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Energy Park Mainz
A Project for the Industry

Marc De Volder / Sales Director

FCH JU Stakeholder Forum 19/11/2015

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Decentralized energy storage plant
First PEM Electrolyzer in the MW-range

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Objectives:

- Connection to 10 MW wind-farm and local Network (20 kV).
- Develop an energy storage plant in order to provide grid services (balancing mechanisms to avoid grid bottlenecks).
- Injection in local gas grid and multi-use trailer-filling.
- New conditioning concept (ionic wet gas compressor).
- Demonstrating safe handling of hydrogen and create awareness in public, politics

Technical and production aspects:

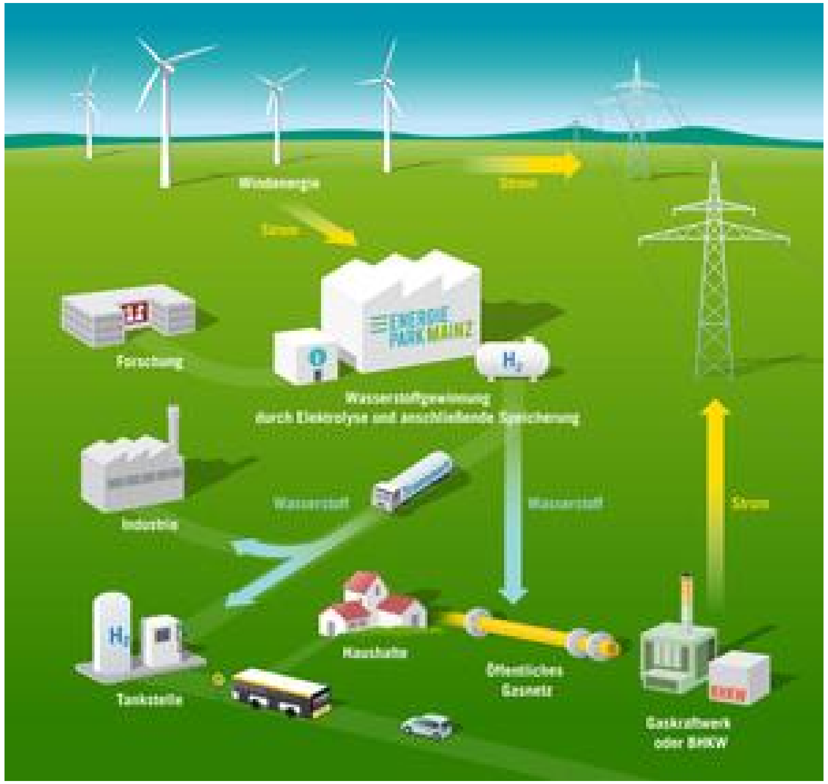
- 6 MW Electrolyzer (3 Stacks à 2 MW peak) delivered in 07/2015
- 1000 kg storage (33 MWh)
- 200 tons target annual output.

Economic aspects:

- Budget: Total: 17‘€ - Funding: ~50% (BMWi)
- Timeline: 4 years (03/2013 – 12/2016)

Project Scope

“Energiepark Mainz“



Partners:

