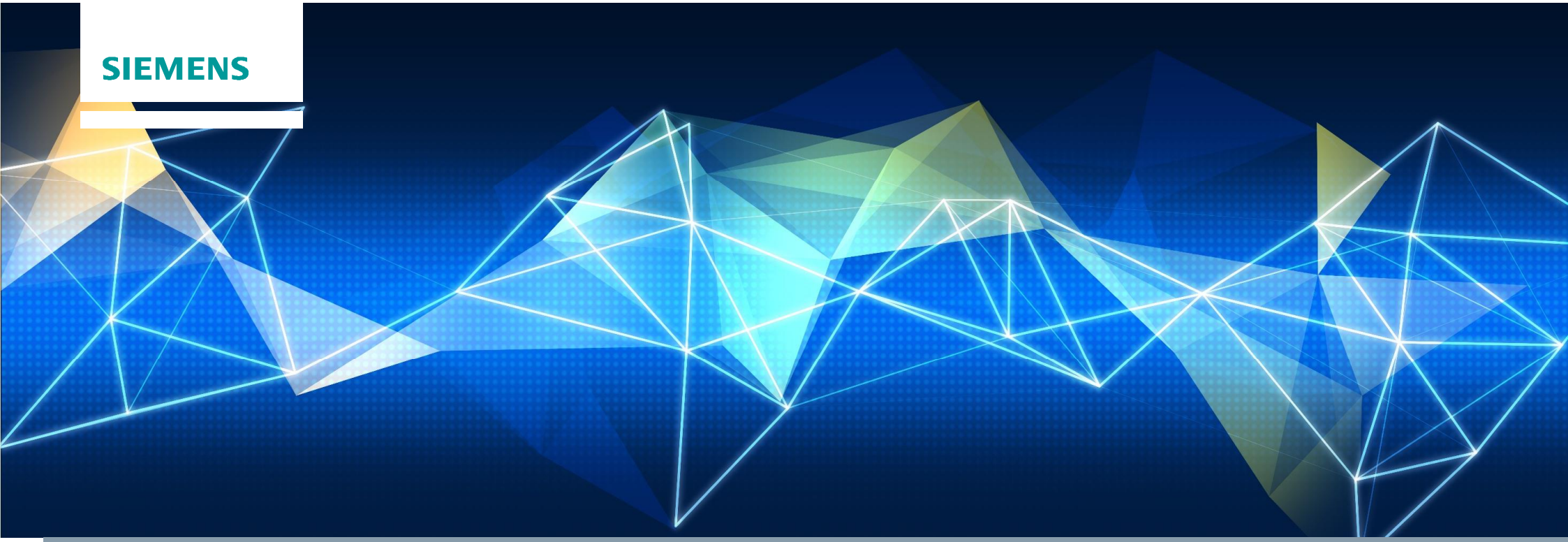
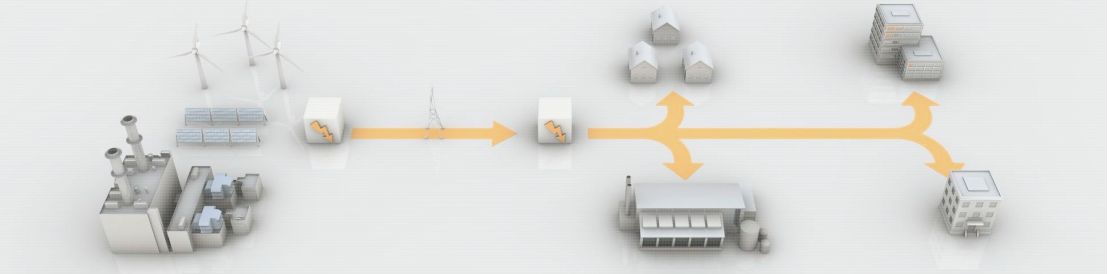


