

Joint SCCER Activity: Power-to-X

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July week 2015: Denmark produces 140% of its electricity demand by wind turbines



Storage of excess electricity in pumped hydro in Norway, Germany, Switzerland

Stromproduktion und Spotpreis in Deutschland in Woche 49 2015

[Hinweise](#)

Datumsauswahl

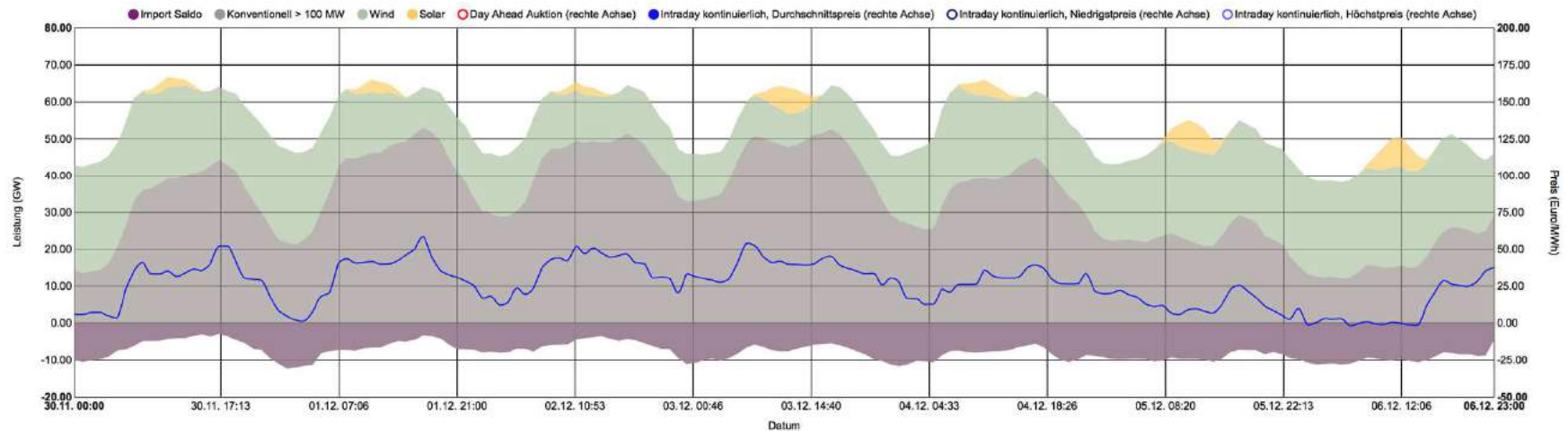
Jahr: 2015
<< >>

Monat: << >>

