Indirect water electrolysis

The EPFL Hydrogen Network

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LEPA
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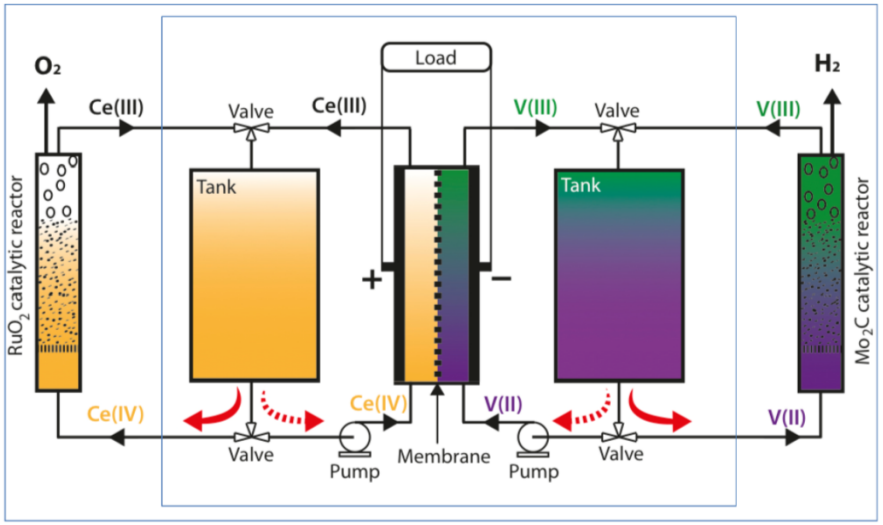
Physique & Analytique

From Electricity to Fuel

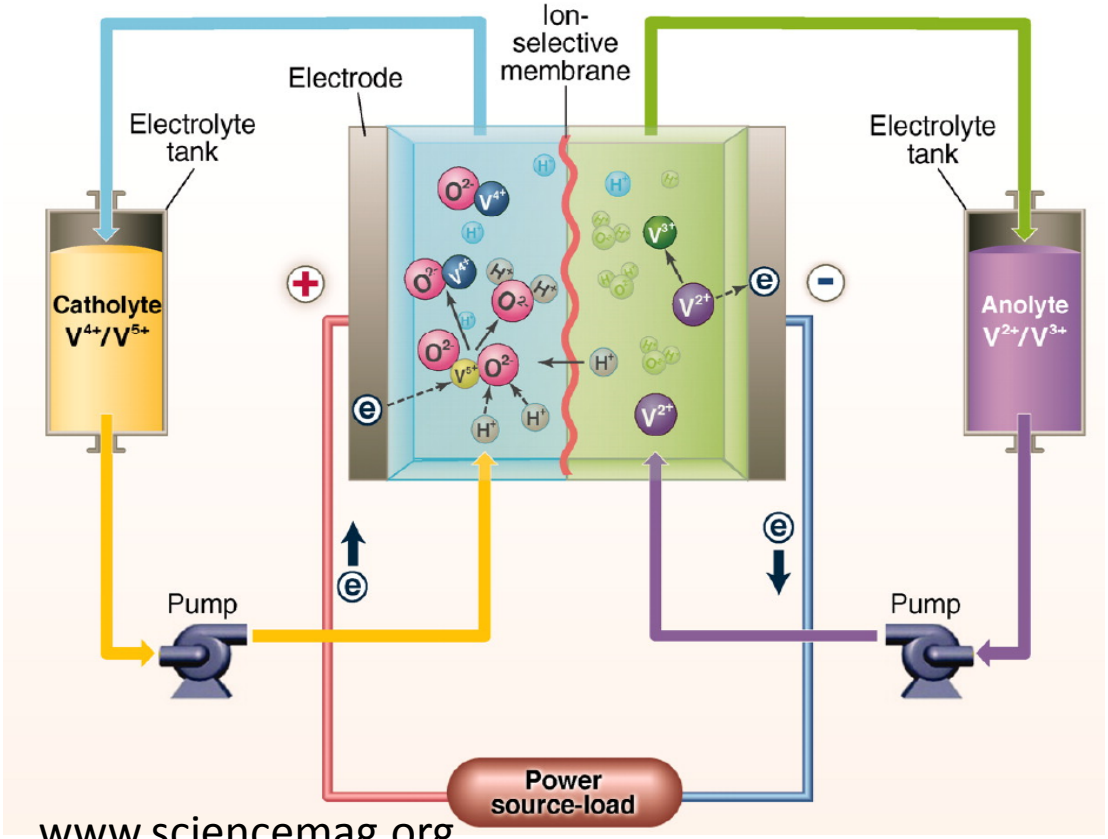
Redox flow Battery



Hydrogen production

Electricity generation

Redox Flow Batteries



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- Medium to large scale energy storage systems
- Electricity stored in liquid electrolytes
- Converts electrical energy to chemical energy and vice versa