PEM-Electrolysis – a technological bridge for a more flexible energy system

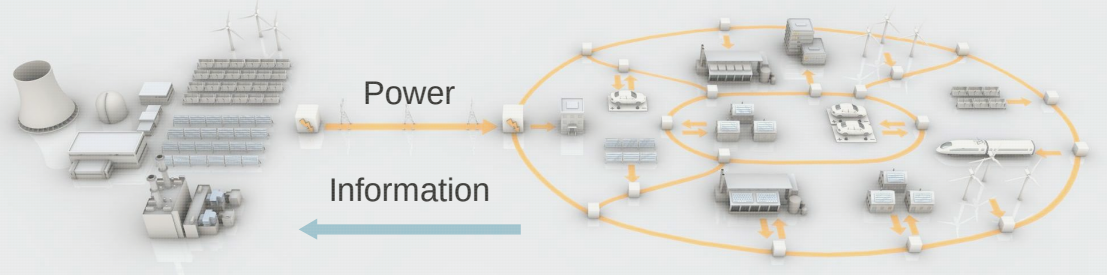
Gaëlle Hotellier, Head of Hydrogen Solutions

Whereto?

Yesterday



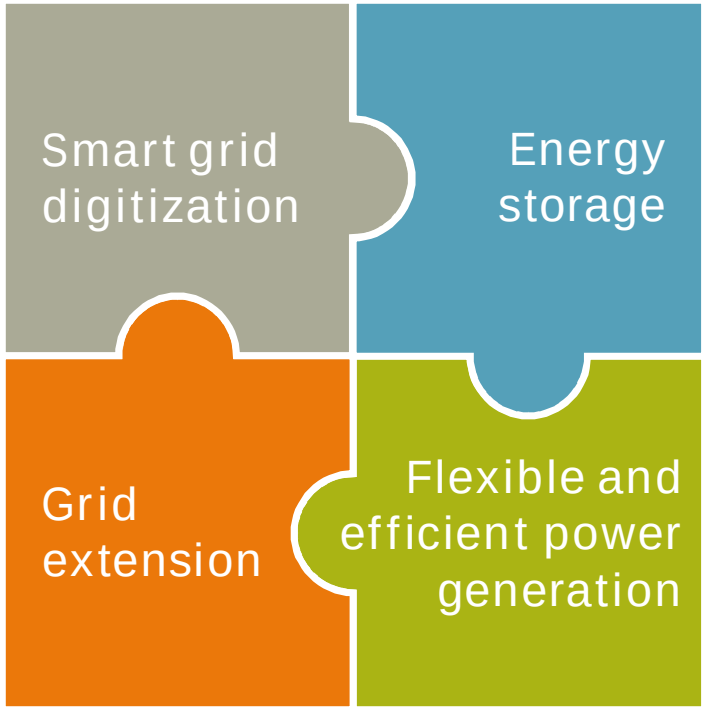
Today



Tomorrow

Components and tasks for a future energy system

Managing increasingly complex energy systems



Grid stability and system efficiency

Cross-regional electricity transfer and integration of distributed generation

Cost-efficient use of conventional and renewable energy

Pushing the integration of infrastructures

Application cases by location of storage

Central Large Utilities	**Decentral** Small utilities, municipalities, industry – prosumer