Woche: 49
<< >>

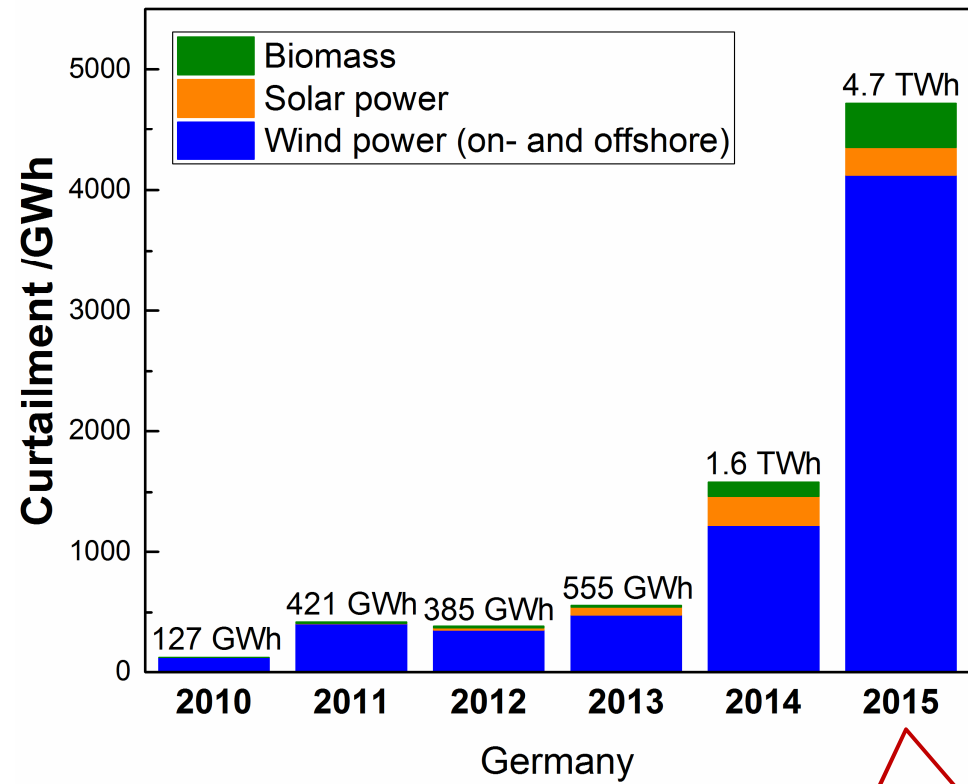
Handel:
 stündlich
 15 Minuten

drucken



In 2020: 1000 hrs of negative electricity prizes are predicted for Germany

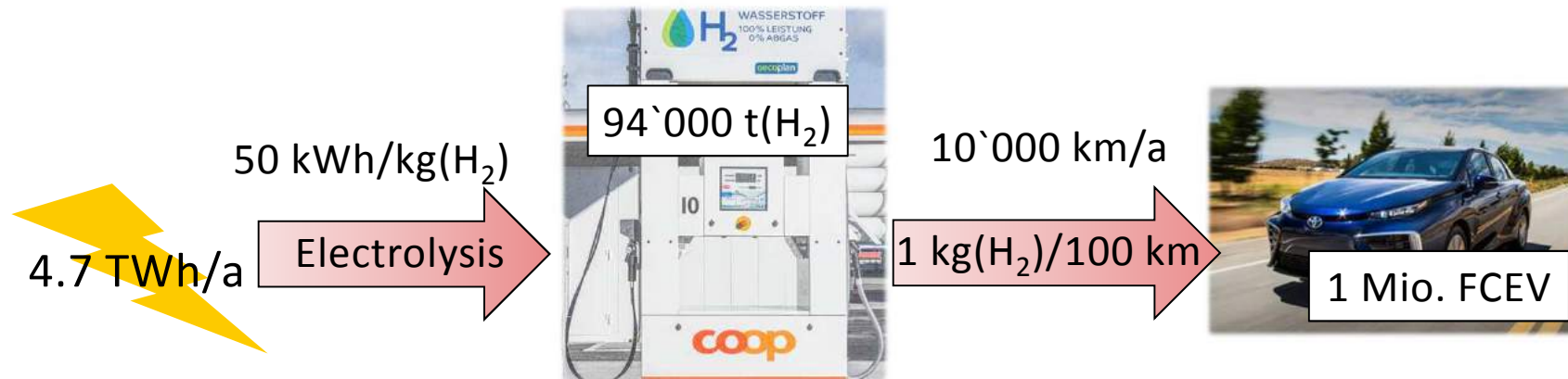
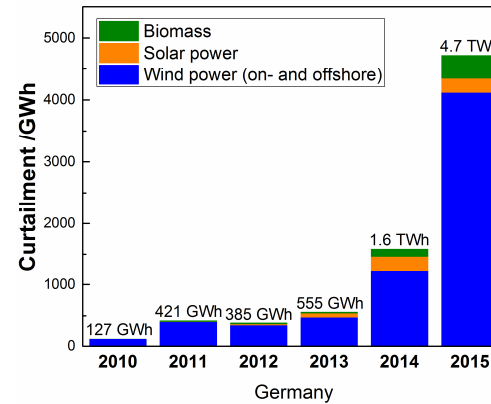
One Solution: Curtailment



predicted **COST:**
≈ 480 Mio. €

[1] Bundesnetzagentur, Bundeskartellamt, EEG in Zahlen 2015 and Monitoringbericht 2016