STADTWERKE MAINZ AG

THE LINDE GROUP

Hochschule RheinMain
University of Applied Sciences
Wiesbaden Rüsselsheim

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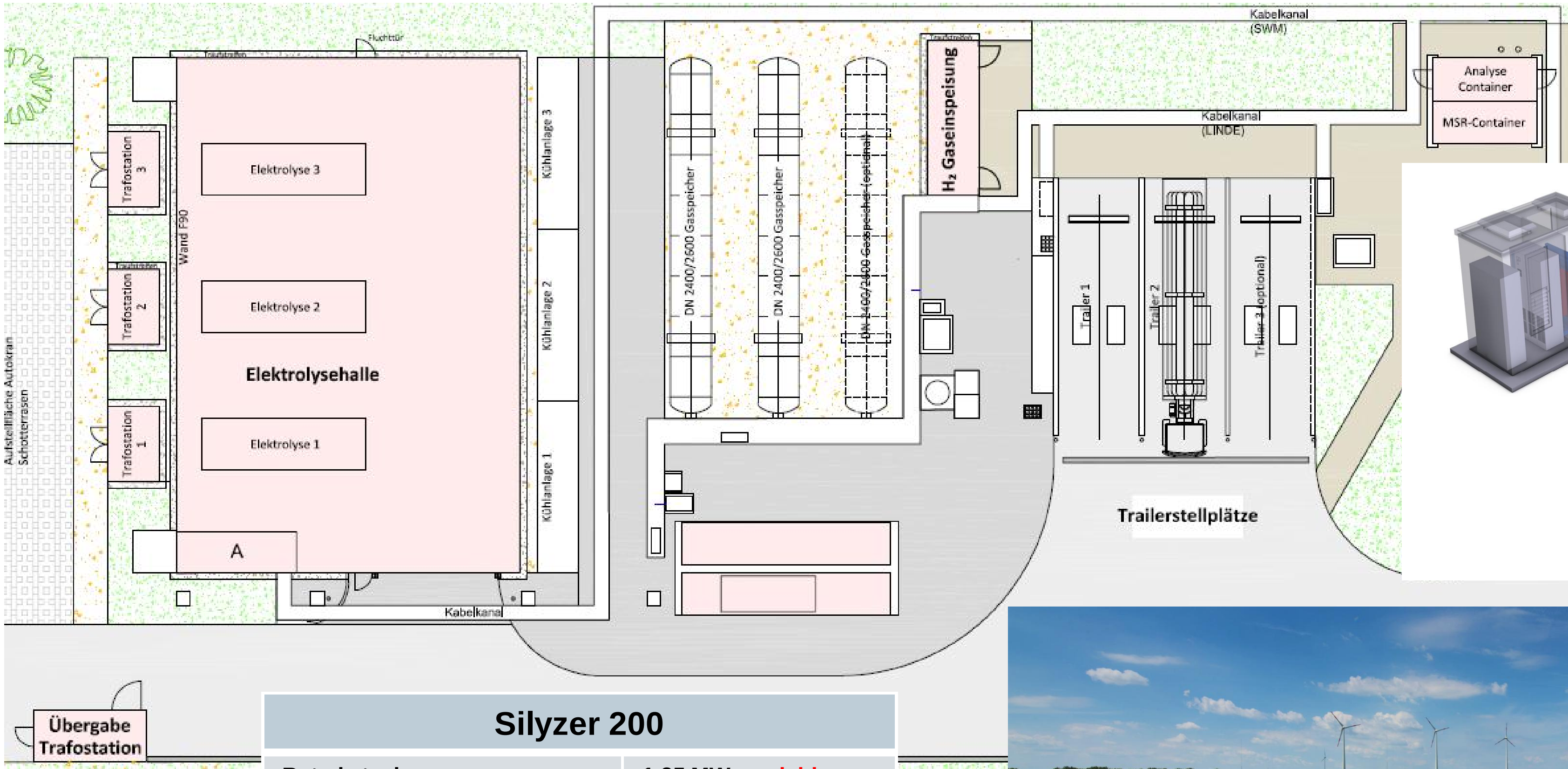
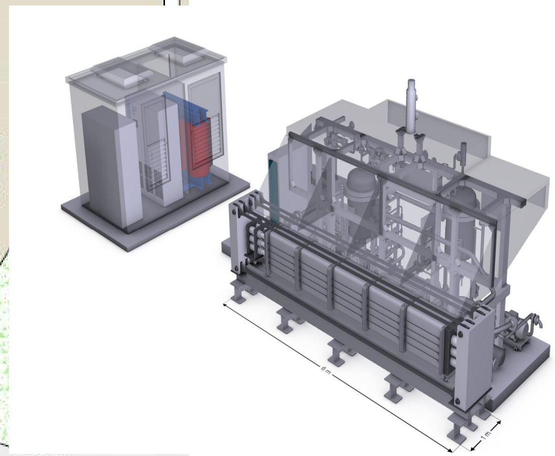
ENERGIESPEICHER
Forschungsinitiative der Bundesregierung

Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Energiepark Mainz – Layout
Main characteristics of the PEM Electrolyser





Silyzer 200	
Rated stack power	1.25 MW, scalable
Start up time (from stand-by)	10 s
Output pressure	Up to 35 bar
Purity H_2	99.5% - 99.9%
Overall efficiency (system)	65 – 70 %
Dimension skid / weight	6,3 x 3,1 x 3,0 m / 18t
Design life time	> 80.000 h
H_2 – Production	225 Nm³ / 20kg