Pumped storage

Electricity

Grid balancing and stability

H2

Electricity | H2/ Methane (gas grid) | H2 Fuel for car

Power-to-gas
Power to value

Battery

Electricity

Grid stability and self-supply

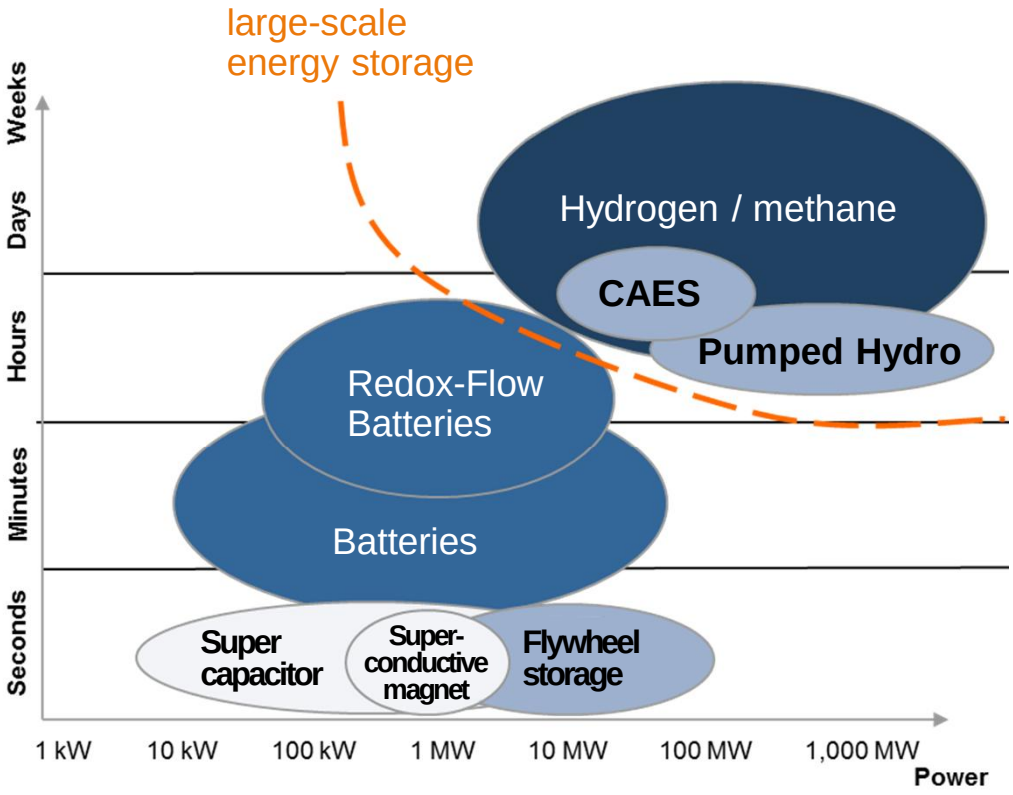
Thermal

Heat (power)

