MESY

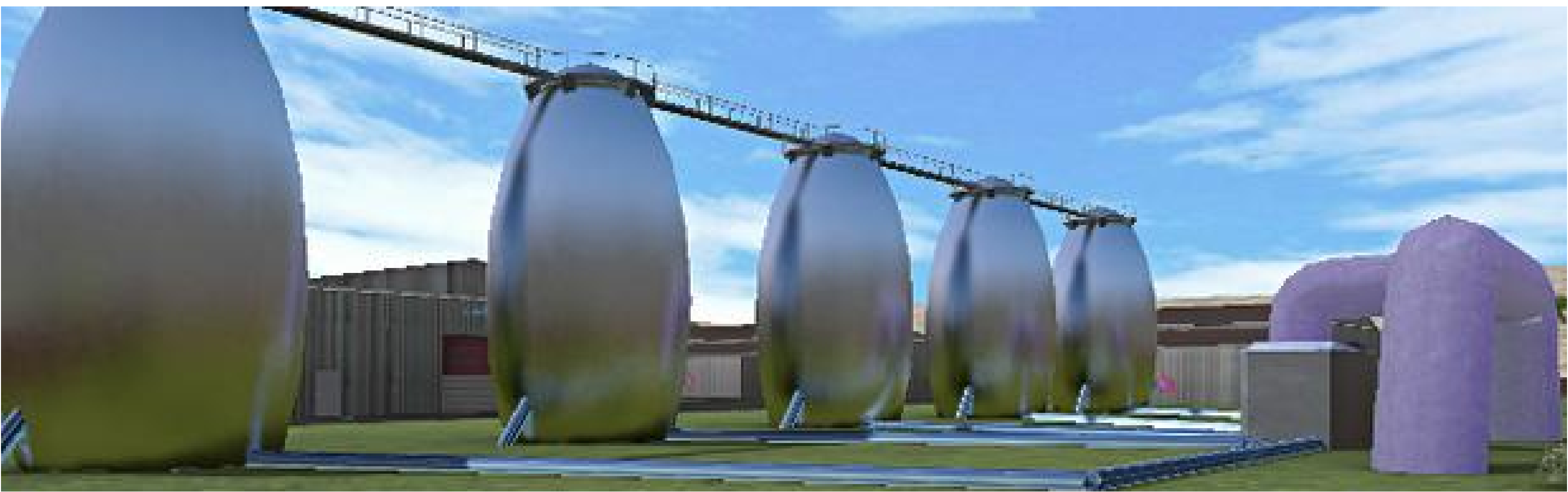
Mobility and Energy storage Systems

THE POWER-TO-GAS GROUP

MESY HP GmbH, Germany

The Power-To-Gas Group

laRET© Product overview, description, samples



Power-to-Gas Technology

Sample Business Case – A Plant for Aluminum Oxide Production

Customer

As an example, we use as following a manufacturing process for aluminum production. The aluminum manufacturer, example manufacturer called Aluminum Manufacturer (hereinafter ALU), is a company specializing in the production of aluminum oxide with an annual production capacity approximately 1,000,000 tons (2.0 million U.S. tons) and using 2.0 TWh of electricity annually for its production processes. The basic raw material used for this process is bauxite ore. Natural gas is the primary form of energy used by this enterprise. It is of vital importance that its energy sources are available, continuously and in sufficient quantity, 24 hours a day, 365 days a year.

Business Model

Sample calculation results indicate that using surplus electricity of 50 MW, approximately 11,400 Nm3/h of hydrogen gas can be produced with the Large Renewable Energy Transformer (hereinafter **laRET©**). The surplus current can be purchased for its own use at very favorable price, or be taken over by an attached wind farm. This produced hydrogen can be used to feed into its natural gas supply, or as a substitute for natural gas. In our sample calculations, approximately 8%–10% of the natural gas supply could be substituted with hydrogen on an annual basis. With a **laRET©** installation, the 8%–10% could be increased. The storage capability of hydrogen assures and makes possible a continuous reliable supply for production processes.

