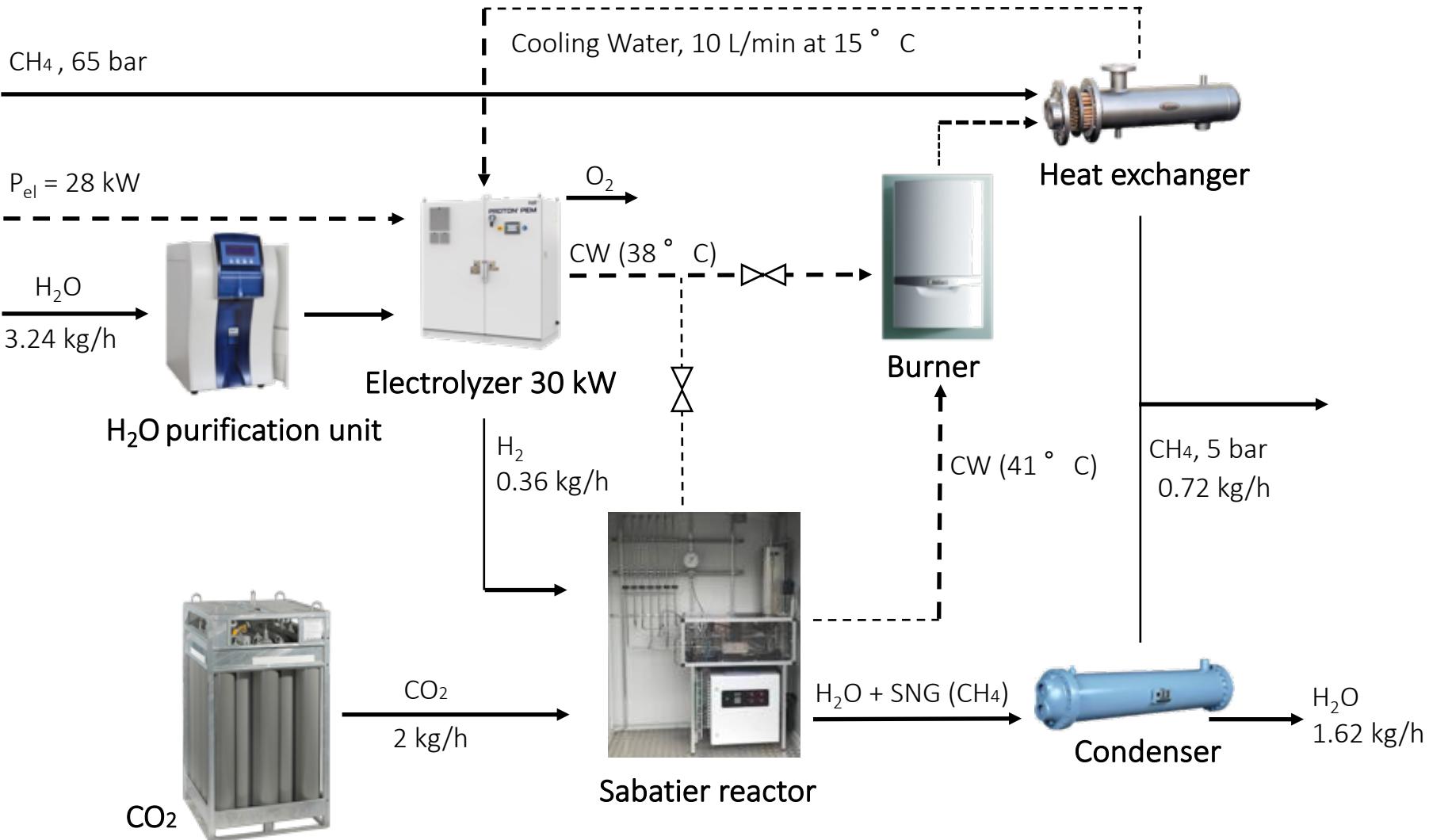


Ref.: Noris Gallandat, Jérémie Bérard, François Abbet and Andreas Züttel, "Small-scale demonstration of the conversion of renewable energy to synthetic hydrocarbons", Sustainable Energy Fuels, 1 (2017), pp. 1748 - 1758