Power-to-heat

Options to address large scale “grid storage” are limited

Segmentation of electrical energy storage



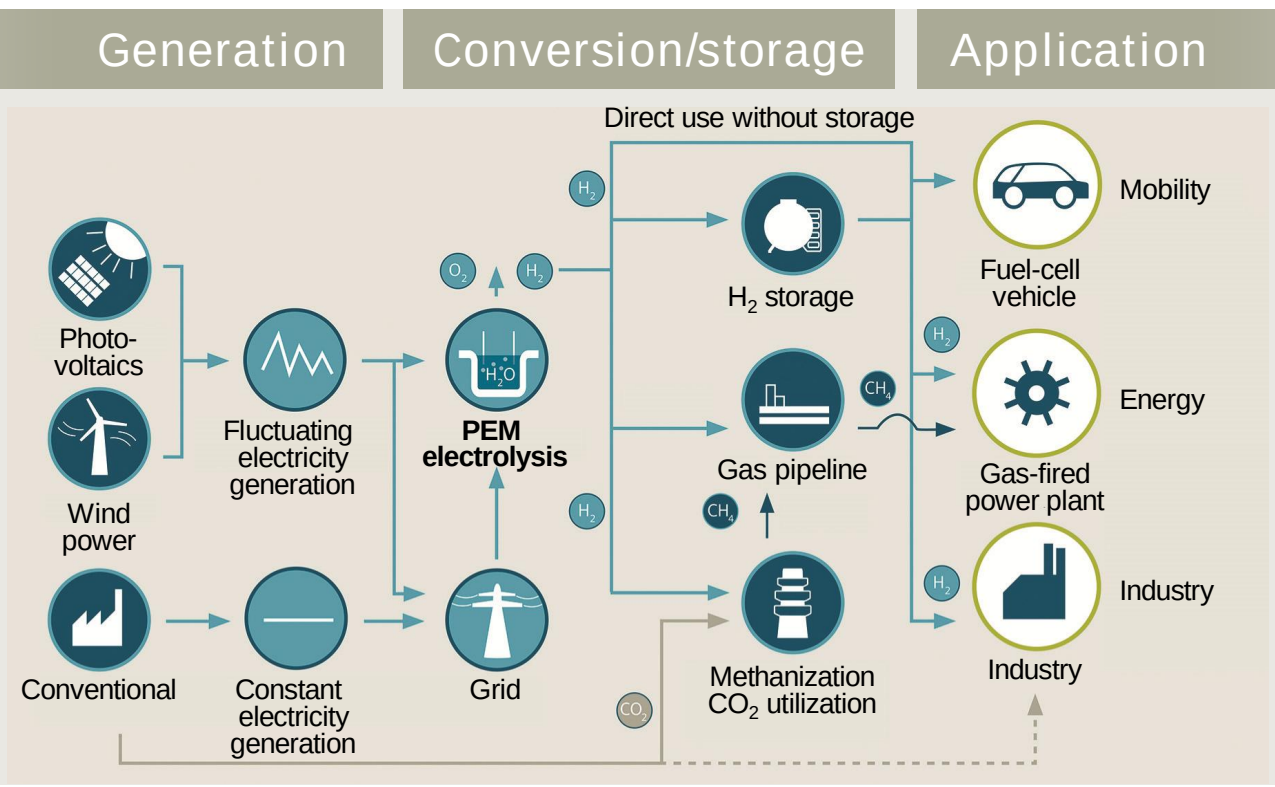
Key statements

- There is no universal solution for electrical storage
- Large scale storage can only be addressed by pumped hydro, compressed air (CAES) and chemical storage media like hydrogen and methane
- The potential to extend pumped hydro capacities is very limited
- CAES has limitations in operational flexibility and capacity

Hydrogen is the only option to implement energy capacities > 10 GWh

SIEMENS

PEM electrolysis enables conversion of electrical into chemical energy



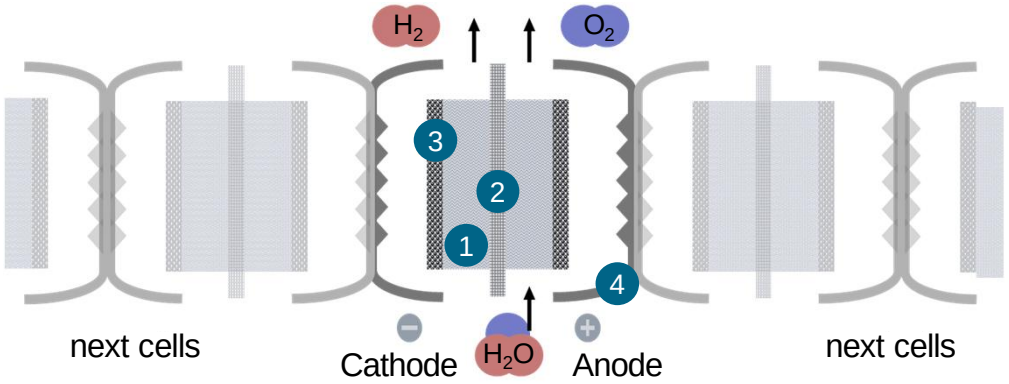
H_2 drives the convergence between energy & industrial markets

PEM* water electrolyzer technology – a perfect match with renewable energy requirements

SIEMENS

Key statements

- High dynamic performance
- Compact design, small footprint
- Simple cold-start capability
- High pressure operation (less compression costs)
- Rapid load changes
- High stability / low degradation