Energiepark Mainz – Scope of supply
Hydrogen storage and handling facility

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Max. output /station: 3500A DC

Input voltage 20 KW 3-ph

Max. water consomption: 1 m3/h

Produced water quality < 1µS/cm

3 x 1.25 MW nominal load

(2.0 MW peak) 35 bar outlet pressure

2 x 82 m3 80 bar, 5.0

0.7 – 0.9 Mpa 10% H2

Power grid connection 20kV

Transformer-Rectifier Unit

Electrolysis 2-3.5 MPa

Water purification

DeOxo Unit

Ionic Compressor

Condensate trap

Compressor 1st stage

Compressor 2nd stage

Condensate recycle

Gas storage (max. 8 MPa)

NG grid injection

Final drying

Trailer filling 22.5 MPa

Min. pressure inlet 15 bar

Max. pressure outlet 250 bar

Trailer pressure 200 bar,

300-600 kg duration fueling ~3h

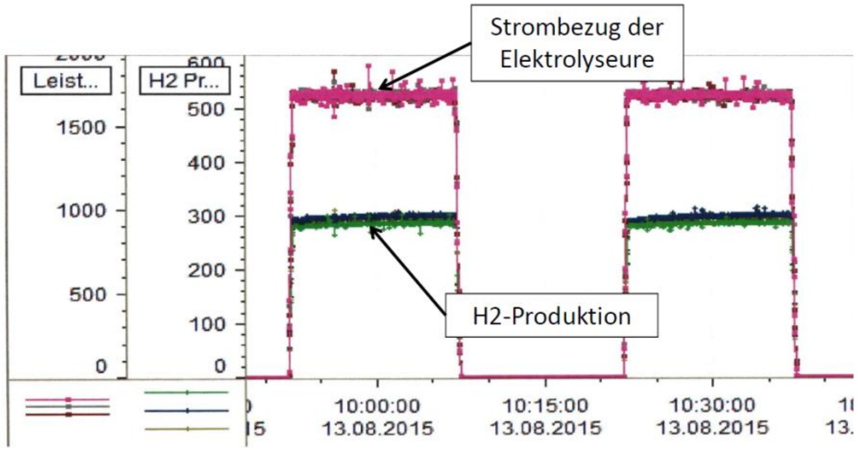
Energiepark Mainz – Status
First experience of operation

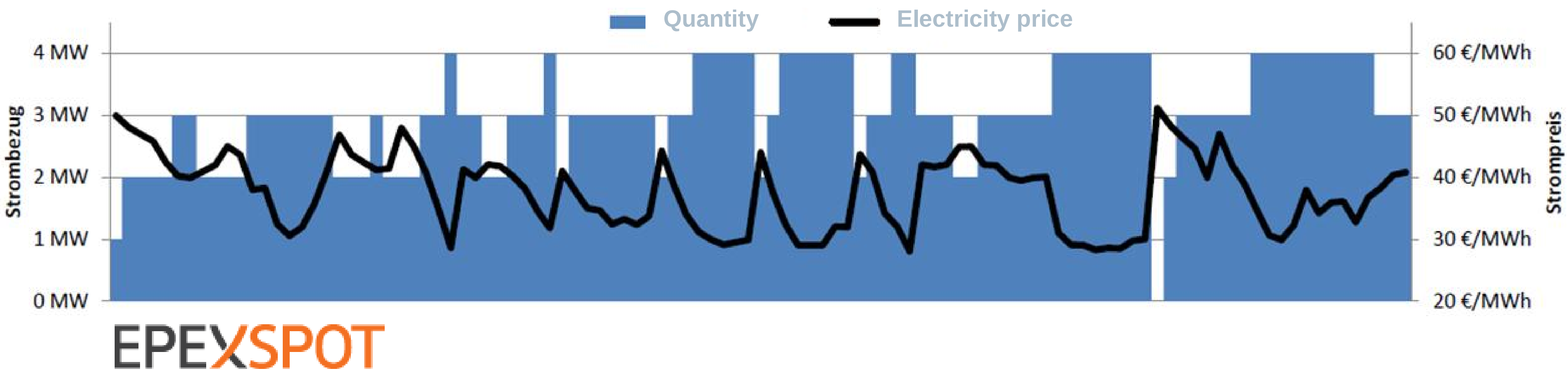
→ Normal operation between 01.09 and 23.10.2015