Efficiency: 70-80%

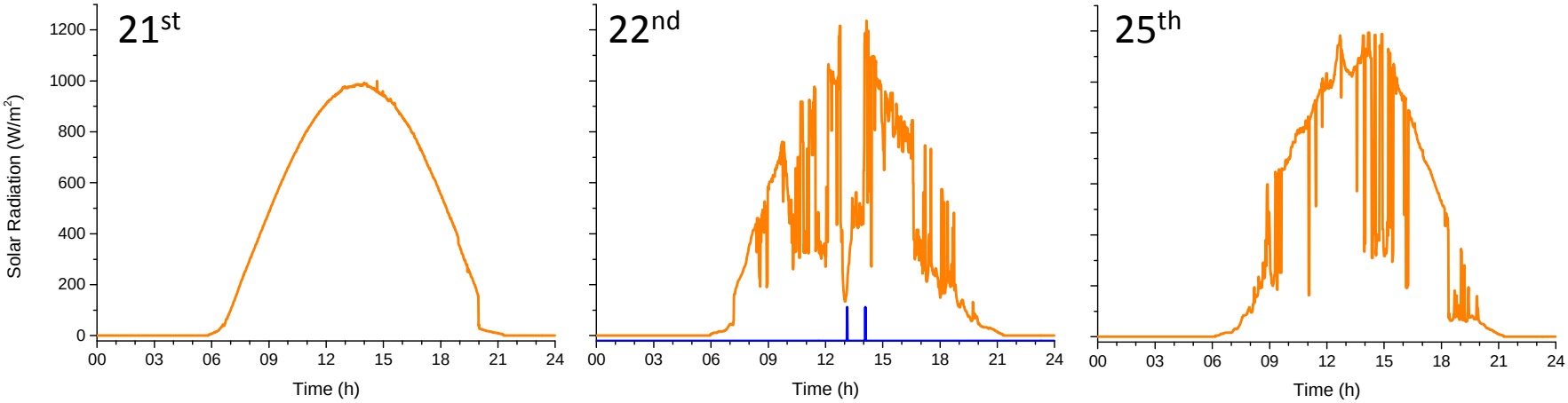
$$VO^{2+} + H_2O \xleftrightarrow{\text{charge/discharge}} VO_2^{+} + 2\,H^{+} + e^{-}$$ Positive half-cell reaction

$$V^{3+} + e^{-} \xleftrightarrow{\text{charge/discharge}} V^{2+}$$ Negative half-cell reaction