One Solution: Curtailment

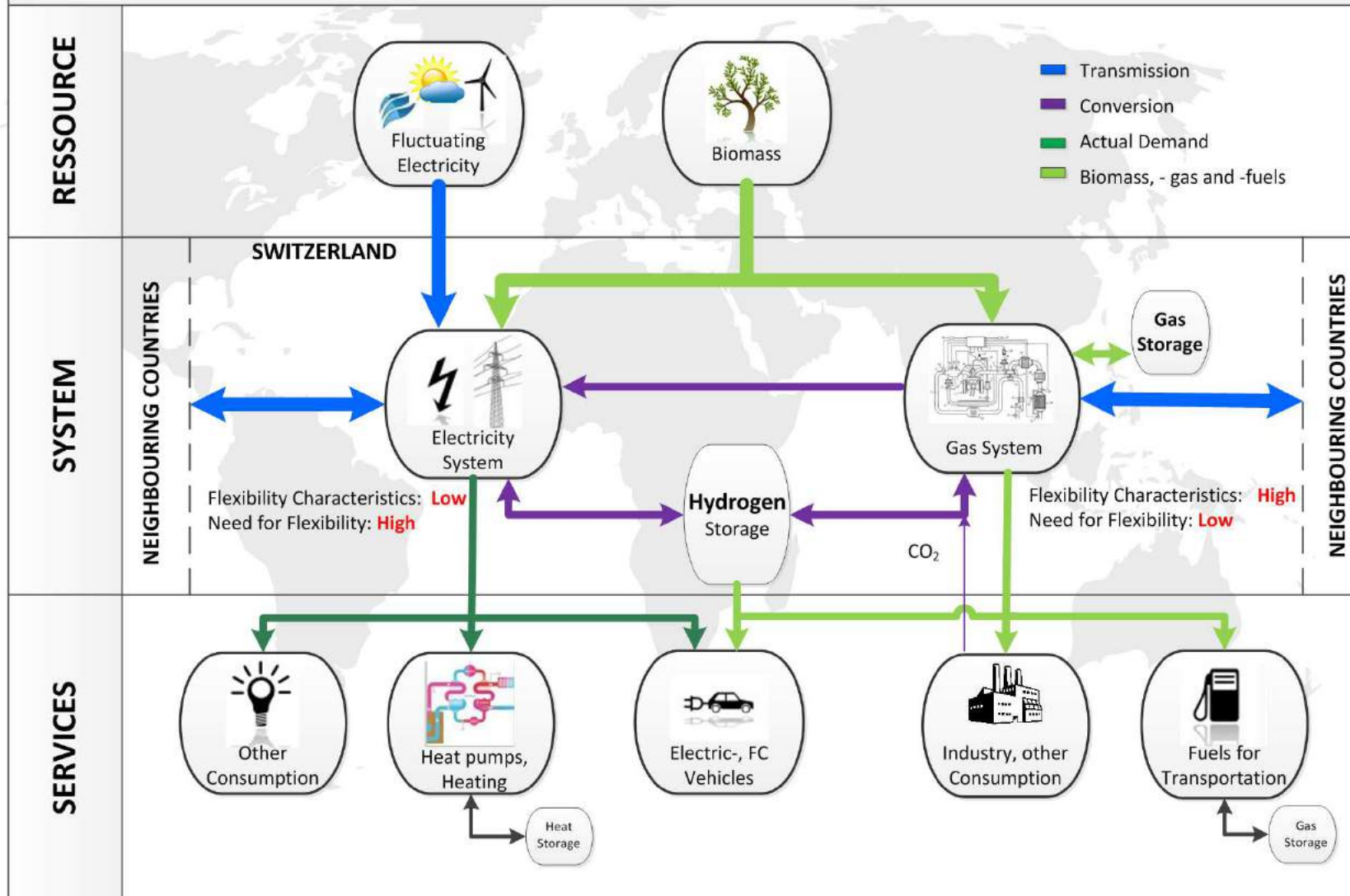


Selling price $\approx 10 \text{ €/kg(H}_2\text{)} \rightarrow 940 \text{ Mio. €/a}$