Installation at PDC in Sion



Noris GALLANDAT Emanuele MOIOLI

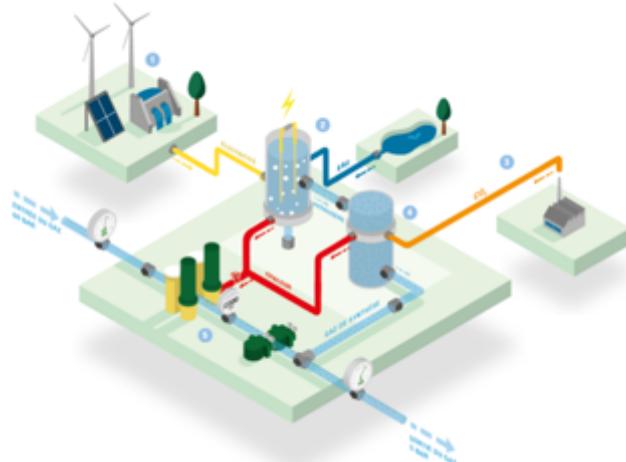


Ref.:René Bautz; Gilles Verdan, Andreas Züttel, "Installation Power-to-Gas Novatrice", AQUA & GAS No3 (2021), pp. 48-53

Inauguration Methane reactor at PDC in Sion 25. 9. 2020



R. Bautz (CEO Gaznat), A. Züttel (Prof. EPFL), Ph. Varon (President Ville de Sion), F. Fellay (CEO Oiken)



EPFL Valais Wallis