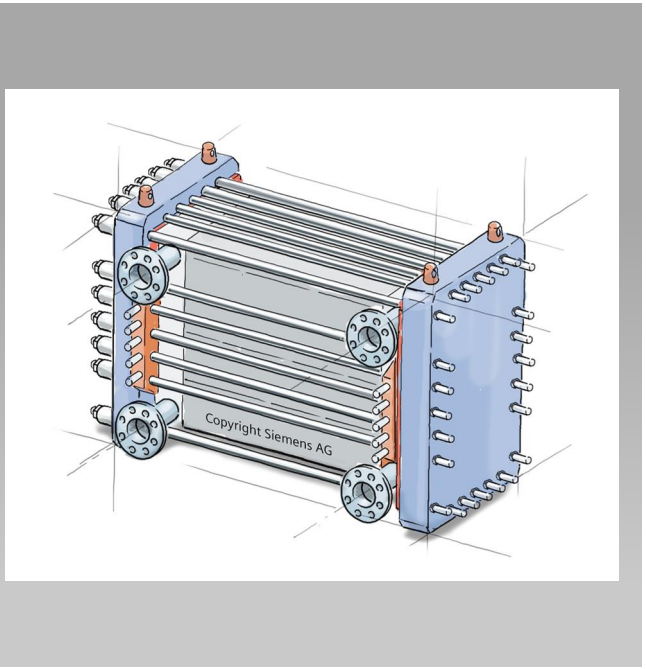
Electrolyzer type	PEM
1 electrolyte	polymer membrane
2 separator	
3 catalyst	platinum + others
4 frame + bipolar plate	metal sheet

PEM technology has numerous important advantages regarding the system properties

* Proton-Exchange-Membrane

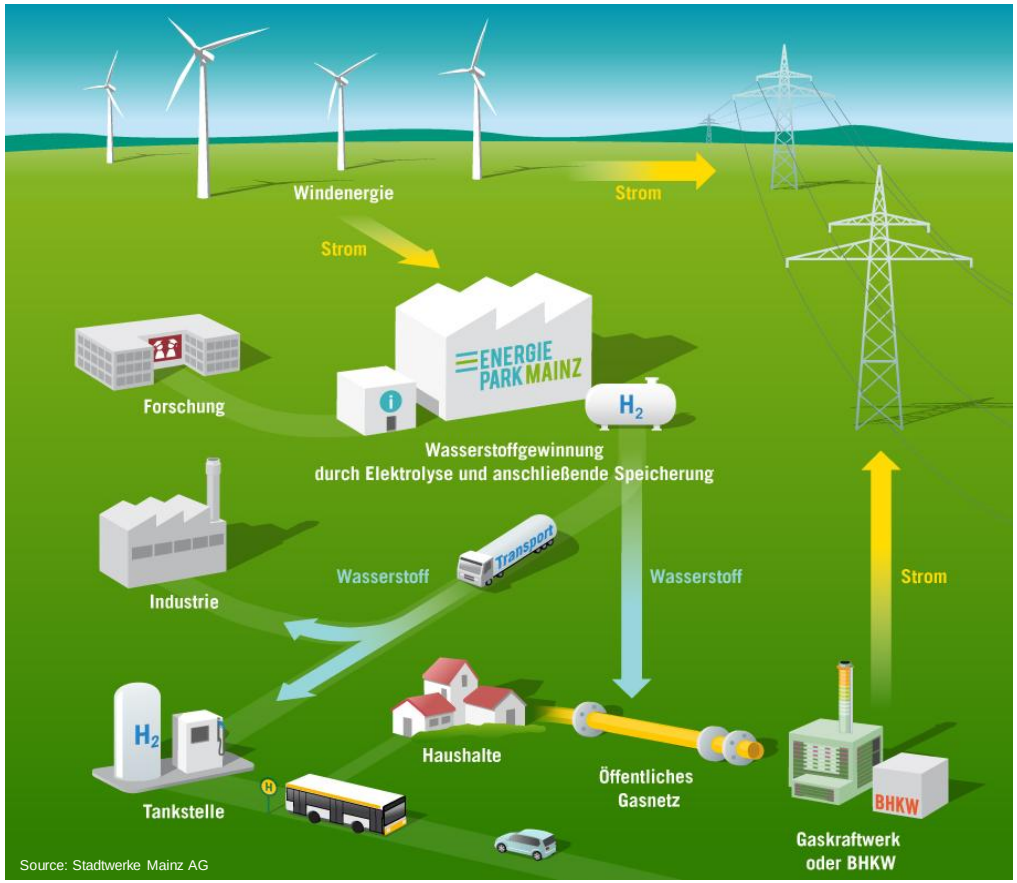
SILYZER 200 – a PEM Electrolysis System made by Siemens