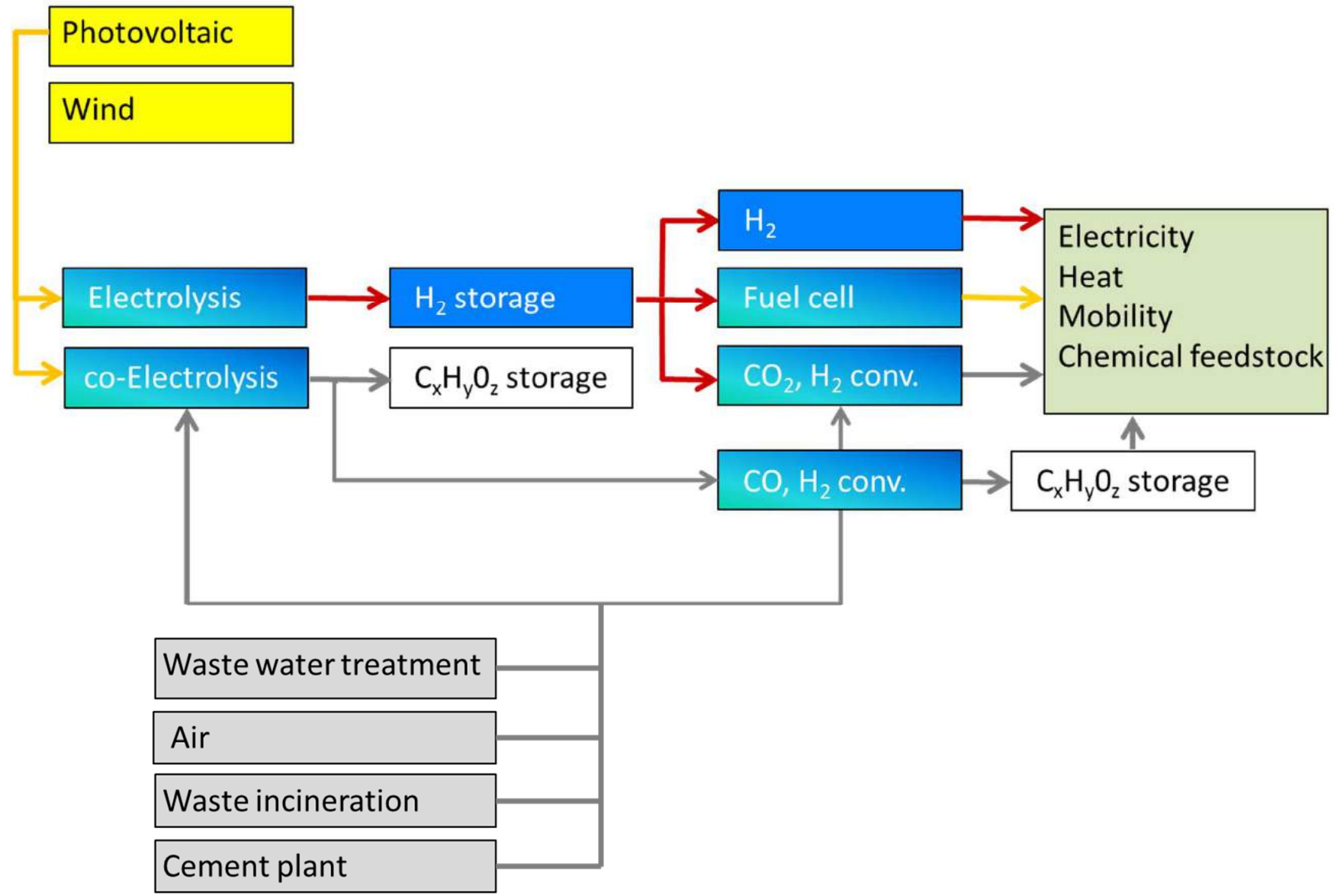
	decentralized Storage		centralized Storage	
	< 0.1 MW	0.1 - 10 MW	10 - 100 MW	100 - 1000 MW
months		Power-to-Gas	Power-to-Gas Pumped Hydro	Power-to-Gas Pumped Hydro
days --> weeks		Power-to-Gas	Pumped Hydro Power-to-Gas	Pumped Hydro Power-to-Gas
hours --> days	Lead Acid Battery Li-Ion Battery	Lead Acid Battery Sodium Sulfur Batt. Li-Ion Battery Na-NiCl ₂ Batt. Redox-Flow Batt.	Pumped Hydro CAES Sodium Sulfur Batt Na-NiCl ₂ Batt Redox Flow Batt	Pumped Hydro CAES
minutes --> hours	Lead Acid Battery Li-Ion Battery	Lead Acid Battery Sodium Sulfur Batt. Li-Ion Battery Na-NiCl ₂ Batt. Redox-Flow Batt.	Lead Acid Battery Sodium Sulfur Batt. Li-Ion Battery Na-NiCl ₂ Batt. Redox-Flow Batt.	Pumped Hydro CAES
seconds --> minutes	Super Caps	Flywheels	Batteries	Pumped Hydro CAES

