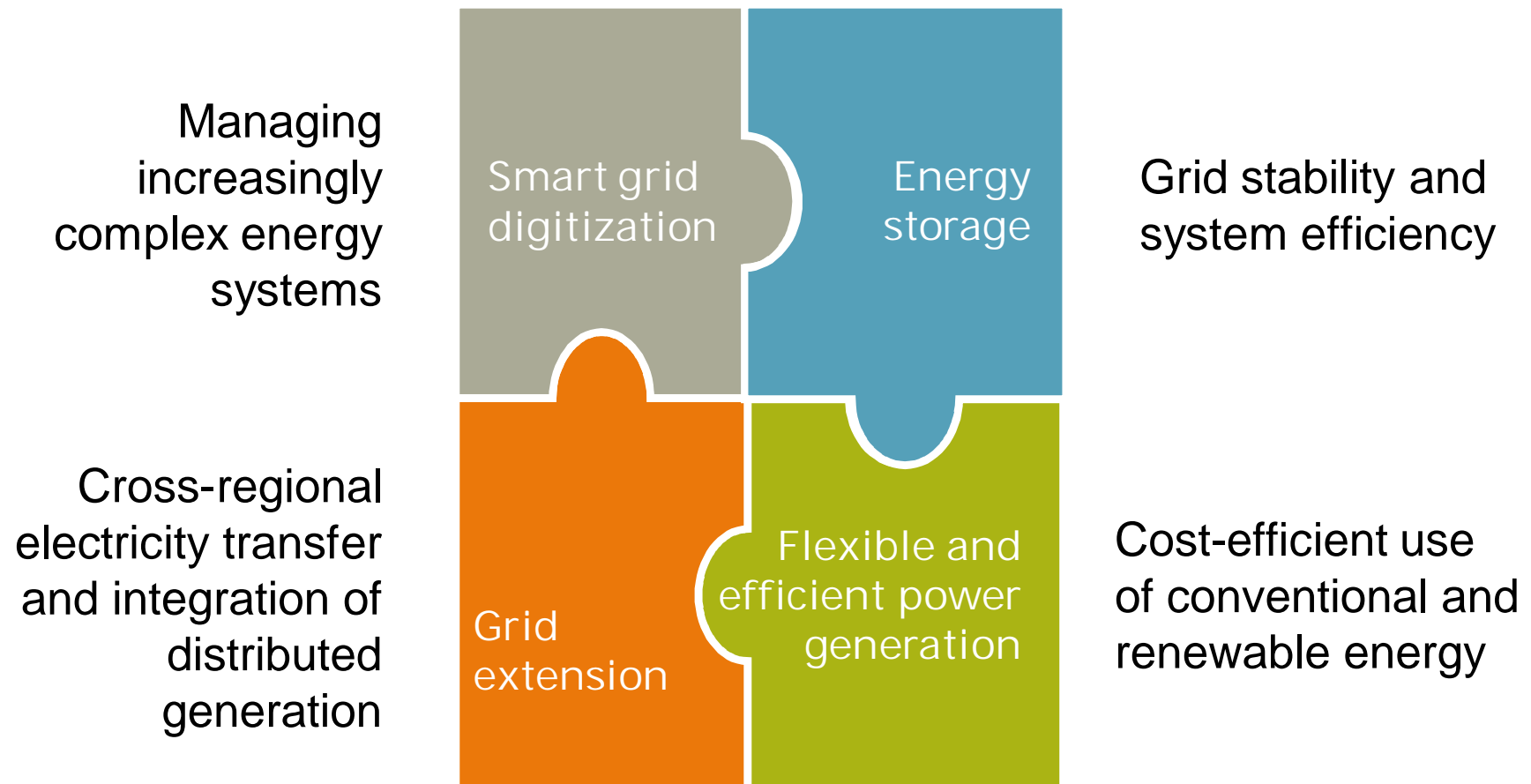


Chances and perspectives for H₂ energy storage systems with PEM electrolyzers

Gaëlle Hotellier, EVP, Head of Hydrogen Solutions, 24.03.2015

Components and tasks for a future energy system



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

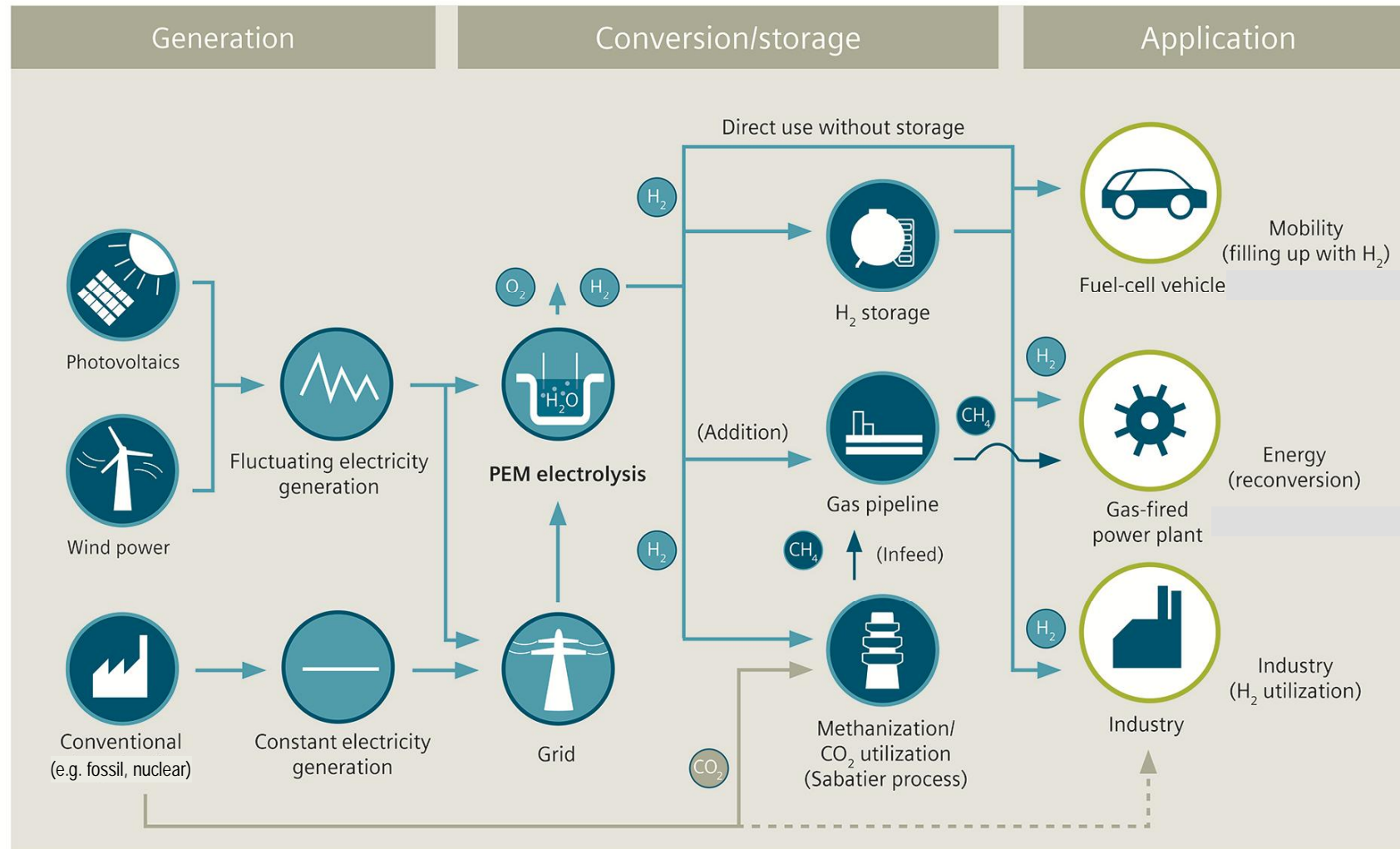
Thermal



Heat (power)

Power-to-heat

PEM electrolysis enables conversion of electrical into chemical energy



H₂ drives the convergence between energy & industry markets

SILYZER produces hydrogen as a multi-purpose energy carrier for industry, mobility and grid services



H₂ production: no CO₂, independent, efficient, onsite

- Chemical synthesis (e.g. ammonia, fertilizer, methanol)
- Petrochemical processes (e.g. cracking)
- Flat glass, nonferrous metal (protective and reductive gas)
- Food & Beverages (hardening)