SILYZER 200 – Hydrogen Production



Feature / Function	Benefit
• Best-in-class PEM electrolysis, based on an own developed system and proven Siemens standard components and technical expertise	• Leading edge green hydrogen production thanks to the reliable electrolysis operation with a high-end system availability
• King-size power (double digit MW class) and high current density operation for efficient hydrogen production up to 35 bar (3.5 Mpa) output pressure	• Small system footprint for lower investment and optimal integration
• Extreme dynamic operation from 0 to max-power combined with a strong lifetime commitment	• Low TCO, high robustness, low investment risk
	• Safety culture & discipline as guarantee – incl. Remote operation and condition monitoring for state-of-the-art electrolysis operation

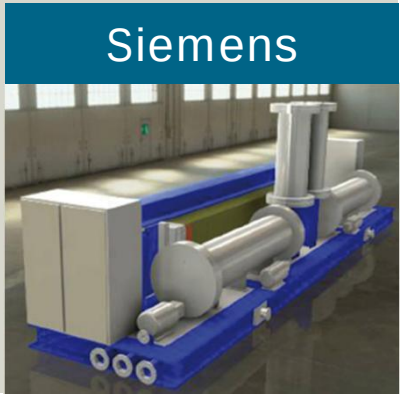
Next projects
Energie Park Mainz



Key statements

- Location: Mainz-Hechtsheim (GER)
- Three high performance electrolysis systems with peak power of 2,1 MW $_{el.}$ Each
- Connection to 10 MW wind-farm
- 1000 kg storage (33 MWh)
- 200 tons target annual output (Trailer-filling station and injection into local gas grid)
- Highly dynamic operation over broad load range (ramp speed 10% per sec.)

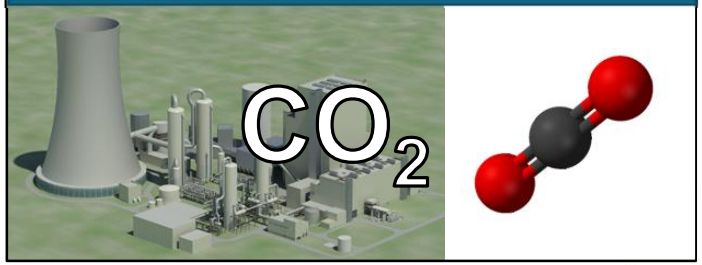
Study SILYZER 200



Project Partners: Linde, Stadtwerke Mainz, Siemens, Hochschule RheinMain

Looking ahead: Power-to-value

CO_2 from fossil-fired power plants



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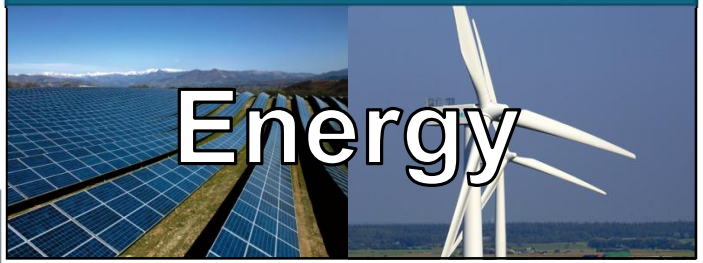
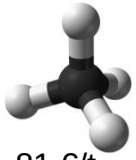
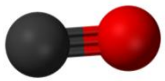
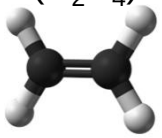
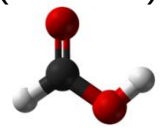
Electricity



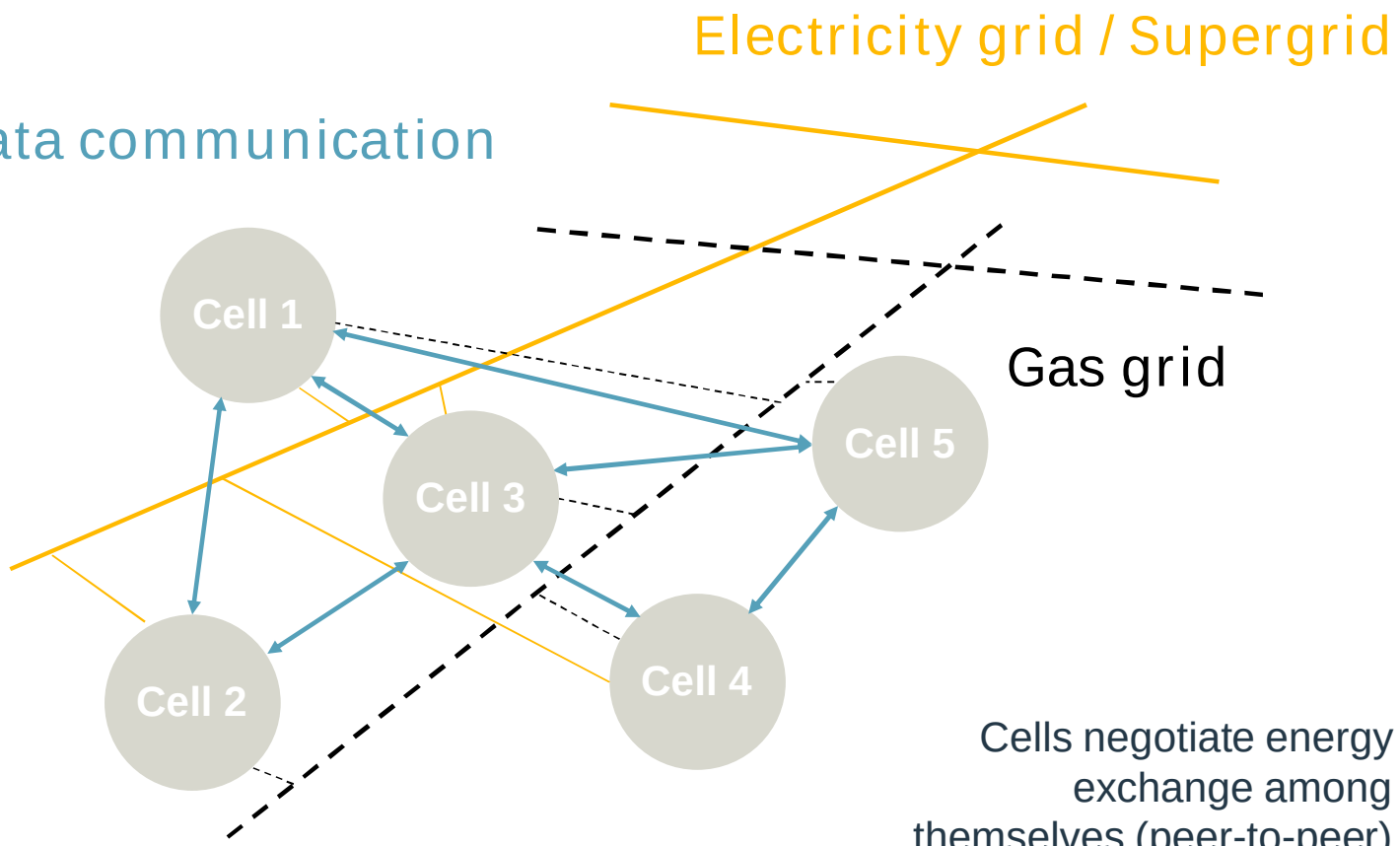
TO

Synthetic fuels or chemical feedstock

Valuable Products

	Methane (CH_4)	Carbon monoxide (CO)	Ethylene (C_2H_4)	Formic acid (HCOOH)
				
Market Price	81 €/t	650 €/t (Naphtha)	1000 €/t	
Market Volume	>2400 Mt/y	> 210000 Mt/y	141 Mt/y	0.7 Mt/y

The energy cell concept



Cells negotiate energy exchange among themselves (peer-to-peer)

Energy cell can be

- Community
- Factory
- Power plant
- Dedicated storage Facility

Energy cell contains

- Power generation
- Energy storage
- Thermal grids
- Loads
- ICT

Thank you!

- Growing share of distributed power generation and Renewables
- Multiple Stakeholders – multiple usage of electricity
- Energy Cells develop – Grids remain essential
- Digitization drives change of technology and business models