Empa



RTS 19:30

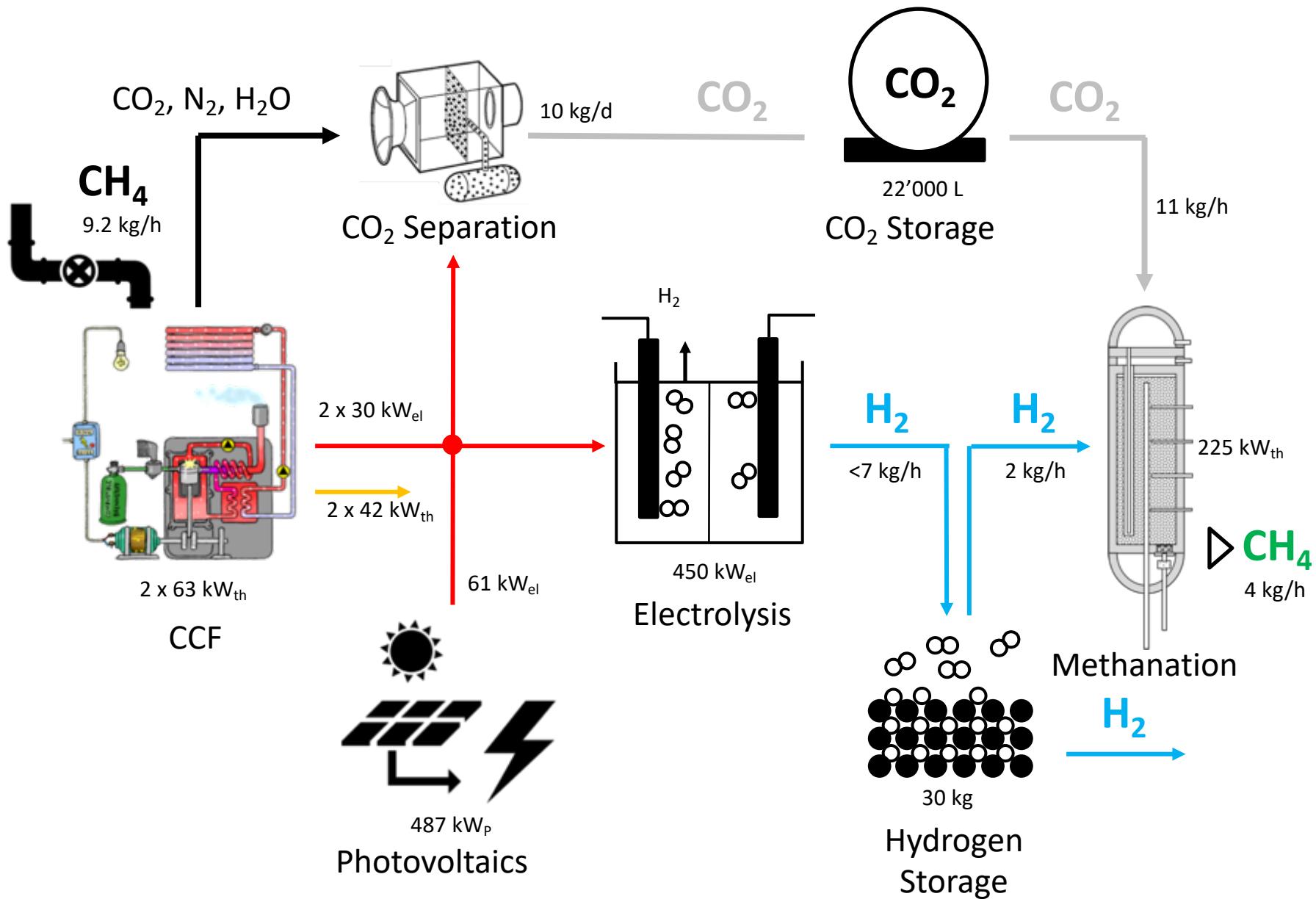
**gaz
nat**



25 kW
99.6% CH₄

250 kW Methane reactor for the Green gas Project in Aigle at Gaznat

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Acknowledgement



Noris GALLANDAT



Krzysztof ROMANOWICZ



Emanuele MOIOLI

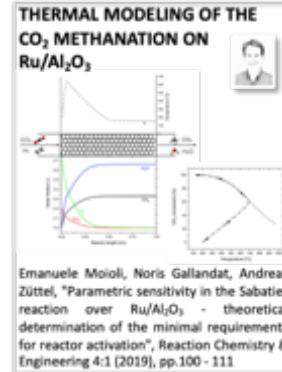
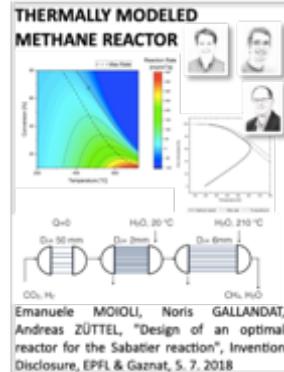
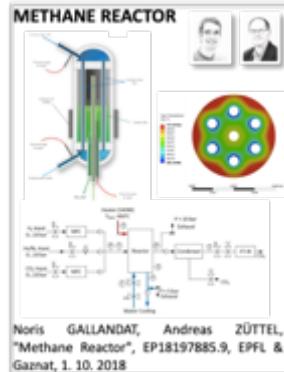