H₂ application: a sustainable fuel for transport concepts

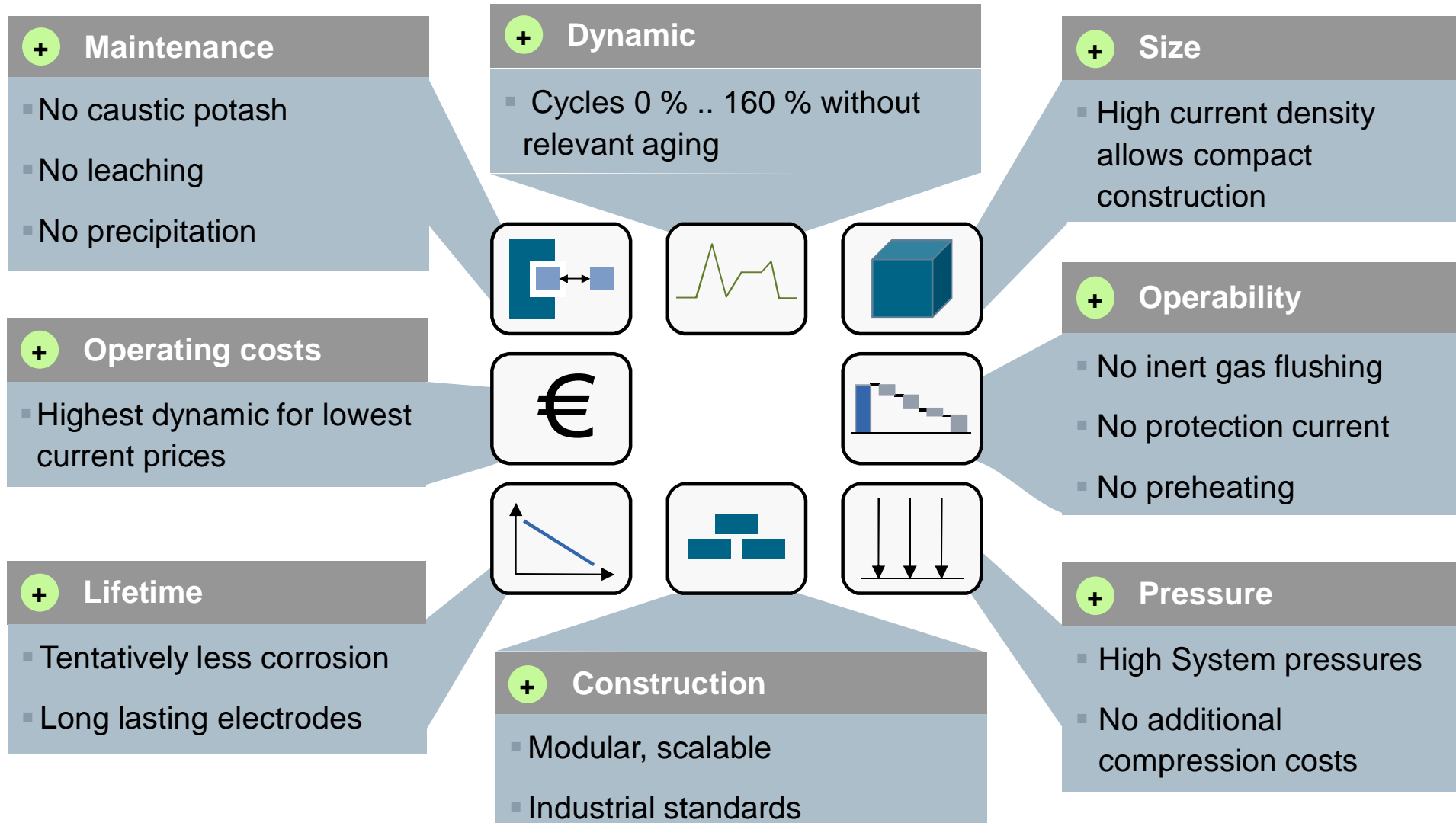
- CO₂ free mobility; Renewable fuel concepts
- Sustainable and pollution-free Public Transport
- Fuel Cell based in-plant logistics (forklifts, floor conveyors)
- Reliable, safe e-mobility: “fast-to-refuel” cars with long ranges



H₂ conversion: stabilizes the power grid

- Grid balancing capability (dynamical behavior in milliseconds)
- Optimization of asset utilization in renewable energies
- Storage of medium- and long-term overcapacities (TWh)
- Power-to-hydrogen and Power-to-gas as future key concepts

SILYZER provides best-in-class PEM technology with a large-scale and industrialized design



Outstanding performance paired with technical options allows integration in any project scope



Main Technical Data - SILYZER 200

▪ Electrolysis type / principle	PEM
▪ Rated Stack Power	1.25 MW
▪ Dimension Skid	6,3 x 3,1 x 3,0 m
▪ Start up time (from stand-by)	< 10 sec
▪ Output pressure	Up to 35 bar
▪ Purity H ₂ (depends on operation)	99.5% - 99.9%
▪ H ₂ Quality 5.0	DeOxo-Dryer option
▪ Rated H ₂ production	225 Nm ³ /h
▪ Overall Efficiency (system)	65 – 70 %
▪ Design Life Time	> 80.000 h
▪ Weight per Skid	17 t
▪ CE-Conformity	yes
▪ Tap Water Requirement	1,5 l / Nm ³ H ₂

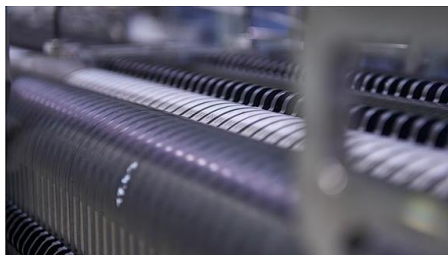
SILYZER and hydrogen together are an unbeatable combination to achieve major targets

Increasing revenues and turnover +

- due to extremely dynamic operation behavior, SILYZER can be used as a load within intelligent energy management systems (EMS) for the grid

Optimization of costs +

- low OPEX and “total Costs of Ownership (TCO)” due to minimal installation efforts, maintenance-free stacks, clean and safe operation, robustness, pressurized mode until 35 bar, lifetime specified with more than 80.000 hours



Environmental protection +

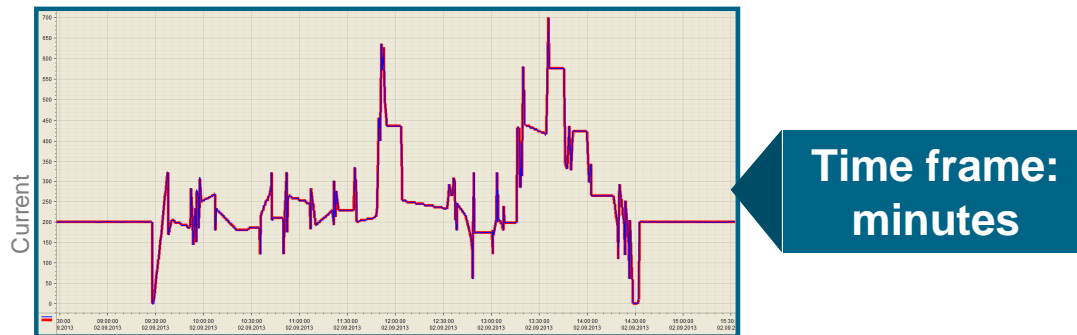
- local onsite production of CO₂-free hydrogen without using hazardous material, such as caustic potash, avoids extensive transports

Investment protection +

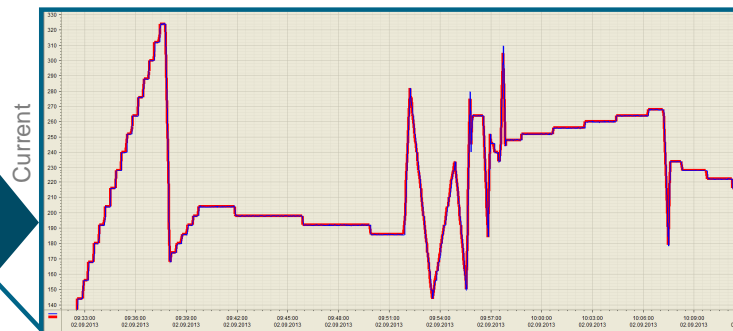
- utilization of wind energy turbines or solar panels even during forced curtailment periods due to grid imbalance increases operation hours and delivers hydrogen as a valuable product further more

Water Electrolyzers for grid services require specific properties

Typical load profile of an electrolyzer in a grid service project



Time frame:
seconds



Current
Nominal: —
Actual: —

source: Siemens

- Quality of grid connection (harmonic distortions, power factor, flicker etc.)
- Capable to be connected to grid control systems (hardware & software)
- Low energy consumption in stand by mode; quick cold start
- Low degradation in intermittent operation modes
- Safety standards for simple installation
- High efficiency of the overall system in intermittent operation
- Robustness and reliability prioritized over performance
- Service-friendly setup

Energiepark Mainz – Project scope and key facts



- Location: Mainz-Hechtsheim (DE)
- Three high performance electrolysis systems with peak power of 2 MW el. each (6 MW peak)
- 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.)



Next steps:
Commissioning 1st half 2015

The energy cell concept

