MESY

Mobility and Energy storage Systems

The Power-To-Gas Group

Surplus Electricity for the Production of Aluminum Oxide

For more information: www.mesy.org

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Business Model for the Use of Surplus Electricity for ALU

Environment

Alternative or renewable energy producers today still have the difficult problem: what to do with surplus electricity production. Their only option to date is turn off their operations feeding into electricity grids. Nevertheless, the producer continues generating power, but this electricity is no longer available for the power market or consumers.

Conditions with Customers

As an example, we use as following manufacturing process for aluminum production. The aluminum manufacturer, example manufacturer called Alumium 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 annually for its production processes. 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.

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 ALU, 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.

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.

Based on our concept, a realization study should be made. This 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.

Conclusion

The MESY Projektgesellschaft suggests the laRET$_{©}$ system be used as the basis for a detailed realization plan of the project and business model, and to execute a realization study.

For further background and explanations, see appendices 1, 2 and 3.

Appendix 1: MESY Project Company

Introduction

The MESY Projektgesellschaft (hereinafter The Company) is an original equipment manufacturer (hereinafter OEM), and will implement these technologies in conjunction with exceptionally qualified partner firms. However, certain OEM innovations and key technology issues remain unresolved. The Company retains an extraordinarily competent management team for projects of this magnitude, and The Company developed the concepts of both the eIES© and laRET© systems. In addition, The Company concentrates a thoroughgoing knowledge of the applicable global market. This know-how is the basis for development of requirement-oriented systems like eIES© and laRET©. The Company is the interface between the market and partner firms (group), and within these relationships, have built-in contingency planning.

Know-How

Our technological analysis proves the industrial-scale conversion of energy, either feeding directly into existing energy networks or comprising a storable energy source like hydrogen, is a technology already available today. It is used frequently in other industries, e.g., the chemical industry. Hydrogen, in this analysis, is one of the most economically producible power sources. Therefore in principal, technology is readily available for the conversion of electricity into hydrogen. However, it must be adapted to different operations like wind power and solar cell energy production. It is here that The Company's know-how is strategically positioned.

Products

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, into a stationary and a transportable product offer.

Characteristics and Uses

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.

Market

With help of high-efficient, water-electrolysis system solutions, approaches for the economical use of surplus electricity are now possible. 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 mitigate 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.

We envision our system offers breakthrough follow-on technology for wind and solar parks worldwide!

Appendix 2: Configuration Example of a Model System

Example for 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%
- Degradation of model plant assets: 18 Jahre ca. 8%
- Cluster scalable installation: a 1300 - 2000 Nm^3/h (9.1 – 12.3 MW)
- Total H2-gas production capability (maximum): 11394 Nm^3/h
- Load-sensitive gas feed: 100 - 107365 Nm^3/h

laRET© electrolysis array consisting of: 25 electrolysis units total

- One array with five clusters
- One cluster with five electrolysis units
- Summary of one plant self-contained systems: 25 + 5 off-sites (see animation)

Computing the economic view, the following framework data were assumed:

1. Link to a wind farm with 250 MW total output. The maximum connected load of 50 MW surplus electricity 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 very dynamic input wattages from wind farms 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 %)

Economic Data:

ALU production energy power consumption:	2.0 TWh per year
Energy costs with 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:	ca. 75 Mio. €
Break-even point:	ca. 7.24 years
Amortization (including interest on capital):	ca. 8.64 years
Planned lifetime:	> 15 years

Calculation Details:

Model of private use (model view)				
Power consumption of energy	GW	2,300.00		
Purchase price of energy	€/KW	0.05	Energy yield per year	Substitution of total energy (in percent) %
Total costs for energy purchase	€	115,000,000	9,964,509.00	8.66
Use total amount of natural gas	Mio. m³	223,63	2,300,000.00	8.66
Produced hydrogen (amount), (after configuration)	Mio. m³	66.54	199,290.00	
Average capital outlays for H2 conversion (without offsites and natural gas valve)	€/kW	1,400.00		
Total investment (without offsites and natural gas valve)	€	69,995,300.00		
Proportion of additional costs of investment	%	3.00		
Proportion of additional costs, total	€	2,099,859.00		
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	%	6.00		
Interest in the first year	€	597,871.00		
Capital return in the first year including interest	€	10,562,379.00		
Interest to ‘break even’, total	€	16,101,065.00		

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.

Calculation details of a second model: EEX (Energy Stock Exchange) based model

Result: Even just from the Energy Saving an economy is evident. This depreciation, tax benefits and other standards are not considered. They are additive.