Technology

Newer studies of storage technologies for fluctuating renewable energy sources indicate using electrolysis technology that transforms electrical power into hydrogen and oxygen, can now be measured in industry-standard units of megawatts or gigawatts. The water electrolysis process is a proven and well established industry standard over the past 60 years. The resulting hydrogen is usually stored and used as a primary energy source. Hydrogen can be stored in underground facilities like caverns, above ground in gasometers, or in transportable tanks like POP's from the **eIES**© system.

Electricity required during peak-production periods can be supplemented by utilizing stored hydrogen in fuel cells, or specially designed gas turbines to produce the necessary amounts required. This hydrogen can also be used as a supplementary supply for the natural gas network (a well known process used for decades, typically called “coal gas”), or simply used as a fuel supply to be burned. Therefore for the customer, hydrogen produced directly from green energy sources, wind or solar, offers a supplementary source that can be mixed with natural gas. The calorific value, depending on the admixture, can be varied to better suit their production processes as required.

Calculation Framework

1. Link to a wind farm with 250MW total output. The maximum connected load of 50MM surplus energy is only achieved up to 80% (weather-related assumptions).
2. The internal energy sliding average price per KWh corresponds to the purchase price of natural gas. For this, an average value was determined.
3. The total system indicates system dynamics of 55.85%. In addition, system dynamics per plant of approximately 60% per single electrolyser system were considered, so that the very dynamic input wattages from wind farm or solar parks can be converted optimally into gas production.
4. **The calculated total efficiency of the technology chain is 68.25%.** (Average efficiency of standard coal power plants worldwide is 31%)

Power-to-Gas Economics

Configuration Example of a Model System

Economic Overview

laRET© system for a wind park with 250 MW production capacity:

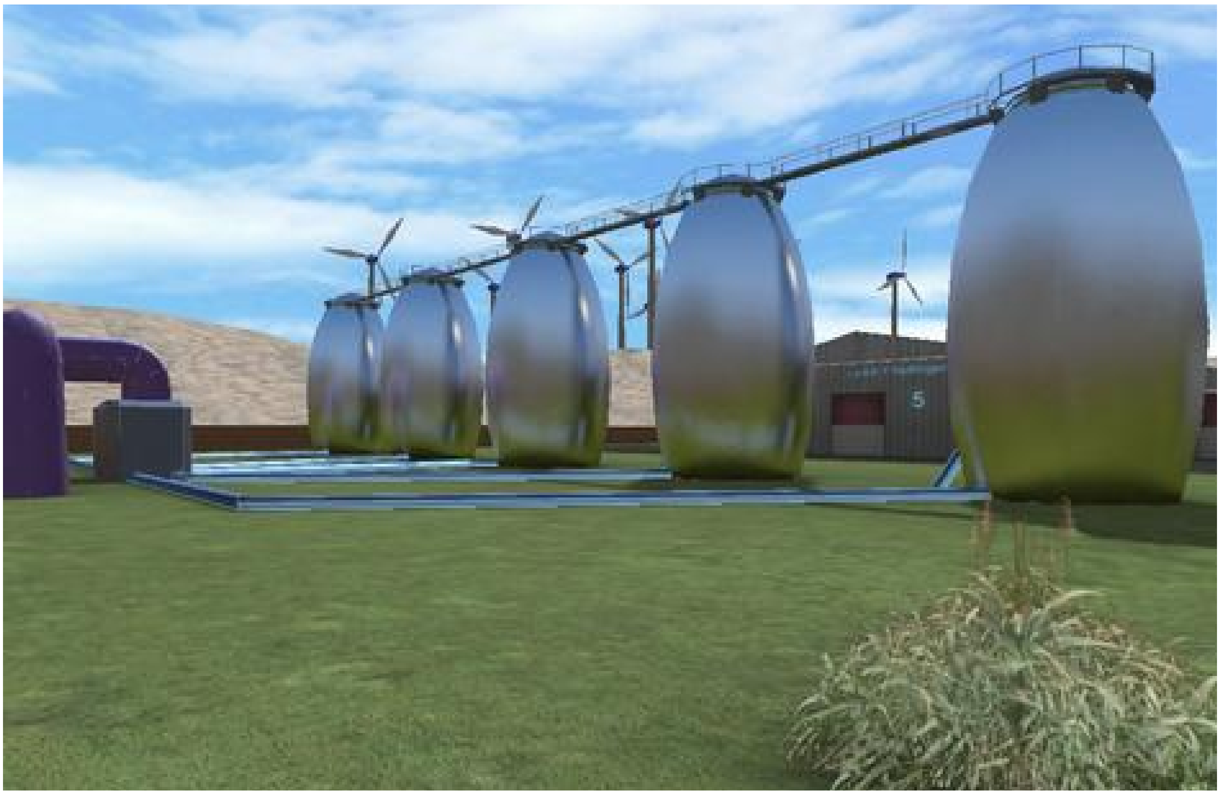
laRET© connected load (final development)	≈ 50 MW
Electrolysis input connected load (nominal)	≈ 49 MW
Electrolysis efficiency	> 80%
Depreciation of model plant assets	18 years (about 18 %)
Cluster scalable installation	1,300 – 2,000 Nm^3/h (9.1 – 12.3 MW)
Total H2-gas production capability (maximum)	11,394 Nm^3/h
Load-sensitive gas feed	100 – 10.7365 Nm^3/h