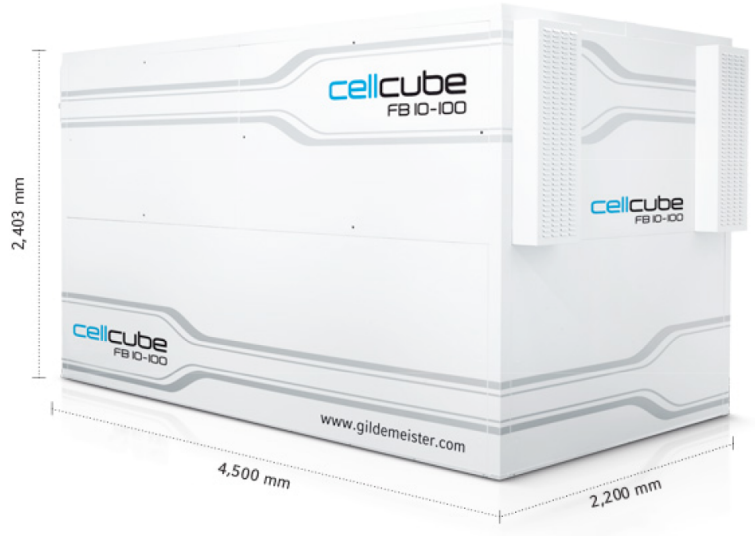
LEPA – Site Martigny

40 kWh
Vanadium RFB

Charging with “cheap” energy

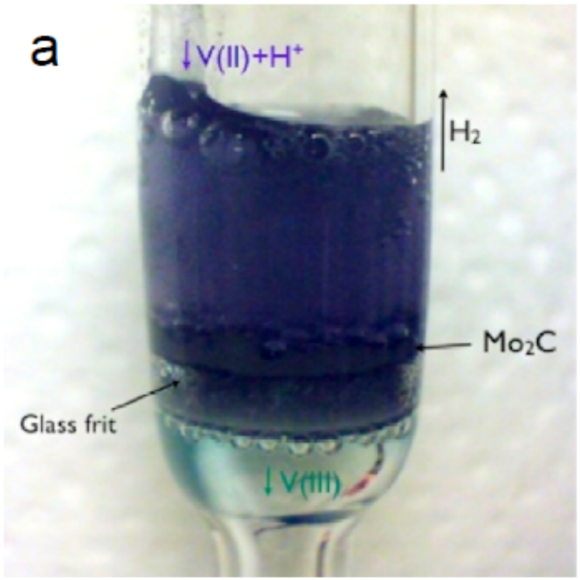


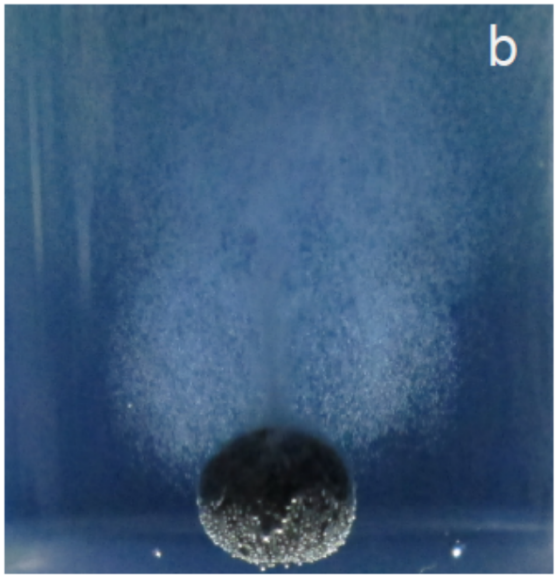
Solar radiation at LEPA – Martigny for June 2014



Catalytic hydrogen generation from V(II)

$$2V^{2+} + 2H^{+} \xrightarrow{Mo_2C} 2V^{3+} + H_2$$





Al_2O_3 supported Mo_2C catalyst

Vrubel H. and Hu X., Angew. Chem. Int. Ed. 2012, 51(51), 12703

Hydrogen and hydrocarbon storage

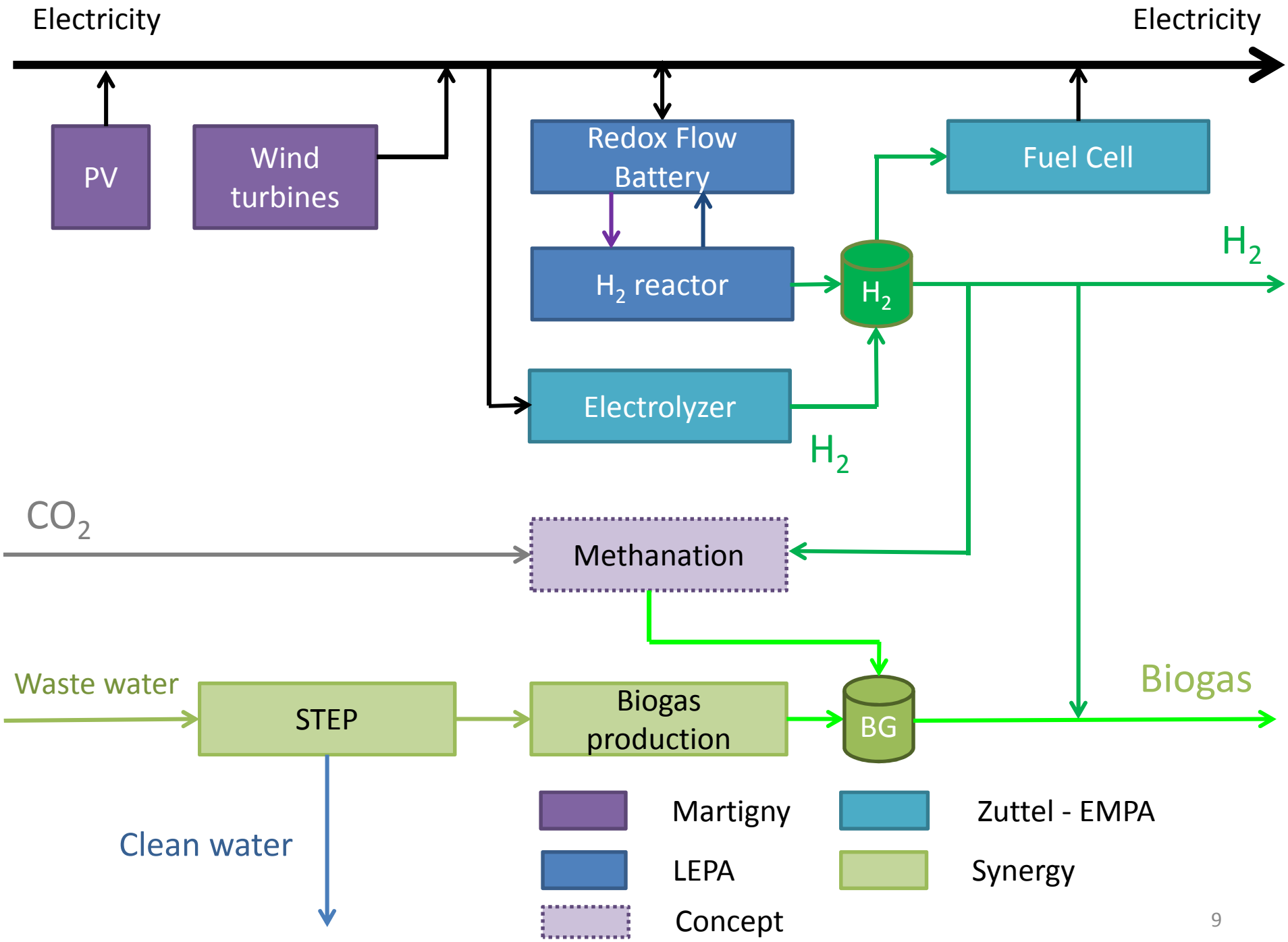
Renewable energy can provide **green** electricity directly

Electrolysis can be powered by renewable electricity to split water into hydrogen and oxygen

$$2H_2O \rightarrow \mathbf{2H_2} + O_2$$

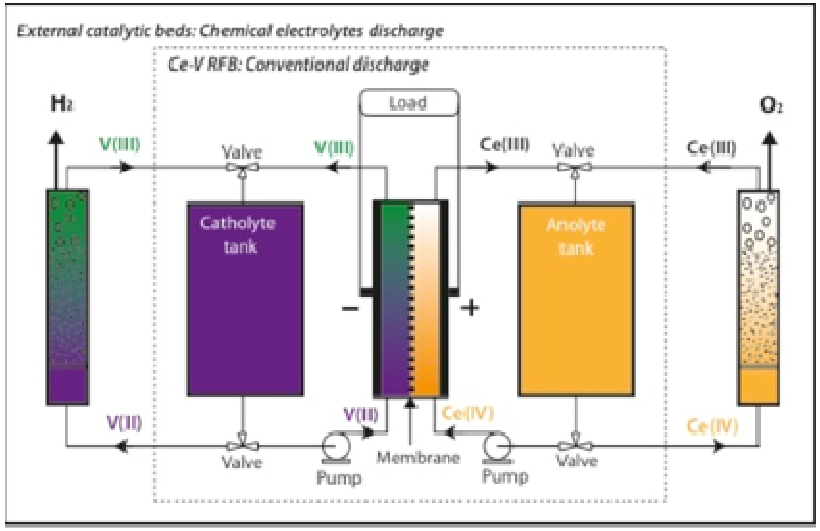
The hydrogen economy

- Hydrogen fuel cells – use hydrogen directly
- Hydrogen in natural gas network – Power-to-Gas
- Hydrogenation of CO_2 – convert CO_2 to high energy density hydrocarbons


Electricity
Electricity
PV
Wind turbines
Redox Flow Battery
Fuel Cell
H_2 reactor
H_2
H_2
Electrolyzer
H_2
CO_2
Methanation
Waste water
STEP
Biogas production
BG
Biogas
Clean water
Martigny
Zuttel - EMPA
LEPA
Synergy
Concept

The dream…

H_2 network



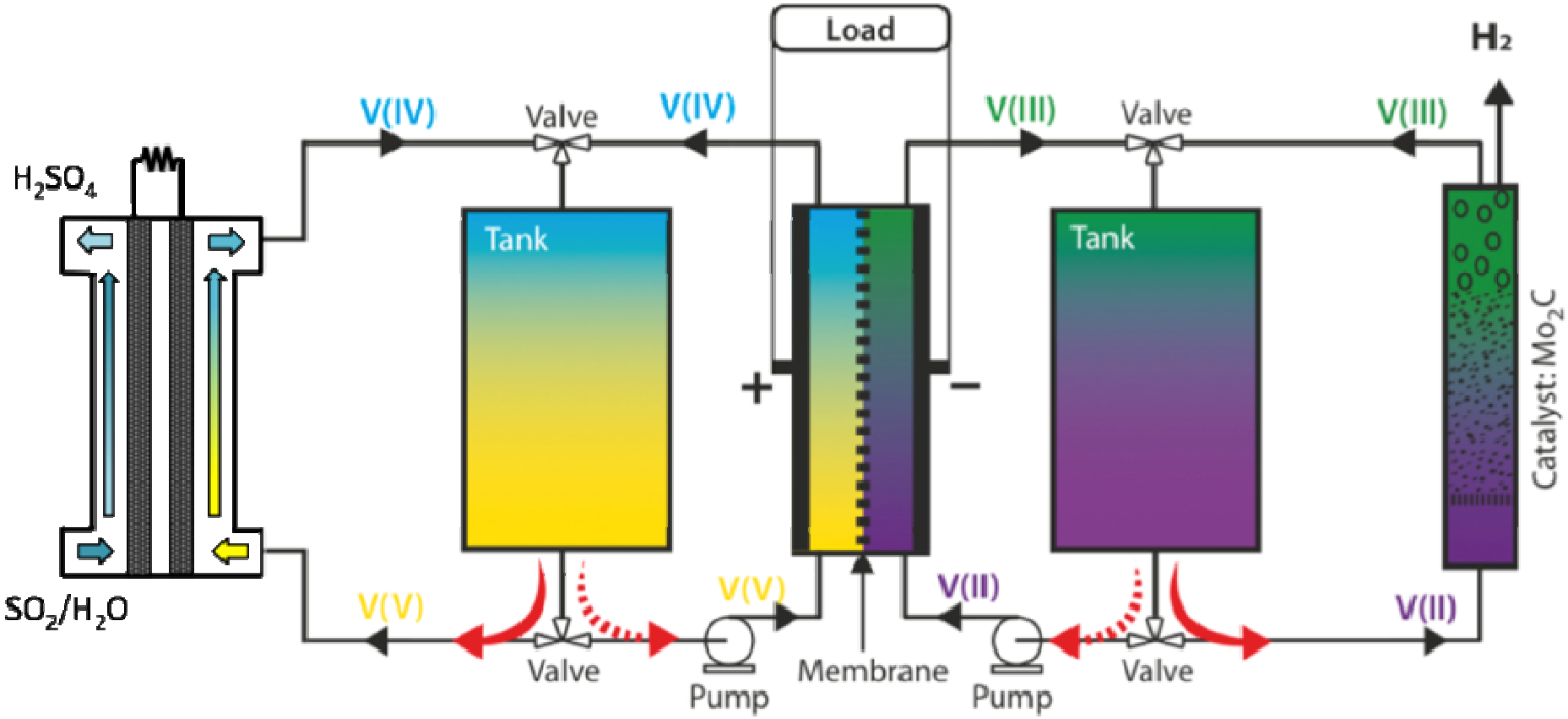
Electricity network

Fuel cell car - Belenos

One station providing both clean H_2 fuel or renewable electricity

Electrical car

SO_2 oxidation: Fuel cell discharge



Project collaborators

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- Centre de Recherches Energetiques et Municipale – CREM
- Ville de Martigny

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