Example

	Unit	Input	intermediate values	Calculation
Max. hours per year	h	8.760	730	
Hours of operation per day	h	22	8.030	91,67
LARET connecting power	kW	50.000	37.500	1.600,00
Utilization per year	%	75		
Efficiency of energy production	%	75		
Performance per year of energy production	kwh		225.843,75	225.843.750
Production performance of the system	kW/Nqm/h	4,51		50.076.220
Operating expenses (Wartung, Pflege, etc.)	%	4		
Efficiency of repowering	%	55		124.214.063
Energy consumption per year	Mwh	2.000.000	225.844	1.774.156
Substitution of own energy consumption	%	11,29		
Energy costs of natural gas	€cent/kW	0,0350	7.904.531	70.000.000
Top level of energy purchase price (EEX)	€cent/kW	0,0200	1.535.738	6.368.794
Min. sales price of energy (EEX)	€cent/kW	0,0800		6.558.503
Proportion of energy sales to consumption	%	66		
Total investment	Mio. €	80	80.000.000	108.800.000
Interest	%	6	36	
Repayment term	Year	6		
Amortisation (incl. Interest)	Year	8,42		

Appendix 3: Plant overview

LARET© Plant Overview
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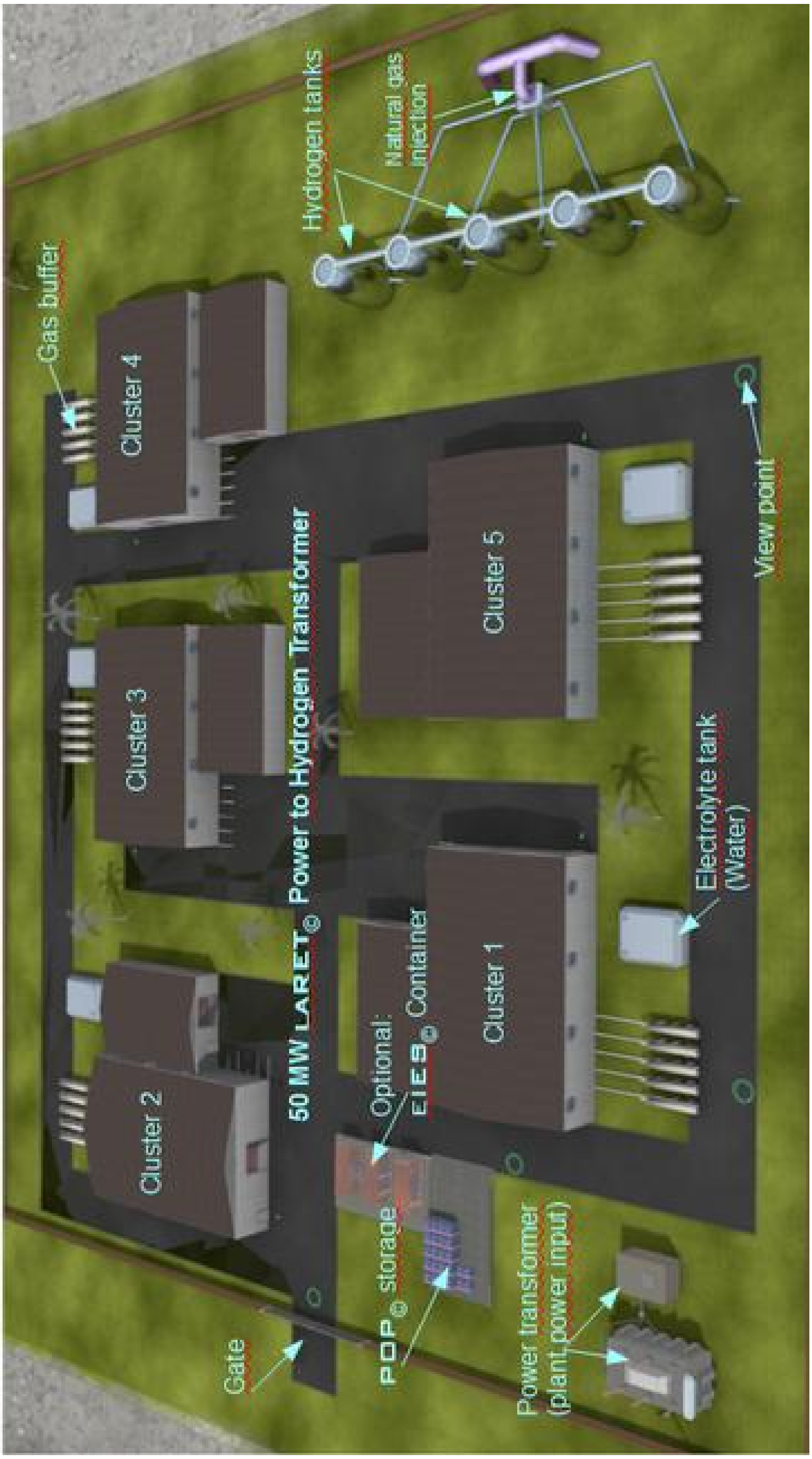

Appendix 4: Group Organization Outline

The eIES© and laRET© are executed by The Company's leadership. MESY is that general enterprise for project and contracting party for the customer. Thus, the customer has a contracting party for the total system.

In the context of a project, the system products are customized, planned and implemented. A project generally comprises two phases:

Phase 1: A realization study; and

Phase 2: Realization and implementation.

The realization study represents the basis of final implementation.

Organization Flowchart

Both phases are realized by the following organization: