WOLF ENERGETIK

Maximizing wind farm revenues through Electricity Storage

WOLF ENERGETIK –
Technology Provider for the industry

DR. BODO WOLF

Expert in energy research and state energy supply systems

Since 1990 development of key technologies for the transition of energy supply to renewable energies

Founder of successful technology companies (Choren Industries, Sunfire, SunCoal Industries)

CLAUDIA HAIN

Managing Director

Founder of Wolf Energetik for the transition of storage technologies to industrial utilization

ENGINEERING TEAM

Engineers, economists and lawyers work on solutions in an interdisciplinary manner.

Dr. Klaus Lucka

Managing Partner of Tec4Fuels GmbH

Olaf Schulze

Authorized signatory of DBI-Virtuhcon GmbH

Dr. Uta Weiß

Managing Director of the Gesellschaft für Mineralölanalytik und Qualitäts-management GMA

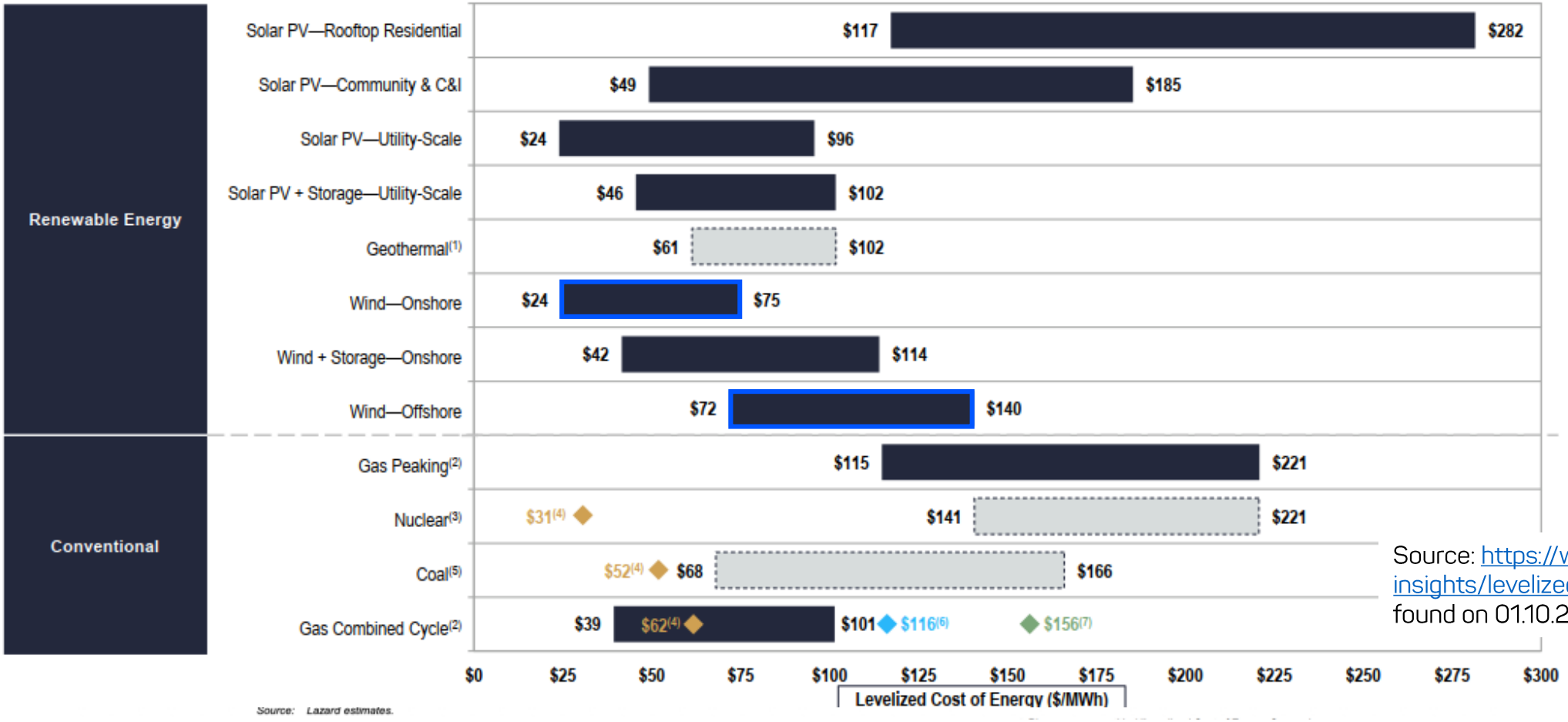
TECHNICAL ADVISORY BOARD

Advises on technical and strategic issues

RENEWABLE ENERGIES
the new primary energy source

Levelized Cost of Energy Comparison—Unsubsidized Analysis

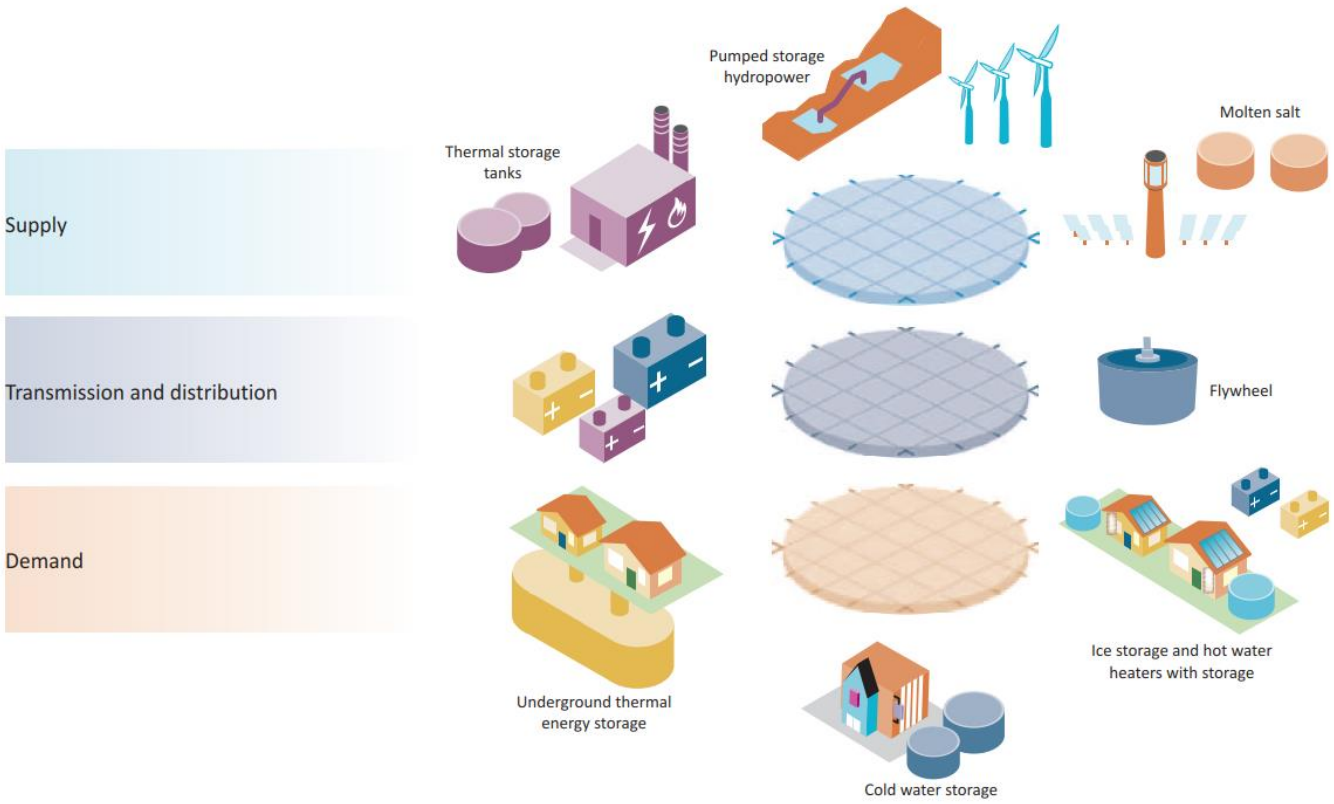
Selected renewable energy generation technologies are cost-competitive with conventional generation technologies under certain circumstances



Source: https://www.lazard.com/research-insights/levelized-cost-of-energyplus/ found on 01.10.2023.

DEPLOYMENT OF STORAGES in the electric power system

Figure 2: Hypothetical deployment of storage assets across an electric power system



Source: modified from EIA (Energy Information Administration) (2012), "Electricity storage: Location, location, location.....and cost", *Today in Energy*, Washington, DC, United States, www.eia.gov/todayinenergy/detail.cfm?id=6910.

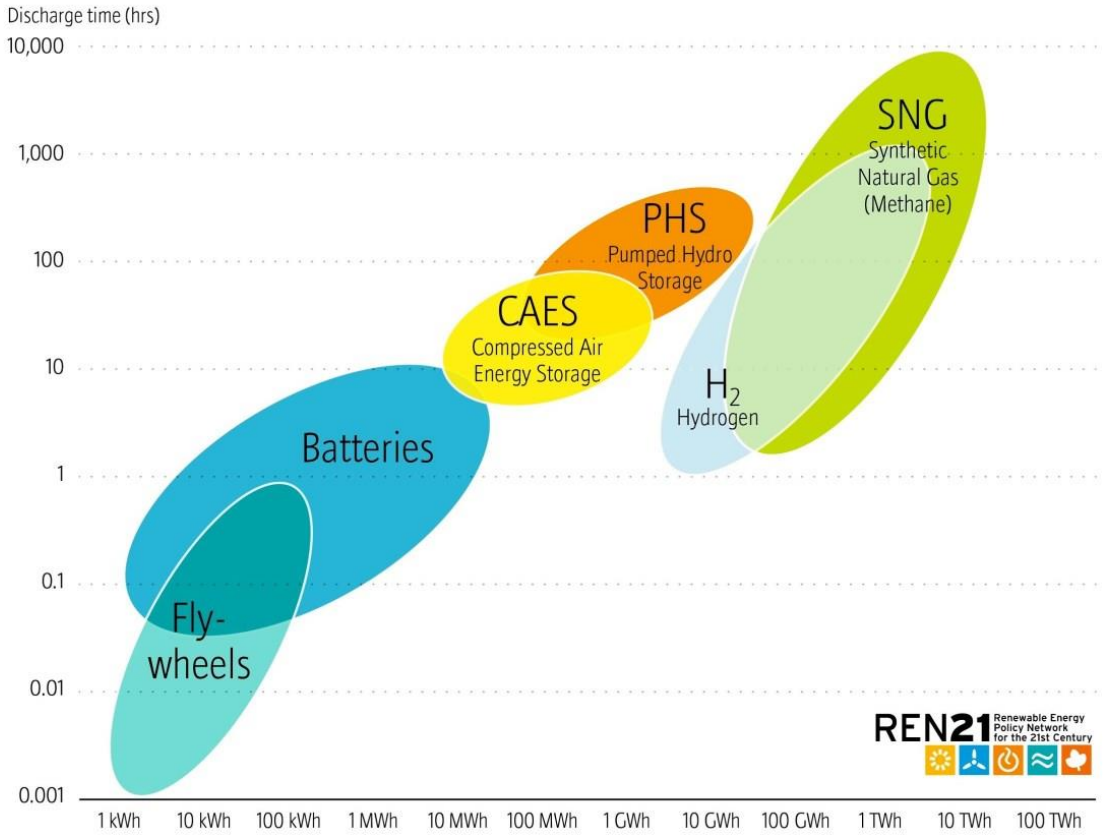
Source: Technology roadmap Energy Storage IEA 2014.