Configuration

- **laRET** electrolysis array consisting of:
- One array with five clusters
- One cluster with five electrolytic units
- Summary of one plant self contained systems 25 + 5 off-sites (see interactive virtual 3D presentation)

Economic Data (Aluminum production sample)

Production: energy power consumption	2,0 TWh per year
Energy costs wit 5€cent/kWh	100 Mio € per year
Energy self-production with laRET©	9,97 Mio € per year
Substitution with laRET©	≈ 10 % per year
laRET© investment without interest on invested capital	About 75 Mio €
Break-even point	**About 7.24 years**
Amortization (including interest on capital)	**About 8.64 years**
Planned lifetime	> 15 years



Calculation Details:

Model of private use (model view)

			Energy yield per year	Substitution of total energy (in percent) %
Power consumption of energy	GW	2.300		
Purchase price of energy	€/KW	0,05		
Total costs for energy purchase	€	115.000.000	9.964.509	8,66
Use total amount of natural gas	Mio. m³	223.627	2.300.000	8,66
Produced hydrogen (amount), (after configuration)	Mio. m³	66,54	199.290	
Average capital outlays for H2 conversion (without offsites and natural gas valve)	€/KW	1.400		
Total investment (without offsites and natural gas valve)	€	69.995.300		
Proportion of additional costs of investment	%	3		
Proportion of additional costs, total	€	2.099.859		
Calculated break-even point	Year	7,24		
Amortization period including tax on capital (internal or external)	Year	8,64		
Interest charges on investment per year	%	6		
Interest in the first year	€	597.871		
Capital return in the first year including interest	€	10.562.379		
Interest to 'break even', total	€	16.101.065		

All calculations were made with great attention to detail. Nevertheless, errors are possible. A certifiable calculation can be made only with consideration of a firm's factual data, with their cooperation re: fiscal and economic data. The firm's submitted data indicate without doubt that internal use of surplus electricity can be accomplished economically.

Power-to-Gas Technology
Mobile and Stationary Solutions

Next Step in Comprehensive Use of Renewable Energy

“Power-to-gas” is a process and storage technology which allows electricity to be held in reserve in the megawatt range. It allows seasonally adjusted storage of significant amounts of power and the provision of CO2-neutral fuels in the form of the resulting renewable energy source gas.