Robin MUTSCHLER

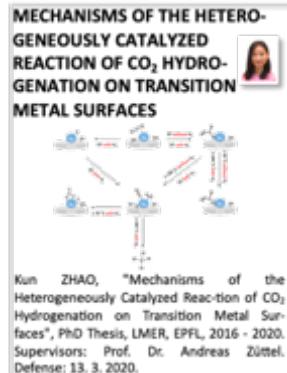
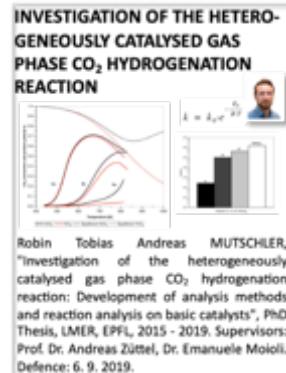
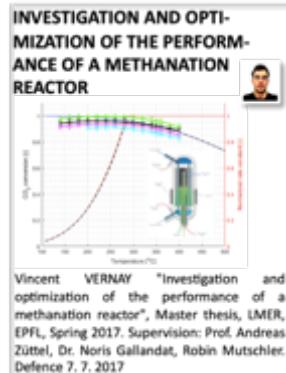
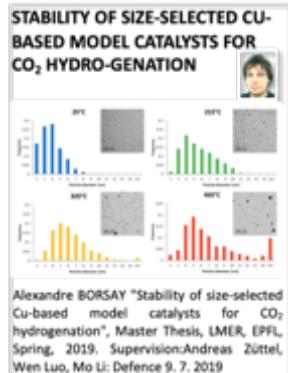


Kun ZHAO

PATENTS:



THESIS:



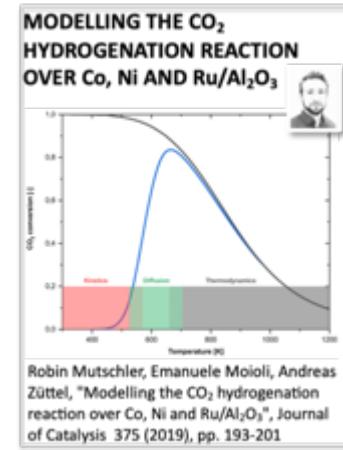
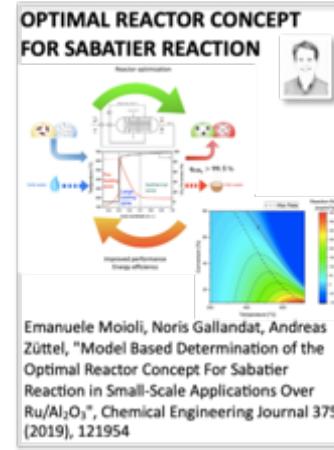
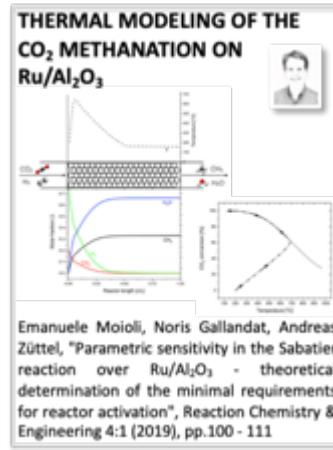
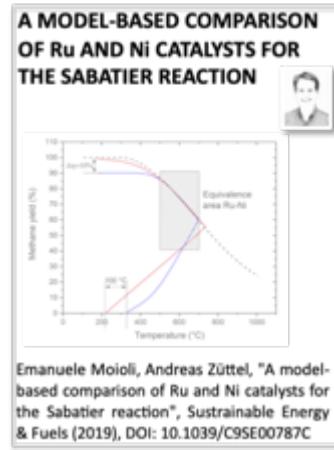
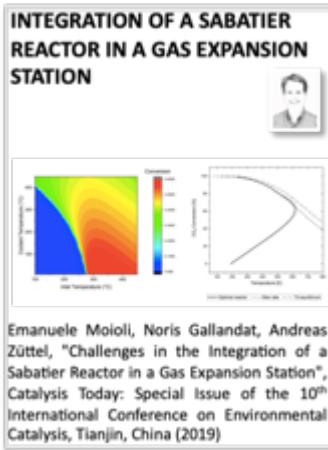
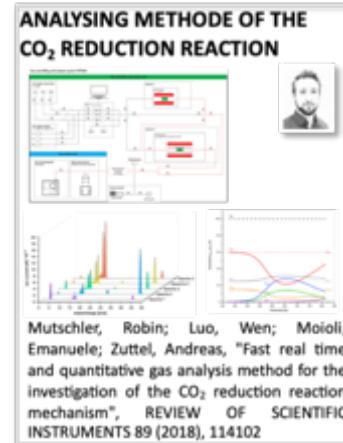
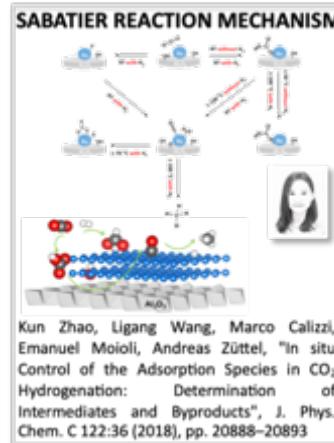
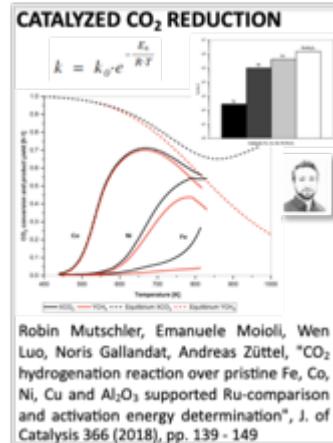
Acknowledgement