ENHANCED BUSINESS MODELS FOR WIND FARMS + STORAGES

- minimizing penalties from imbalances from forecasted production
- optimizing earnings from the intraday power market by shifting parts of its production
- PPAs for renewable base load instead of delivered as produced
- Additional provision of ancilliary services to the grid
- Autarch island supply within renewable micro grids

STORAGE NEEDS
& technologies available

Overview storage capacity of different energy storage systems



Renewables Global Futures Report Great debates towards 100 % renewable energy

Source: Fraunhofer Institute, Germany, 2014

STORAGE TASKS
IN THE ENERGY SYSTEM

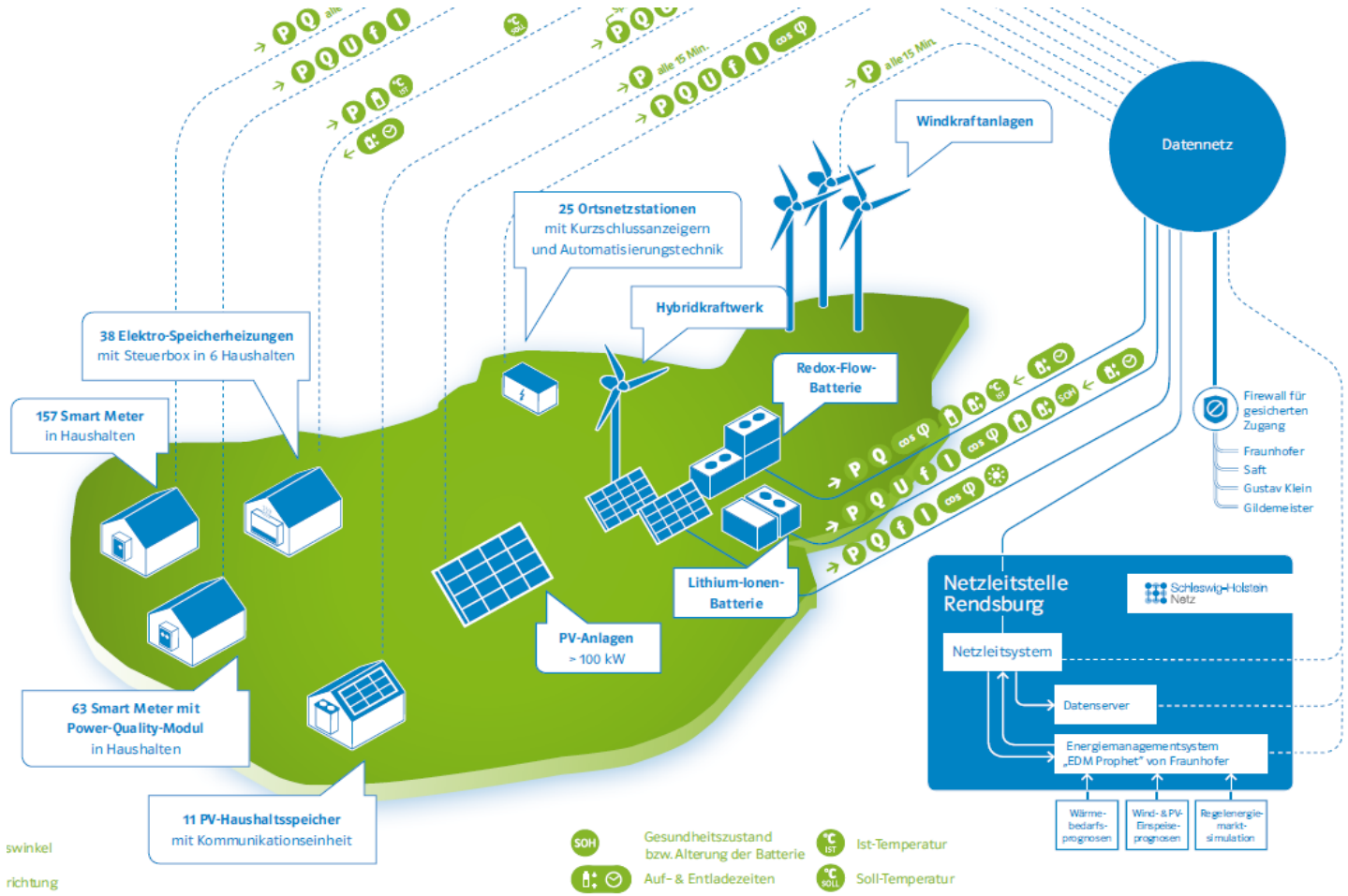
- Batteries are too high in costs per MWh to be attractive for a power shift
- Hydrogen and SNG are very inefficient for power production (<25 % overall efficiency power-to-power)
- PHS are not location independent and interfere with nature protection
- Something in the dimension of CAES is needed for decentral power storage for supply with intermittent renewable energy