- Electricity supply through EPEX Spotmarket (during the week 8:00 -18:00)
- Approx. 700 MWh electricity consummed
- Approx. 40 Trailer filled

→ Expected dynamic and power consums is achieved

→ No critical breakdown





Hydrogen as Energy Storage and Energy Vector
Technical and Economical Optimization in 3 steps

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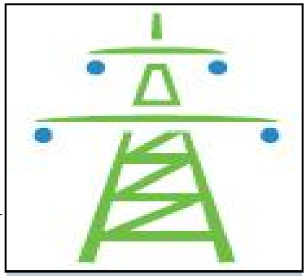
Installation Optimization Objective
« Energie Park Mainz »

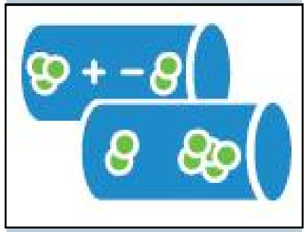
Minimization of purchase prices

- Use of the wind overproduction
- Participation to the Grid Services
- Purchases on the SPOT market



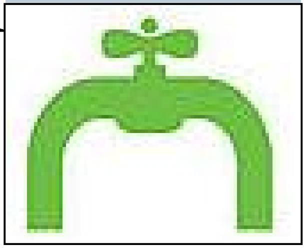
conditions of use of the installation

- Technical characteristics (peak & nominale load, …)
- Efficiency evolution of the installation.
- Installation shutdowns
- Others



Maximization of the sale prices

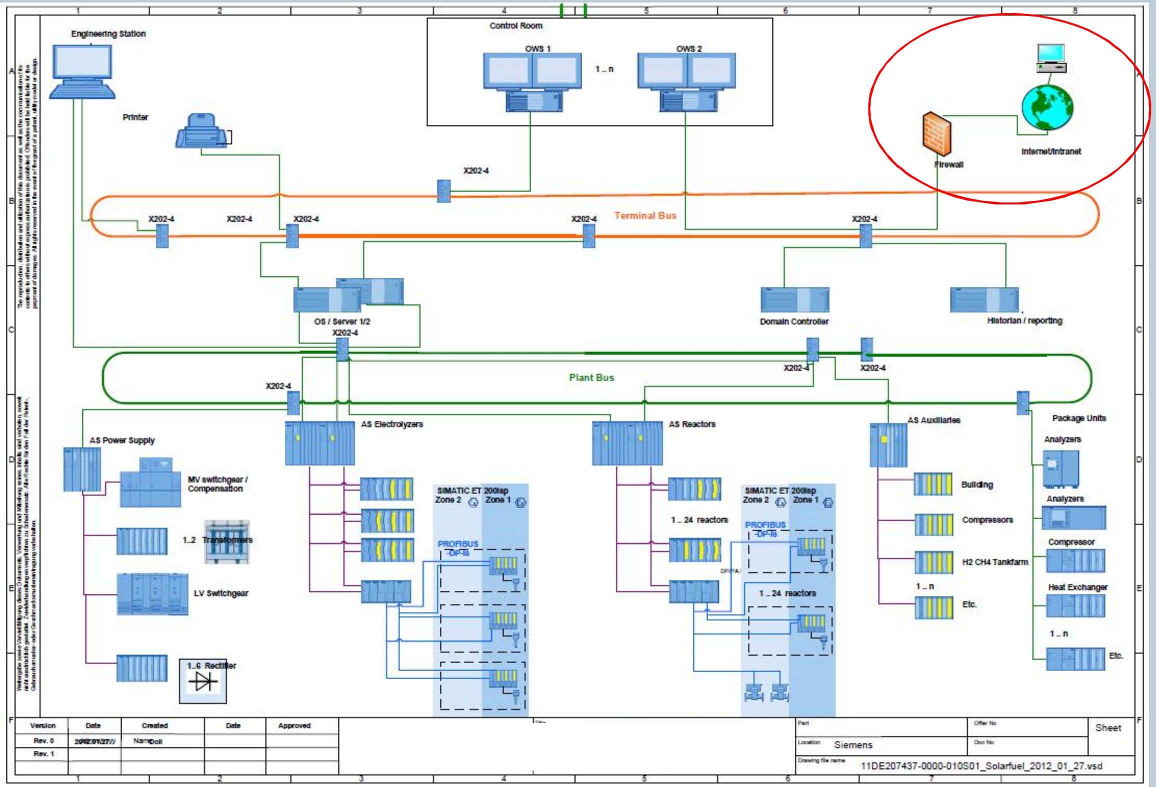
- Methane pipeline injections
- Tube trailers filling