Technological solutions like **eIES**© and **laRET**© are complex. They comprise several system components. After a multi-year market study, no comparable complete energy-conversion solutions could be found on the market. As a consequence, the MESY network project was formed. We offer a unique technological innovation, a follow-on technology superbly complementing existing renewable energy production worldwide. Presently, MESY is the only provider of a total system solution for the conversion and storage of surplus electricity worldwide.

Characteristics – Use – Markets

The network project represents a select group of specialized firms with innovative solutions under the umbrella of a project company, which offers only two system solutions **eIES**© and **laRET**©! The **eIES**© mobile system is designed for smaller amounts of converted energy. It can be utilized to supply energy for camps and bases and other similar applications. The **laRET**© system is permanent, and is conceived for large-scale energy conversion. **laRET**© is designed for conversion of surplus electricity production into storable hydrogen, either by wind- or solar-park complexes.

With help of high-efficient, water-electrolysis system solutions, approaches for the economical use of surplus electricity are now available. Normal amortization characteristics can be expected vis-a-vis our follow-on technologies for wind and solar parks. When wind parks disconnect from the power grid because they are producing surplus electricity, ownership sustains financial losses. Utilizing **laRET**© for energy storage will minimize these losses, or result in no losses whatsoever.

It is the same for solar parks. Invested capital in a solar park is based on the main condition that it is in operation approximately 50% of each day (on average per year). The energy loss on any given day is an economic loss. Utilizing **laRET**©, a solar park’s economic efficiency increases above the normal 50% usually encountered—surplus electricity is stored and converted, e.g., during the night or other off-peak periods.

Power-to-Gas Project Management

Life Cycle Partnership

MESY Single Point of Contact

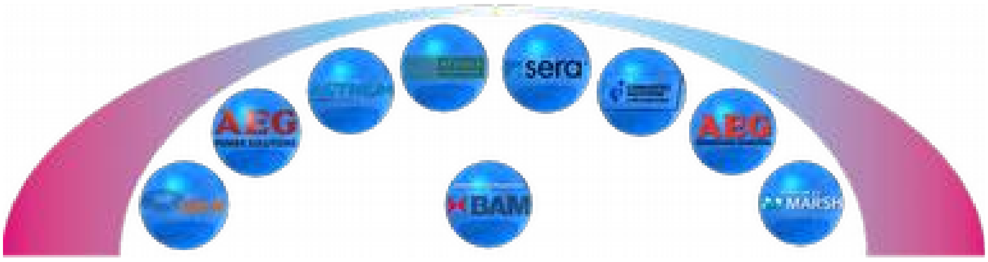
MESY is your General Contractor for your **eIES**© and **laRET**© projects. MESY is single point of contact for all contracting and project management issues. Competent consultants and experienced engineers accompany the whole life cycle from the first idea until implementation and operation.

- Feasibility Study
- Requirements Management
- Project Management
- Quality Assurance
- Pofessional Services.

Case Study ALU

Based on our concept, a realization study should be made. The study's focus would determine the amount of surplus electricity and its optimal economic conversion into hydrogen. Another area of investigation: what quantity of hydrogen would be necessary in order to use efficiently the higher flame temperature of hydrogen compared to natural gas. Further, we assume there are other "hidden" economic benefits. From a marketing viewpoint, uses of green energy sources in production processes will have benefits, e.g., a more positive public perception in advertising. Further, exclusive use of hydrogen for aluminum oxide production, would bring a "green product" into the market.

The **MESY Group** of companies for world wide Power-To-Gas solutions



info@MESY.org

MESY HP GmbH
Tel.: +49 30 2556 2719
FAX: +49 30 2556 2720
Internet:www.MESY.org
E-Mail: info@MESY.org

Central mail address
c/o WIPN Group
POB 420 554
D-12065 Berlin, Germany