ISLAND POWER SUPPLY
storage for microgrid systems

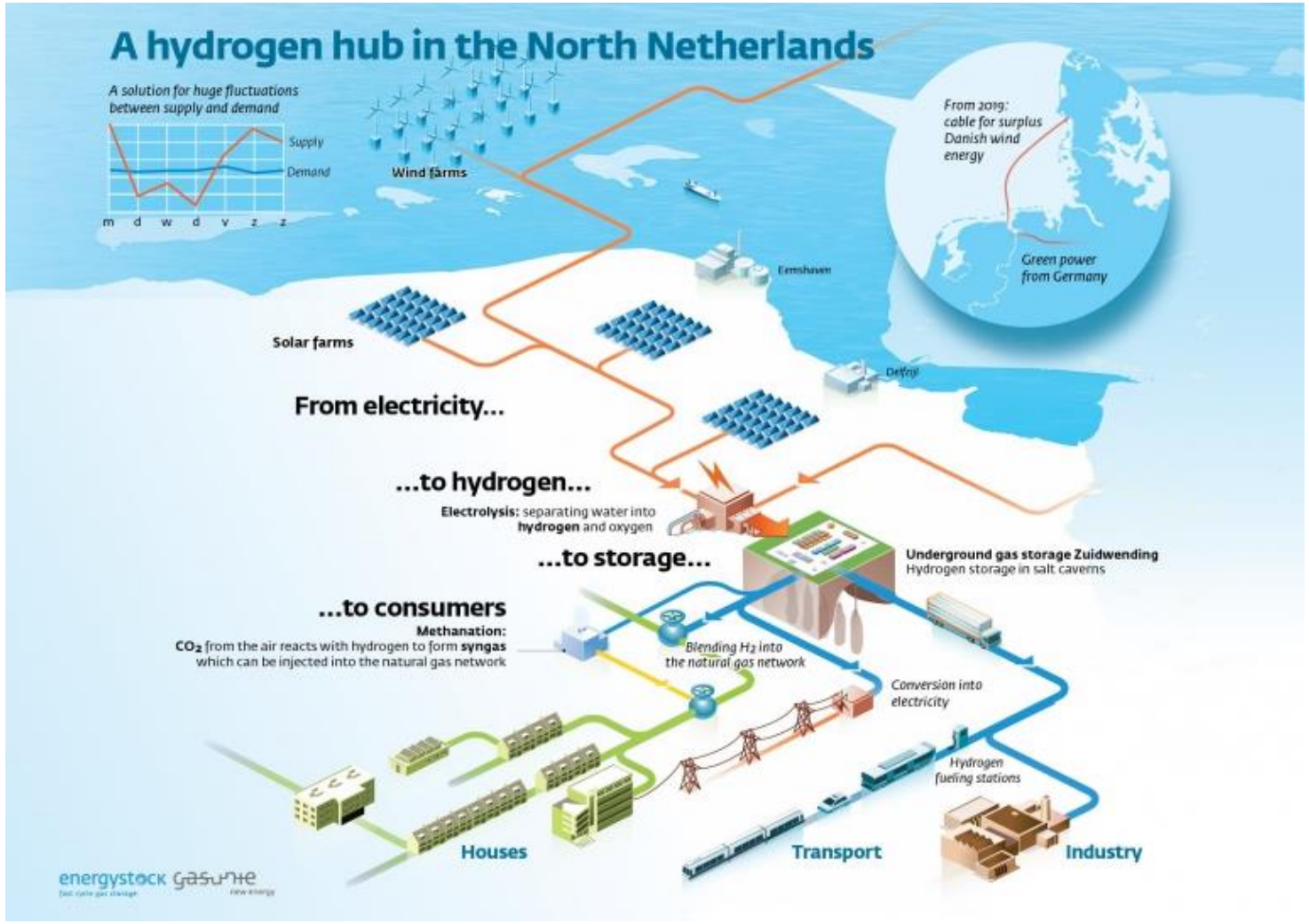
CASE STUDY ISLAND PELLWORM

- A degree of self-sufficiency of 97% was achieved
- A completely energy self-sufficient island would have required a dimensioning of the storage about twice as large
- Even the economic efficiency of the built compound power plant is not given

Conclusion:
For self-sufficiency, a storage technology is needed that allows capacity to be multiplied in a cheaper way



HYDROGEN ECONOMY without power storage?

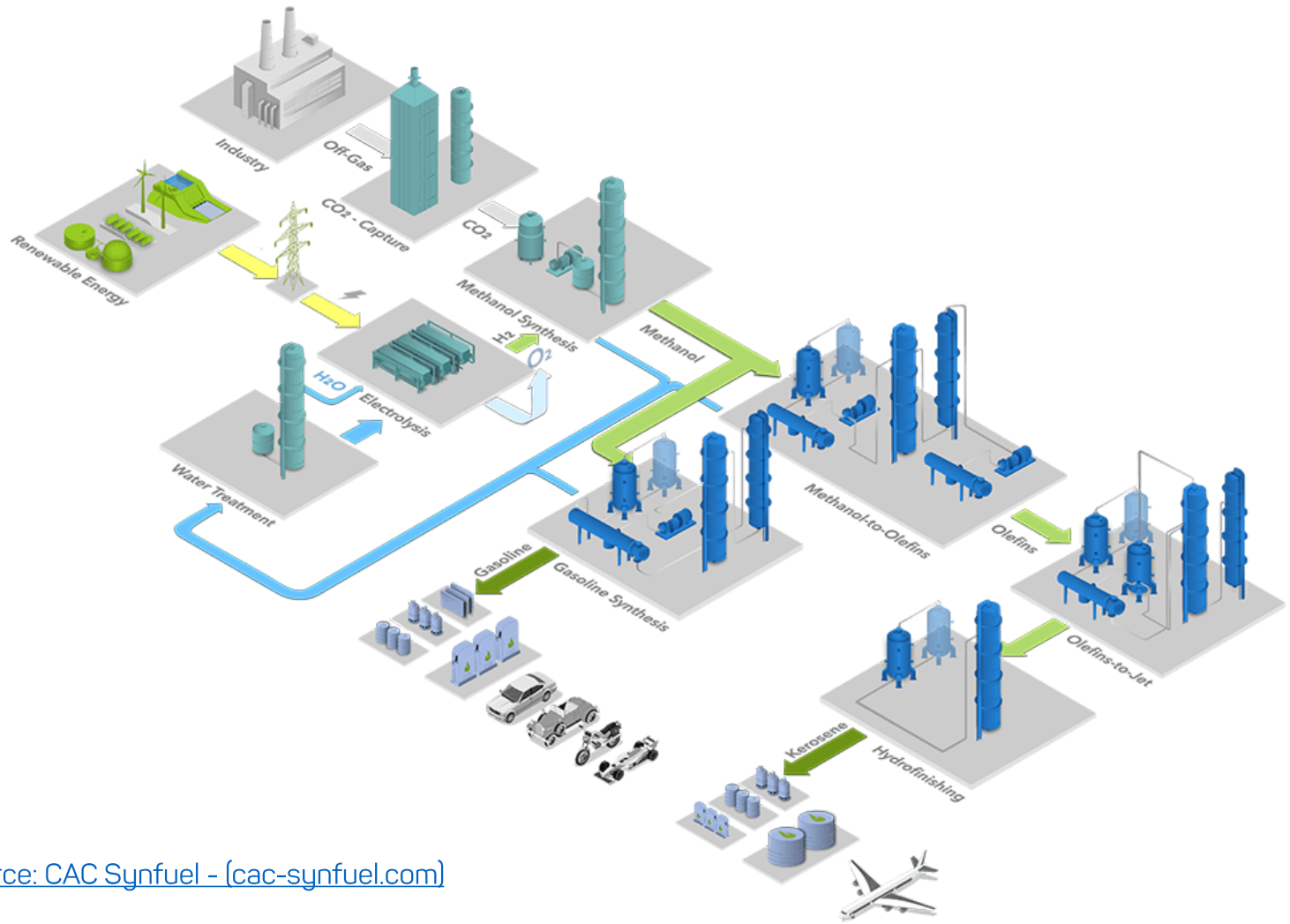


ECONOMICS OF HYDROGEN

- The electrolyser as core technology should be operated >8,000 hours per year to minimize costs of hydrogen
- Storage and transportation of hydrogen is technically difficult and expensive (geological storage and pipelines are not available but new infrastructures)
- An efficient power storage system before the electrolyser is needed, that stores the energy demand for one week

Source: https://1.bp.blogspot.com/-jmt-QJ-0PEw/WVUmXUM3JRI/AAAAAAAAb5o/0RRz0izHkHss0OvPp4h0mKp40HgzgwDXQCLcBGAs/s320/PP_Gasunie%2BWaterstofbuffer_NL-01.jpg

SYNFUEL PRODUCTION from renewable energy



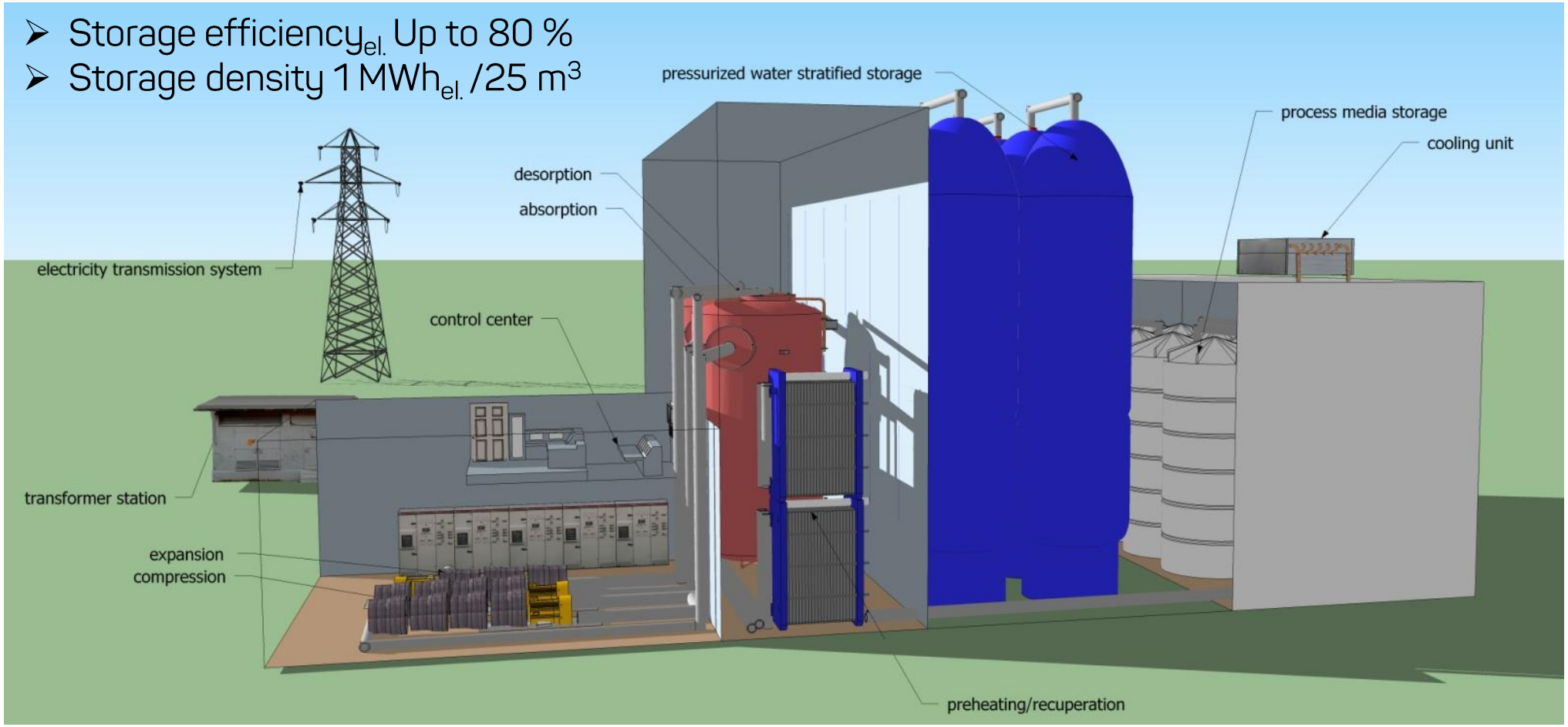
Source: CAC Synfuel - (cac-synfuel.com)

ENERGY STORAGE WITH SYNTHETIC HYDROCARBONS

- E-fuels and synthetic hydrocarbons have the best energy density and properties for storage transportation
- They can be stored and transported in the existing, grid independent infrastructure
- Consumers infrastructure is already available
- CO_2 is an important commodity in the future

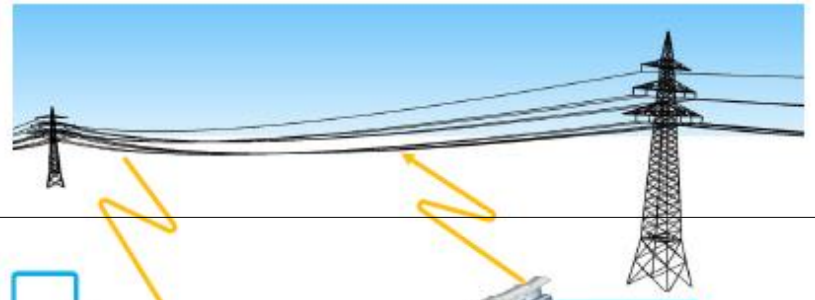
NACOMPEX® TECHNOLOGY for storage power plants