SMALL SCALE DEMONSTRATOR: SOLAR ENERGY TO SYNTHETIC FUELS (POWER to X)

Noris Gallandat, Jérémie Béard, François Abbet and Andreas Züttel, "Small-scale demonstration of the conversion of renewable energy to synthetic hydrocarbons", *Sustainable Energy Fuels*, 1 (2017), pp. 1748 - 1758

METHANE SYNTHESIS REACTOR
Patent application no. EP17209981.4 filed EPFL with Gaznat
0.5%wt Ru / Al₂O₃

Noris Gallandat, Robin Mutschler, Vincent Vernay, Heena Yang, Andreas Züttel, "Experimental Performance Investigation of a 2kW Methanation Reactor", *Sustainable Energy Fuels*, 2 (2018), pp. 1101 - 1110



CV Andreas ZÜTTEL, Prof. Dr.

Born 22. 8. 1963 in Bern, Switzerland. 1985 Engineering Degree in Chemistry, Burgdorf, Switzerland. 1990 Diploma in Physics from the University of Fribourg (UniFR), Switzerland. 1993 Dr. rer. nat. from the science faculty UniFR. 1994 Post Doc with AT&T Bell Labs in Murray Hill, New Jersey, USA. 1997 Lecturer at the Physics Department UniFR. 2003 External professor at the Vrije Universiteit Amsterdam, Netherlands. 2004 Habilitation in experimental physics at the science faculty UniFR (www.unifr.ch). President of the Swiss Hydrogen Association „HYDROPOLE“ (www.hydropole.ch). 2006 Head of the section “Hydrogen & Energy” at EMPA (www.empa.ch) and Prof. tit. in the Physics department UniFR. 2009 Guest Professor at IMR, Tohoku University in Sendai, Japan. 2012 Visiting Professor at Delft Technical University, The Netherlands, 2014 Full Professor for Physical Chemistry, Institut des Sciences et Ingénierie Chimiques, Ecole Polytechnique Fédérale de Lausanne EPFL (www.lmer.epfl.ch), Switzerland. 2017 Co-Founder of GRZ Technologies Ltd. (www.grz-technologies.com). 2020 Member of the Swiss Academy of Technical Science (SATW, <https://www.satw.ch>)



A. Zützel



BSc Chemistry
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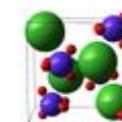


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2000

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2004

Start Up Company
2017 Grolley (FR)
grz-technologies.com

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Total Publications: 260, h-index: 65 , Citations: 29'000



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