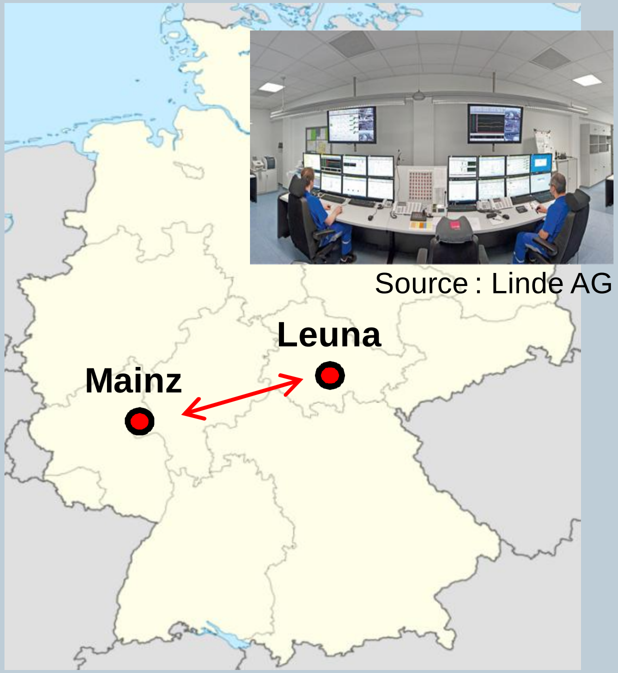
Quelle: Hochschule RheinMain, Martin Kopp

Next step 1 (Q4/15) : Automatic operation of the plant
Secure Remote Access between Mainz and Leuna

- Supervisory Control And Data Acquisition (**SCADA**)-System.
- Distributed Control System (**DCS**)-System.
- Connected Field Devices for Process Automation (Pressure, Temperature, Gas analysis,…).



Linde Remote Operation Centre (ROC)
- Automatic Load Control (ALC)
- Linear Model Predictive Control (LMPC)



Reference: Google

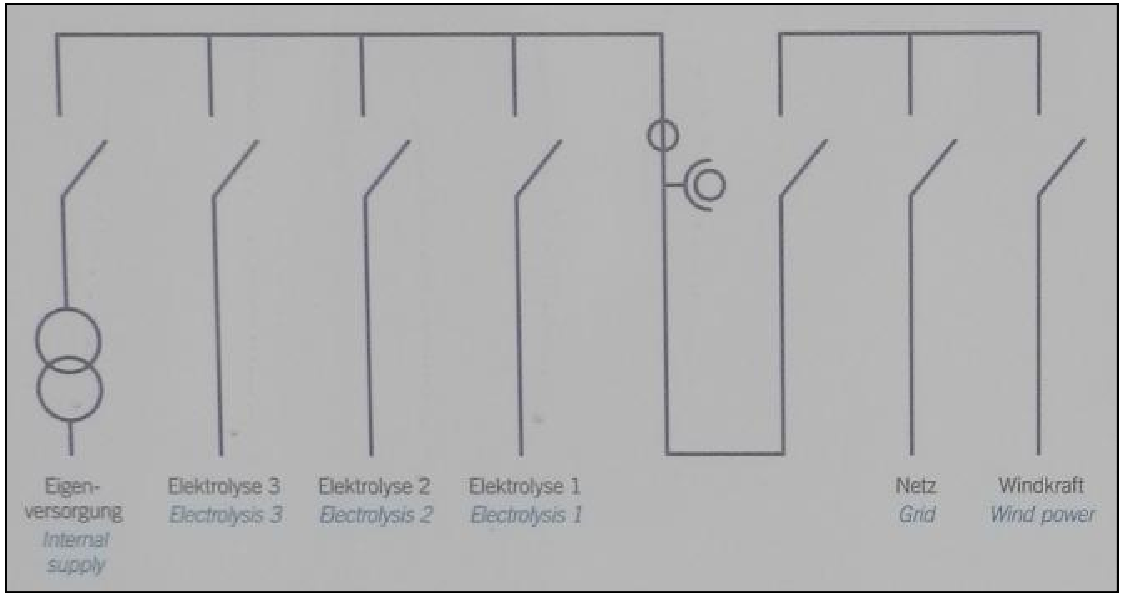
Next step 2 (Q1/16) : Wind farm Operator Cooperation
New contract / new negociation

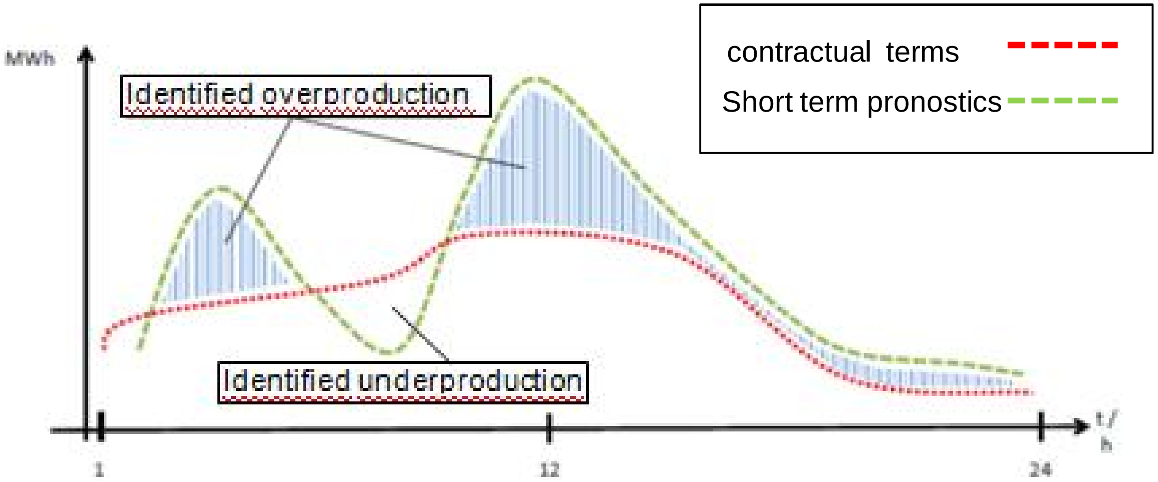
Challenge :

- Submission of production predictions
- Avoid additonal costs / penalties

Solution :

- Adjustment of prognostic errors



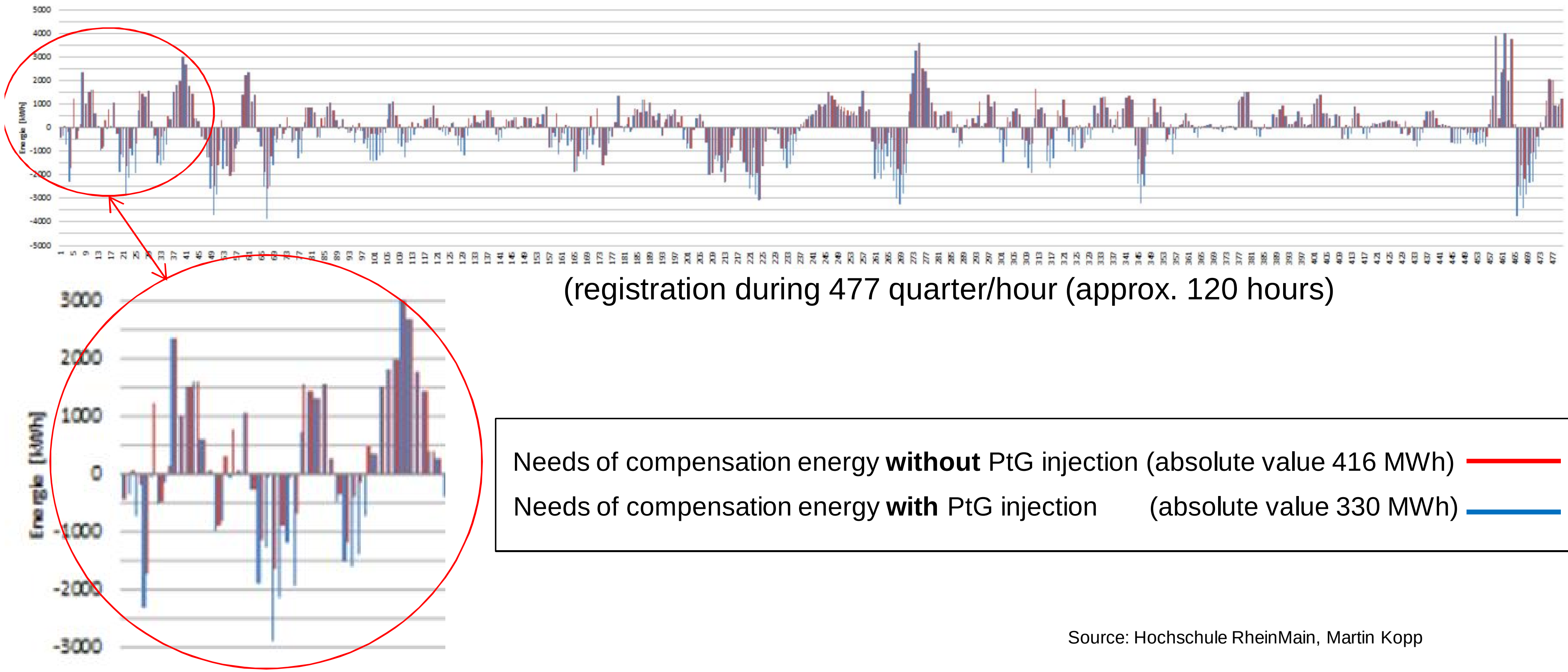


Next step 2 (Q1/16) : Wind farm Operator Cooperation PtG as flexible load for wind energy overproduction

Assumption : PtG use till max. 1,15 MWh per 1/4h

contractual terms **<** Short term pronostics → H2 injection **increase**

contractual terms **>** Short term pronostics → H2 injection **decrease**



(registration during 477 quarter/hour (approx. 120 hours)

Needs of compensation energy **without** PtG injection (absolute value 416 MWh)

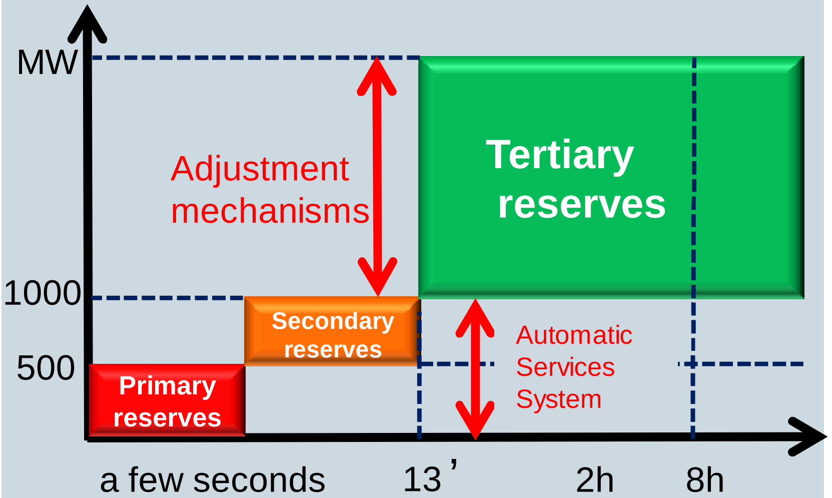
Needs of compensation energy **with** PtG injection (absolute value 330 MWh)

Source: Hochschule RheinMain, Martin Kopp

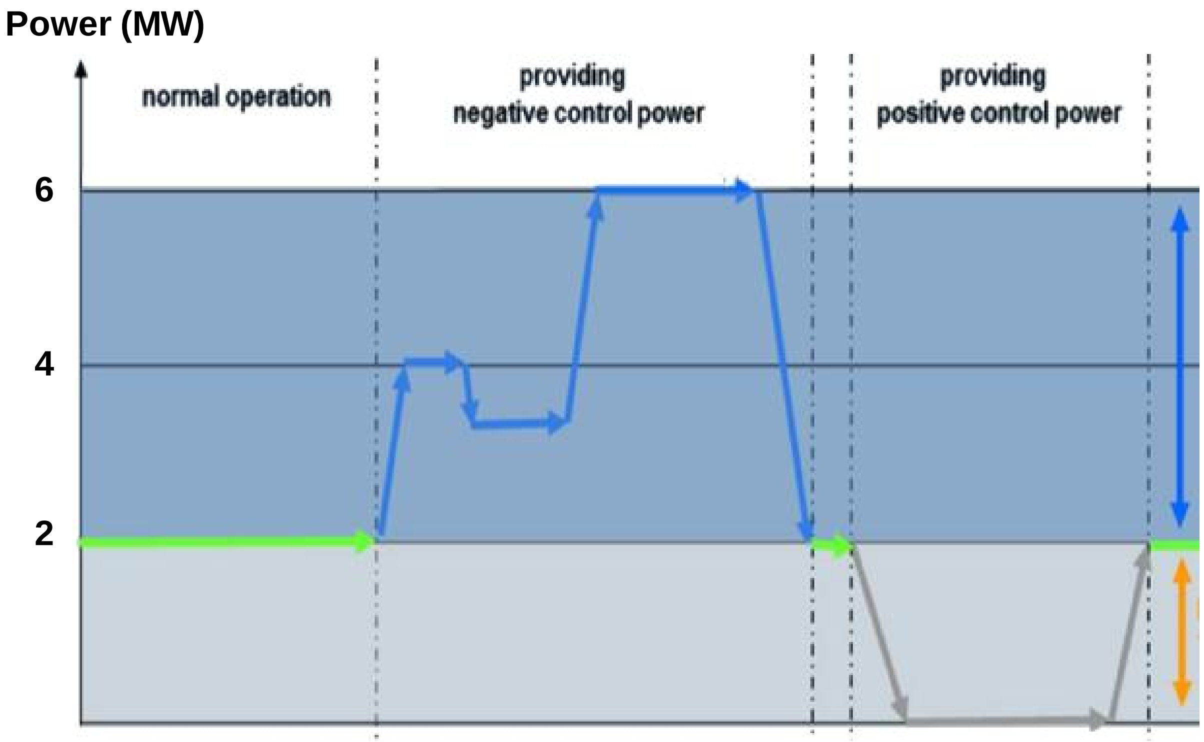
Next Step 3 Q2-4/2016 Energy Balancing Service to the Grid – Operation example

- Black start capability
- From standby to full load: < 10sec
- Stack load cycles 0 % …160 %

- Primary & secondary reserves
- Pooling with other installations



(Source RTE France)



Full dynamic behavior (positive, negative or combined mode control power)

Hydrogen as Energy Storage and Energy Vector
Economic efficiency and Market

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Numerous variable determinants affect the economic viability of the hydrogen out of electrolyze on the energy market.

- Weather (case of Wind- and PV-farms)
- Stock Exchange price
  (arbitrage business in case of reconversion into electricity)
- Revenue from grid services
- Gas price
- Fuel price
- H2 Price as raw material
- Price CO2-certificate

⇒ Necessity of a period of time for the optimization of different processes and revenue possibilities.

50hertz amprion TRANSNET BW tennet

regelleistung.net
INTERNETPLATTFORM ZUR VERGABE VON REGELLEISTUNG

EEX EUROPEAN ENERGY EXCHANGE

Source : Dr. Christoph Stiller Linde AG

Hydrogen as Energy Storage and Energy Vector
Regulatory environment and suggestions

- Previous promotion of the Power-to-Gas-Technology limits itself to research project and demonstration intention.
- Creation of a market environment with specific incentive systems necessary. Moreover the legal frame must be concretized (**market launch instruments**).
- Analogously to other storage technologies renunciation of electricity taxes by electrolyze processes (**not-last consumer concept**) :
    - Transmission grid fees
    - Electricity taxes
    - EU-Contribution
- Electricity adjustment incentive: when storage installations avoid new grid extentions, their costs should be taken into consideration by the calculation of the transmission grid fees (**Opportunity costs**).

Source : Dr. Christoph Stiller Linde AG

Questions?

Further information:

www.energiepark-mainz.de

www.forschung-energiespeicher.info

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