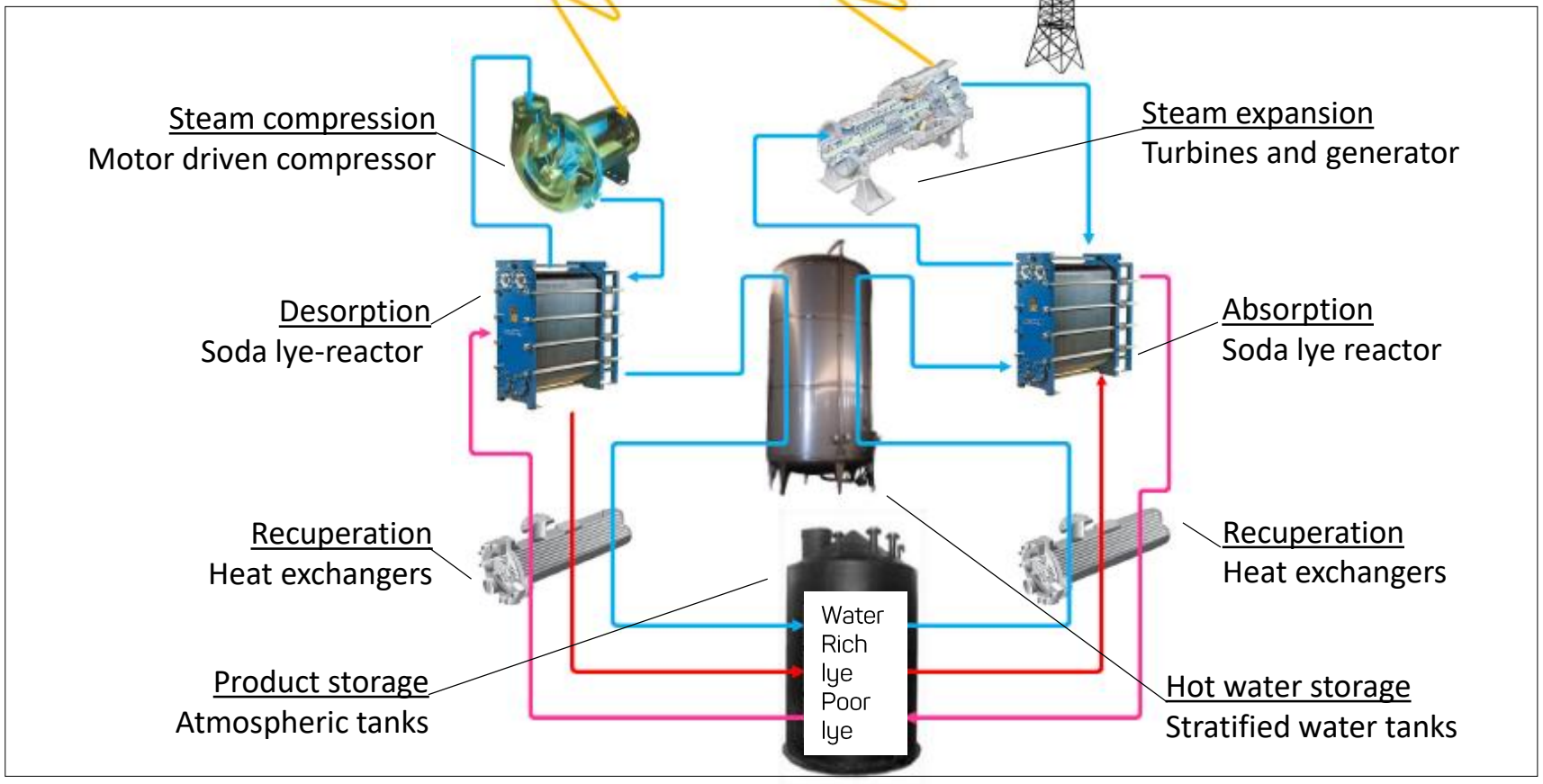
- Storage efficiency$_{el.}$ Up to 80 %
- Storage density 1 MWh$_{el.}$ /25 m^3



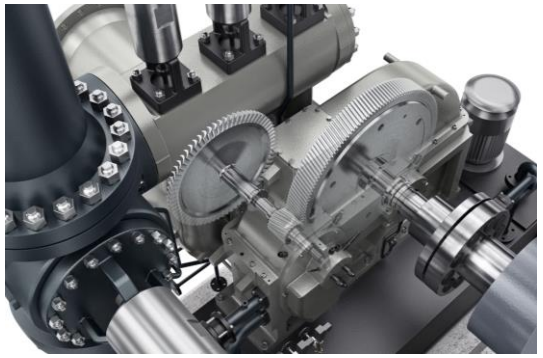
NACOMPEX® – Storage power plants with steam turbines

MAIN EQUIPMENT



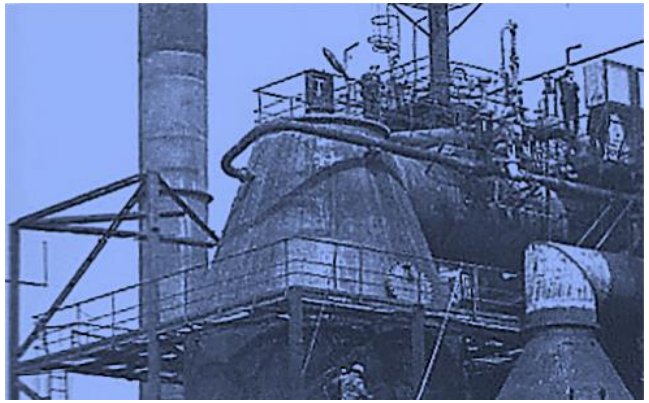


All equipment is market available, e.g. compressors and turbines from Siemens

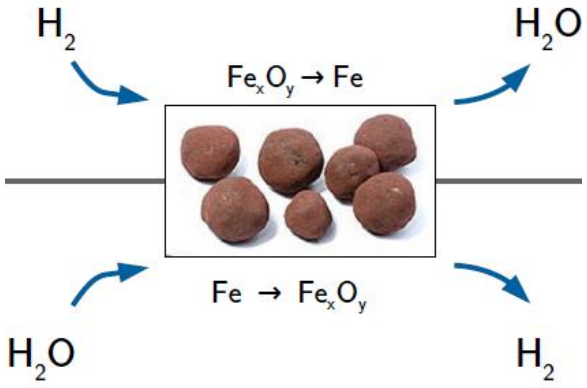


FEREDOX® TECHNOLOGY – Chemical energy storage with iron

Storage material made of specially treated iron masses.



