



Deliverable Report

Report on first workshop and symposium

(D7.4)

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Contents

Contents	2
1 Introduction	3
2 The program	4
3 Summary and outputs of symposium presentations	5
4 Summary and outputs of workshop	8
5 Results and conclusions	8

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1 Introduction

1.1 The QualyGridS project

The overall objective of the QualyGridS project is to establish standardized testing protocols for electrolyzers to perform electricity grid services. Alkaline electrolyzers and PEM electrolyzers will both be considered within the QualyGridS project. A variety of different grid services will be addressed as well as multiple hydrogen end users. The protocols developed will be applied to both alkaline and PEM electrolyzers systems, respectively, using electrolyzer sizes from 50 kW to 300 kW. Additionally, a techno-economic analysis of business cases will be performed covering the grid and market situations in the most relevant regions of Europe for large electrolyzers (>3MW). Testing protocols and economic analysis will also include the review of existing and possibly set-up of new Key Performance Indicators (KPI) for electrolyzers.

The consortium addressing these tasks includes three electrolyzer manufacturers and as well as research institutions with highly relevant experience concerning hydrogen technologies, electricity grid operation and smart grids. Inclusion of a European standardization institution will allow for maximum impact of the protocols. An advisory committee including TSOs from several countries and a key player in US renewables and electrolysis research will support the project with valuable advice. Experience from previous FCH-JU electrolyzer projects and national projects is available to the project.

1.2 First symposium and workshop

As stated in the Grant Agreement of the QualyGridS project, several workshops and symposia will be organised to allow exchange of information with researchers and related projects, and dissemination of key lessons to relevant stakeholders; to share project findings with relevant stakeholders. As deliverable this report (Deliverable D7.4) provides a summary of the output of the first workshop and symposium. The symposium and workshop were intended to have input, discussion and attention as result.

The way how the electrical energy market is organized in Europe is changing, opening opportunities for more flexibility in generation and consumption. New sustainable technologies such as water electrolyzers, fuel cells, batteries and others meet the needs of the future transmission and distribution grid. Flexibility, virtual power plant, dynamic load management, direct marketing, control reserves, grid services are few of the key words addressing this challenge.

To exchange information on these topics and get in touch with the relevant expert a symposium was organized by the project in Lucerne.

During the symposium international experts highlighted the topics around the grid service markets, focusing on the market logic, business model experience, regulations, grid balancing, future trends and long term business plans. The symposium aimed at reaching an understanding of the differences in the European grid service markets and at pinpointing prospects of flexible emerging technologies to contribute to grid services. It addressed scouts and managers from the European electricity industry, administration bodies and researchers interested in the commercial aspects of grid services. Furthermore, 6th European PEFC & Electrolyser Forum, one of the world's most important conferences on hydrogen and fuel cells, was hosted parallel to the QualyGrids symposium at KKL in Lucerne. This opened excellent opportunities for project dissemination.

Finally, for the QualyGridS project is agreed to organize a workshop in the early phase of the project, inviting especially electricity grid experts and companies that will help for further input. Given the synergy opportunities and target audience, the workshop and symposium have been combined in a single day event. See chapter 4 for a summary of the outputs. A FCH JU project exchange meeting was also hosted during the event, but this is outside the scope of deliverable 7.4 and will not be discussed in this report