	decentralized Storage		centralized Storage	
	< 0.1 MW	0.1 - 10 MW	10 - 100 MW	100 - 1000 MW
months		seasonal balancing	seasonal balancing	seasonal balancing
days --> weeks	demand/supply optimization	demand/supply optimization	weekly load balancing	weekly load balancing
hours --> days	demand/supply optimization (4 - 8h) RE balancing (1-8h) and mobile applications	demand/supply optimization (4 - 8h) RE balancing (1-8h) and mobile applications	demand/supply optimization (4 - 8h), RE balancing (1-8h)	demand/supply optimization (4 - 8h), RE balancing (1-8h)
minutes --> hours	control power (<15min)	control power (<15min)	control power (<15min)	control power (<15min)
seconds --> minutes	frequency regulation (<30s), UPS	frequency regulation (<30s), UPS	frequency regulation (<30s)	frequency regulation (<30s)

Energy System Integration (New Renewable Energies)



20140327 Renewable Energy System integration V2.2 / Elber



Stakeholders

- Scientific Community
- Policy Makers (e.g., SFOE)
- Public Sector
- Private Sector

The White Paper will not be new research, but a commented synthesis of existing information

New energy landscapes

- growing share of intermittent renewable energy, acceleration in future
- Increasing challenges of temporal and spatial grid balancing
- P2X technologies represent future potential solutions for this balancing challenge

Difficult to assess the role of P2X

- Growing attention for P2X technology with limited available knowledge on this technology
- Information on P2X often distributed and not synthesised
- Few information available to public

Objectives of the White Paper on P2X

- collect the major existing P2X knowledge
- provide a synthesis and evaluation for the Swiss energy market
- derive a technical, economic and environmental assessment of P2X in the energy system, with a focus on interdependencies on the gas market, the mobility sector and the electricity market

Content - Outline

- a) Techno-economic and environmental perspective
- b) Embedding P2X into markets / supply & demand side interactions
 - CO₂ sources (biogene, industrial, atmospheric capture)
 - CO₂ markets
 - Power System Perspective
 - Market for gaseous fuels and impact on gas market
 - Hydrogen market
 - Transportation sector (synfuels in mobility, infrastructure)
 - Industry sector
 - Revenues from different markets
- c) Regulatory and policy aspects (laws and policies)
 - Effects of laws for the different sectors
 - Innovation policy aspects





Lead Editor

Dr. Tom Kober
Head Energy Economics
Group, PSI



biosweet

Biomass for Swiss Energy Future
Swiss Competence Center for Energy Research



Scientific literature

- Grond et al., 2013
- Jerode et al., 2014
- Hofstetter et al., 2014
- Ausfelder et al., 2015
- Spielmann et al. 2015
- de Bucy et al., 2016
- Parra and Patel, 2016
- Zhang et al., 2016
-

Experiences from pilot and demo projects

- RENERG
- BAFU project
- NRP 70 project
- Horizon 2020 project of RegioEnergy
- Store&go
- ESI platform @ PSI
-

Participating organisations

- PSI
- ETHZ
- HSR
- Empa
- ZHAW
- Uni Lucerne
- University Geneva



ESI Platform, PSI



P2G, Rapperswil (HSR)




Hybridwerk Andermatt, Solothurn



EPFL - Martigny


In cooperation with the CTI

 **Energy funding programme**
Swiss Competence Centers for Energy Research

 Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Commission for Technology and Innovation CTI

 Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Energie BFE
Swiss Federal Office of Energy SFOE



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