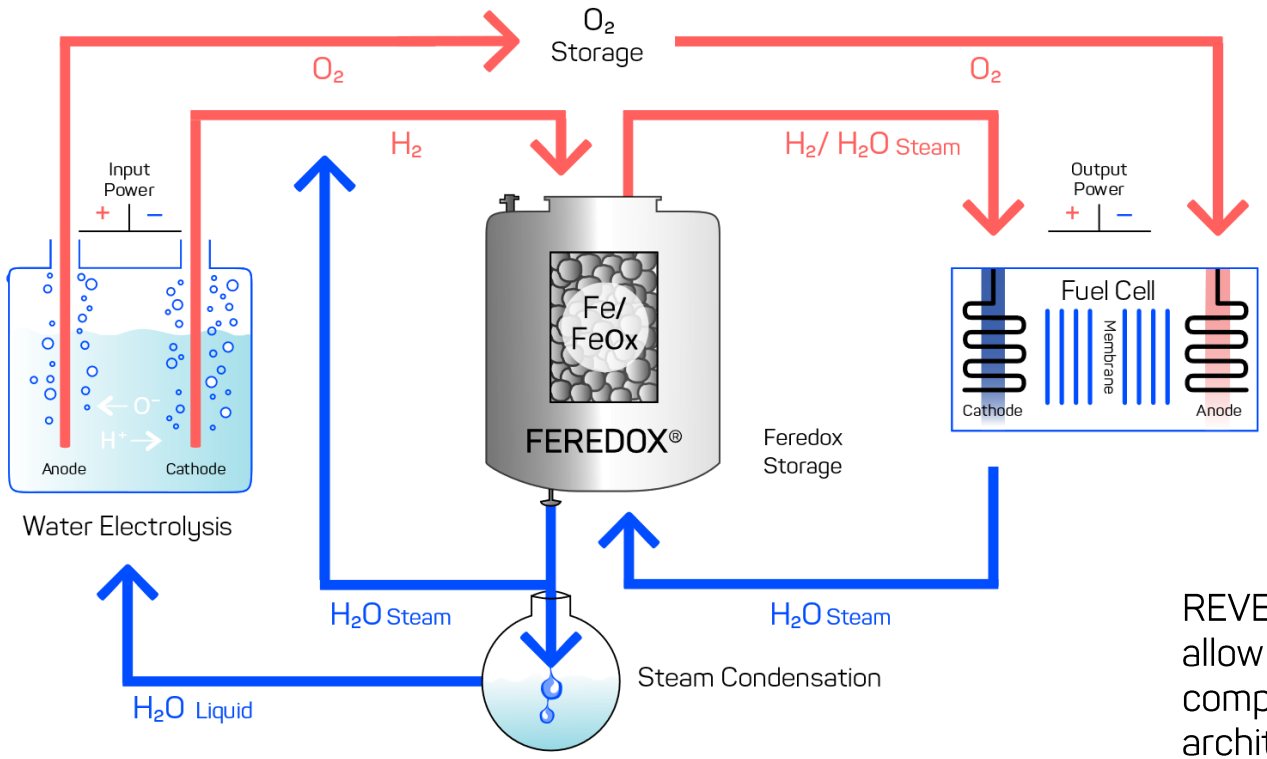
H_2 production plant for 20,000 m^3/hour for the production of town gas, Magdeburg 1974



ADVANTAGES OF THE FEREDOX® TECHNOLOGY

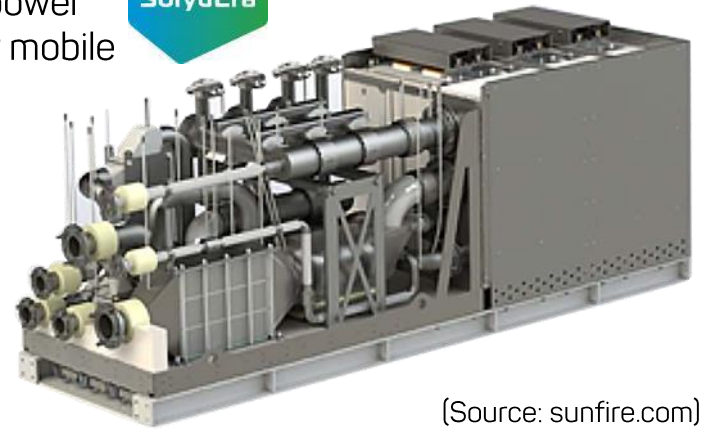
- Efficient power storage of up to 1 MWh/m^3 iron mass and up to 85 % overall efficiency
- Patented process for the use of CO_2 for the production of synthesis gas
- Safe indirect hydrogen storage with high energy density of up to 70 kg/m^3 iron mass
- Robust industrial process with high cycle stability and long service life
- Very good scalability for large applications

FEREDOX® – Power storage with electrolysis, fuel cell or gas turbine



FUTURE H DRIVE

Development of a power storage system for mobile application



(Source: sunfire.com)

REVERSIBLE FUEL CELLS allow for a very simple and compact power storage architecture.

EXERGY STORAGE
The materially closed loop operation is avoiding energy losses by emissions.

FEREDOX® – CO_2 CONVERSION for synthetic hydrocarbons

MABANAFT

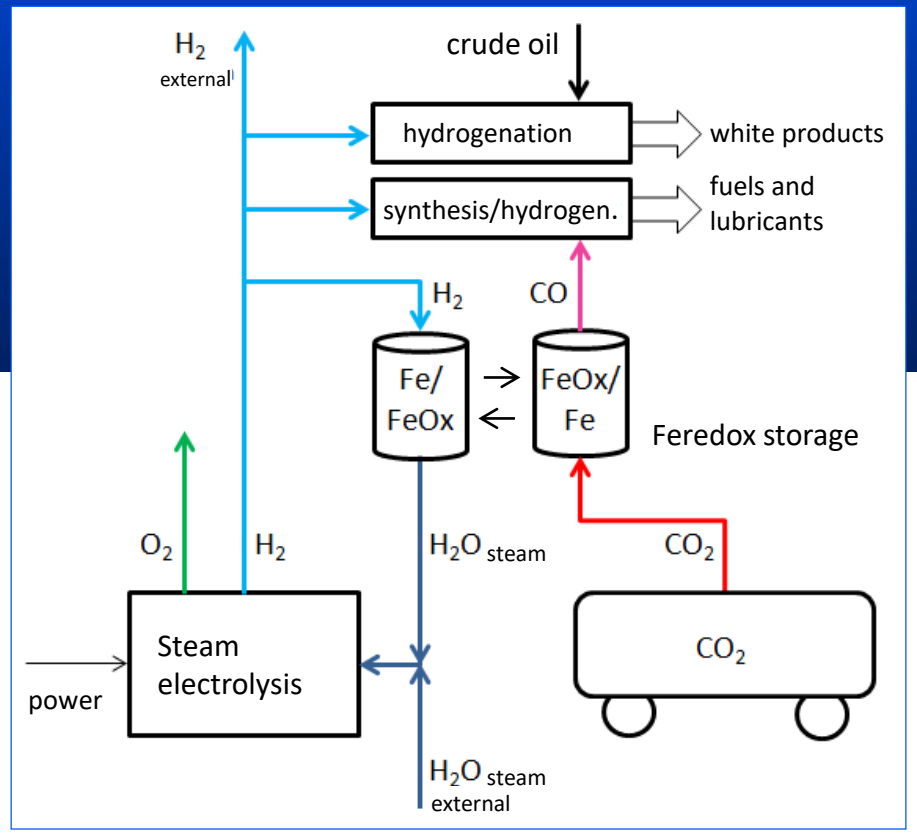
P2X Europe

STRATEGIC PARTNERS

Power-to-liquid Joint Venture for the marketing of E-fuels and petrochemical specialities

Synthesis gas is a hydrocarbon base material in the chemical and oil industry for the production of fuel, combustibles and lubricants (methane, gasoline, Diesel, kerosene, wax).

FEREDOX® Application – CO_2 conversion of CO for the synthesis gas production



Production of synthetical hydrocarbons

Heavy oil hydrogenation in the petroleum industry to make it more eco-friendly, thus insertion of renewable energy in heavy oils to reduce carbon dioxide emissions

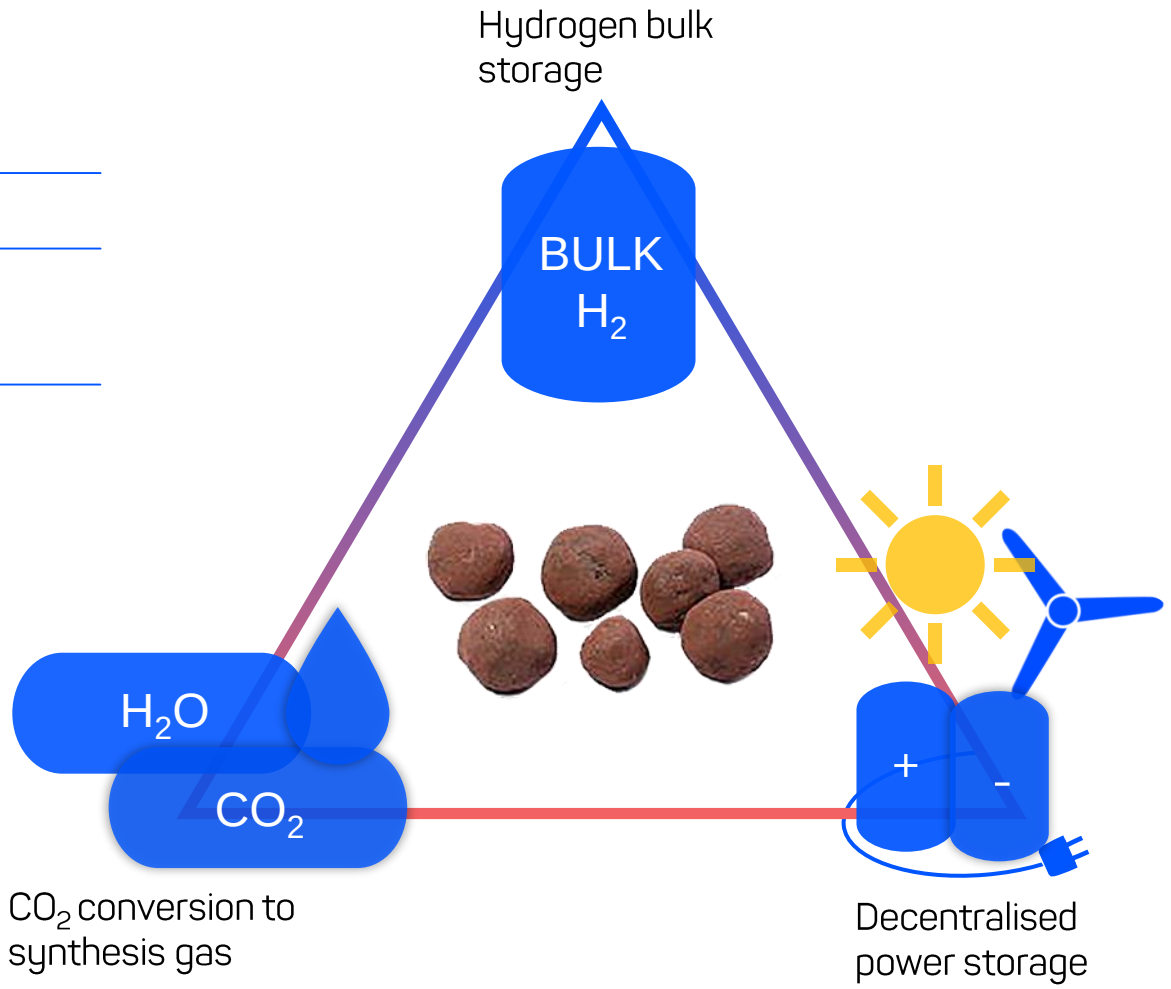
FEREDOX® – Applications in the energy and basic industry

APPLICATIONS

Simple and safe hydrogen storage

Decentralised power storage as a system with electrolysis and fuel cell

CO_2 conversion to synthesis gas for the production of renewable hydrocarbons



FEREDOX® – The energy storage technology

OUR SERVICES

- Conceptual storage integration
- Basic Engineering and support for Front End Engineering Design (FEED)
- Licensing and know-how transfer
- Commissioning support

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