2 The program

QualyGridS Symposium on European Grid Services Markets		
Lucerne, Switzerland 6th of July 2017 Club Rooms 2 nd Floor KKL		
Time	Topic(s)	Who
09.00	Registration Welcome & Introduction	Prof. Dr. Christoph Imboden, Head Research Group Power Economy, Lucerne University of Applied Sciences HSLU, CH, Regine Reißner, Project coordinator QualyGridS, DLR
Regulations & Markets		
09.15	A journey towards pan-European ancillary services	Dr. Bastian Schwark Head of TSO Markets, Swissgrid
10.00	Impact of renewable energies on the balancing market in Belgium	Bob Hebb Head of Ancillary Services, Elia
10.30	Networking Coffee Break	
11.00	Demand side response in the GB market	Thomas Maidonis Storage & Flexibility Expert, National Grid
11.30	Opportunities of water electrolyzers in the European flexibility markets. A report from the FCH ELYntegration research project	Lara Lück Research engineer, RWTH Aachen, DE
12.00	The role of demand side management in the Scandinavian and Baltic countries	Thomas Elgaard Jensen, Dir. Strategic Business Development, Energi Danmark
12.30	Business Lunch on the Terrace of KKL, Coffee in the exhibition & in front of the Club Rooms	
Experience with Business Model		
14.00 *	Chances with Wind in the Grid: How to meet the needs	Giles Dickson CEO at WindEurope asbl/vzw, Brussels BE
14.30	The commercialization of demand side flexibility: A customer journey	Thomas Kudela, Regulatory Manager, Sen. Commercial Developer, DONG Energy, DK
15.00	Application of a Li-ion battery in the frequency containment reserve market	Dr. Marina González Vayá Smart Grid Specialist, EKZ, CH
15.30	Networking Coffee Break	
16.00	Explicit Demand Response in Europe	Jayson Dong, Policy Officer, Smart Energy Demand Coalition Brussels BE
16.30	Economic operation of a water electrolyser - a field report	Dr. Hans Kaspar Scherrer CEO, IBAarau AG
17.00	Workshop and Summary	Prof. Dr. Christoph Imboden
17.30	Grid-Apéro & FCH JU project exchange meeting	
19.30	Networking Dinner on the Lake (optional, together with EFCF) Boarding 19.20, lake side of KKL pier 5/6 – back 23.15; 22.30 short stop in Brunnen for early return by train	
*The presentation of Giles Dickson was cancelled due to circumstances and replaced by the presentation “Balancing the Grid with hydrogen technologies » by Bernard Frois, CEA, France		

The original presentations are publically available and can be downloaded from <http://www.control-reserves.ch/event/european-grid-service-markets/>.

3 Summary and outputs of symposium presentations

3.1 Bastian Schwark (CH, SwissGrid): Ancillary services, int. cooperations and projects (FCR, IGCC, TERRE, MARI)

Mr. Schwark first gave an overview of the ancillary services in Switzerland, in particular for balancing purposes. The procurement cost for balancing reserve provision reduced significantly since 2009. The Swiss TSO has been developing several market mechanisms for the procurement of balancing services. Switzerland is largely dependent on pumped hydro power for ancillary services. Costs for reserves are also reflected in seasonal water tides. For the tertiary reserves programme, the aggregation concept was introduced in 2013 allowing decentral flexibility to participate in Swiss ancillary services market. Swissgrid has introduced many measures for the promotion of competition within the primary, secondary and tertiary control power markets. International cooperations are an essential driver to further increase liquidity in these markets though. Therefore Swissgrid is active participant in several international balancing energy cooperations. The Network Code on Electricity Balancing (EB) guideline will be very important for the European balancing market. As a result, prices are likely to converge. Mr. Schwark subsequently discussed several international cooperations and projects (FCR, IGCC, TERRE and MARI) from the perspective of the Swiss TSO. At last he finished with the idea of Swissgrid on an integrated market. Balancing and congestion are so far dealt separately, but could be integrated into an integrated market for manually activated products.

3.2 Bob Hebb (BE, Elia): RES integration

Mr. Hebb started off with an introduction of Elia Group. Elia Group encompasses two TSOs: one in Belgium and one in Germany. The presentation focused on the balancing market in Belgium. The context is changing in Belgium. In the past, a lot of balancing was done through CCGT's. In the past few years a lot of fluctuating renewable energy sources (RES) have been connected to the grid. As a result, grid reinforcements are being made. In parallel, Belgium has to deal with a phase-out of nuclear (by the end of 2025). Since 2009 the standard deviation of the system imbalances is therefore increasing. Belgium becomes very dependent on (relatively expensive) CCGT spinning reserves, which are shutting down. The need for new reserves is increasing in result. With status quo, emergency contracts would have to be employed on a structural basis. Elia Group therefore made an action plan. They have planned to take measures on four axes: system imbalances, more efficient and more reliable determination of needs, realize cross border (XB)-synergies and diversify the assets providing balancing services. Each of these four axes are explained by Mr. Hebb.

3.3 Thomas Maidonis (UK, National Grid): DSR and changes in the UK grid service markets

Mr. Maidonis first gave an introduction of the National Grid. They are currently unbundling ownership and system operation in the UK. He explained the current developments in the energy mix of the UK. The share of coal is decreasing and the share of gas is increasing. The UK has a relatively large share of nuclear installed. The share of RES is not that significant yet, but increasing much faster than expected. This is also the case for the level of embedded generation. In the future energy system, increased interactions between the transmission and distribution grid will take place. Better coordination between the TSO and DSO is required. According to research there's a rapid increase in flexibility markets and a decrease in traditional energy markets. In their vision, flexibility can be achieved through sync. generation, interconnectors, electricity storage, demand side response (DSR), distributed generation and async. generation. Several possible revenue streams for National Grid were discussed. Mr. Maidonis focused on DSR for the rest of the presentation. Flexibility is increasingly achieved through markets instead of bilateral DSR contracts. It's a challenge for National Grid to coordinate local and national markets. They should be complementary and not competing. For the future, National Grid is further exploring new procurement approaches and wider markets for ancillary services. In order to achieve flexibility, National Grid focuses on information provision, optimizing the use of distributed energy sources (DERs), simplifying Products and structural market change.

3.4 Lara Lück (DE, RWTH Aachen): WEs in the European flexibility markets, report from the ELYntegration project (focus on market potentials).

Mrs. Lück introduced the FCH ELYntegration research project. The goal of ELYntegration is the design and engineering of a robust, flexible and cost competitive Multi Megawatt alkaline water electrolyser, based on IHT technology. Two trends are expected. First, rising average electricity prices because of higher primary costs for coal, gas, etc. and CO₂ expenditures. Second, more fluctuation of spot market prices due to the increased connection of RES. This results in new market opportunities for electrolyser with dynamic operation capabilities (fast start-up and ramping capabilities). They may potentially be applied in spot markets and control reserve markets. Within the project is explored which markets and operations are promising. Future prices of different markets and technical restrictions for electrolyser dispatch are considered for each business model calculation. The results show that the business model efficiency is highly dependent on hydrogen prices. Regarding participation at spot markets, contribution margins are rising for future scenarios with high RES shares and promising markets are especially those with high shares of wind power. Regarding participation at control reserve markets, provision of positive FRR is profitable. The advantage of reserve provision is decreasing in future scenarios though due to competition and relevance of flexibility. Finally is concluded that flexibility becomes highly relevant in the future for exploitation of low spot market prices and control reserve opportunities.

3.5 Bernard Frois (FR, CEA): Balancing the Grid with hydrogen technologies

Mr. Frois underlines that hydrogen is a versatile energy carrier. Hydrogen should be seen as a new energy vector like electrons. Many examples were given in which hydrogen technology is (already) used. Cars are only a small part of the hydrogen revolution. According to Mr. Frois, hydrogen technology is there, it's very interesting and should be compared to battery technology. Germany, Japan and California are currently pioneers in the field of hydrogen. The introduction of hydrogen enables new linkages between energy supply and demand, in both a centralized or decentralized manner. It contributes to flexibility of the energy system, helps to decarbonize industry and fuel cell vehicles lower carbon emissions and improve air quality when replacing conventional vehicles. A cost-comparison was shown by Mr. Frois between a lithium ion (battery) system and power-to-gas system for energy storage, in which the latter turned out to be most cost-efficient. Mr. Frois underlines that power-to-hydrogen is bankable already today. Storing large amount of energy requires inevitably to go for power to gas, and hydrogen is a very flexible and adapted solution for both mid scale and large scale systems needing to store energy for more than a day. It's efficient, long term and has low energy cost. Subsequently several long term energy system visions were shown in which hydrogen play an important part (i.a. of the US and German governments). Occasionally, these visions have been transposed into policy measures and even regulation. Next, a (word-wide) overview was given of recent demonstration projects on hydrogen and their main conclusions. The presentation was concluded with the statement that batteries based storage systems and hydrogen based storage systems will co-exist in a world where renewable intermittent energy will increase and will need to be stored on a large scale, both at centralized and decentralized level.

3.6 Thomas Elgaard Jensen (DK, Energi Danmark A/S): DSM in Scandinavia and Baltics (Nordic Pool)

Mr. Elgaard Jensen first introduced Energi Danmark Group, the Nordic region's leading energy trading group and one of the largest purchasers of energy on the NASDAQ OMX Nordic energy market. Subsequently Mr. Elgaard Jensen gave an overview of the Nordic electricity markets and current developments. Electricity (wholesale) markets were illustrated in order of time of the market before real time. Something has to be done; system frequency is more often getting out of "good" band. Furthermore, Energi Danmark Group currently has to do with three synchronous areas: Nordic, Continent and Russia (Baltic). In result, they apply three optimization functions in which balancing costs are minimized. Several developments lead to the need of more integration and harmonization between the three areas. Subsequently Mr. Elgaard Jensen discussed the role of demand response. There is no common European approach on demand response. Currently the consensus in Europe is that flexibility is key in the future to achieve balance in real time. It is unclear how to achieve this flexibility however. For example through demand response,

batteries or fuel cells. It was shown that there are different philosophies in European countries on this, primarily due to historical reasons. Finally he advises to push for market integration and one unified European approach, push for RES integration in all markets, accept increased price volatility, harmonize RES support schemes, remove political uncertainty (let the EU ETS work) and push for retail market integration.

3.7 Thomas Kudela (DK, Dong Energy): Pooling solutions

First, Mr. Kudela introduced Dong Energy. Subsequently it was shown that the estimates of flexibility potential in Europe according to different studies vary significantly. It was made clear that all relevant stakeholders need to be included in a flexibility value chain: demand response supplier, aggregator, DSO, TSO and balancing responsible party. The basics of electricity market and ancillary services were discussed subsequently. The potential revenues of grid services alone are limited. Therefore Dong Energy has decided to take on the role of aggregator (pooling) to offer demand side flexibility. According to the vision of Dong Energy, just providing grid services is not enough for flexibility providers (consumers) to participate. There are high entrance costs in terms of having to know a lot before you can be connected as consumer. Moreover, there are differences among different countries. Harmonization would be a step in the right direction, but will take a lot of time and it is unclear to what extent full harmonization is going to be achieved. Dong Energy therefore developed a customer journey which begins with low commitment solutions. Different flexibility products that Dong Energy offers were discussed. Finally he explained the vision of Dong Energy to offer energy as a service. Several customer offerings compiled in one journey.

3.8 Marina González Vayá (CH, EKZ): Li-Ion battery for FCR.

Mrs. González Vayá discussed the application of a Li-Ion battery in the frequency containment reserve market within the BESS project. The goal of the project is to gain experience with this technology by testing different applications. For the project they currently have 1 MW installed in Zurich. Noteworthy, the promised lifetime of the battery by manufacturers is five years. However in their experience they may extend this to a much longer period. The BESS storage facility is integrated into EKZ's power distribution network and evaluated in key areas such as peak load management, voltage control, islanded operation and increasing PV self-consumption. A concept that is currently under evaluation is the BESS battery and other flexible units jointly providing secondary frequency control as Virtual Power Plant. From research can be concluded that battery energy storage may provide primary frequency control with a higher speed and accuracy than conventional units that are currently providing this service. Further it's advised to regulators to carefully weight cost-benefit to avoid setting overly restrictive rules for energy storage. Finally, combining the capabilities of different technologies within a virtual power plant offers new opportunities for the provision of a diverse portfolio of ancillary services.

3.9 Jayson Dong (BE, Smart Energy Demand Coalition SEDC): Demand response access in 18 European countries

Mr. Dong first introduced the Smart Energy Demand Coalition (SEDC). He discussed a research on the demand response potential in Europe in 18 countries. The study explores the regulatory framework for explicit demand response across a wide range of markets (day-ahead, intraday, balancing and capacity mechanisms). The countries were assessed according four key areas: demand-side resources access to the markets (1), service providers access to the markets (2), programme requirements (3) and measurement and verification, payments, and penalties (4). For each area, Europe has been visualized according to color codes, from red (closed) to green (commercially active). The study concludes that the regulatory framework in Europe for demand response is progressing, but that further regulatory improvements are necessary. It is finally advised to allow real price signals (incl. scarcity prices, full cost of balancing), reduce the blunting effect of taxes, charges and levies, realize right-size capacity (assessments) and include demand-side flexibility and avoid perverse incentives (e.g. certain grid charges).

3.10 Hans-Kaspar Scherrer (CH, IBAarau): 200 KW PEM WE operation experience report (Diamond Lite/Alpiq)

IBAarau is currently developing a SmartGrid which is converging their (regional) networks. Electricity, gas, heating/cooling, drinking water and communication networks are managed by one single dispatch center for all networks. As a result they are able to exploit the different characteristics of the networks (e.g. transformation, storage and quality). Furthermore, IBAarau started a pilot for a commercial hydrogen project in Switzerland. Within the project, hydrogen is produced through a PEM electrolyser that is in direct connection with a river plant. The hydrogen is subsequently transported to a fuel station nearby. The missing link is currently that there are too little consumers (trucks and cars) for the hydrogen. Additionally, tests were done with electrolyzers and in particular potential is seen for fast response applications. Subsequently several other projects were discussed: energy hub Telli, a power-to-gas (p-t-g) plant in Iceland and p-t-g project Limeco. In conclusion Mr. Scherrer states that hydrogen provides many opportunities for DSOs.

4 Summary and outputs of workshop

Within the QualyGridS project is agreed to organize a workshop in the early phase of the project, inviting especially electricity grid experts and companies that will help for further input. Given the synergy opportunities and target audience, the workshop and symposium have been combined. After the last presentation, the symposium was concluded with a final workshop. Within the workshop, the attendants, specialists from the market, were asked for their vision on the future role of electrolyzers for grid services. The attendants were asked what requirements electrolyzers should meet and how a successful roll out of electrolyzers could be organised. The discussion was led by Mr. Imboden.

It was said that it's not a technical question, but it's a commercial or economical question whether electrolyzers will be used for grid services. Whether people are willing to take the effort or risk, whether there is a business case, etc. Another point stressed are the regulatory difficulties and issues for a roll out of electrolyzers. Advice was given to contact lawyers and regulatory experts to cover potential regulatory issues and to explore the full potential. Furthermore it's suggested to partner up with local stakeholders as each environment is different in terms of suitability for electrolyzers. A potential interesting service for electrolyzers could be to handle disruptions.

A discussion followed on if it would be more suitable to focus on DSOs/local level than on the TSO level because of the regulatory issues. Response was given that it may be even more difficult to employ electrolyzers on the local level. DSOs desire no congestion and want to manage this as less as possible from the perspective of security of supply. In the end it has to be coordinated between TSO and DSO, so there may be no advantage in that case.

In conclusion Mr. Imboden made a final statement. The technology and markets are there. However it's not quite sure how to bring those together. Somebody should take the lead though. We are trying to achieve this with our research project QualyGridS.

5 Results and conclusions

The symposium and workshop have been very valuable for the QualyGridS project. In total, 52 participants from 13 countries participated (A, B, CH, D, F, Ireland, Israel, I, Japan, NL, South Africa, E, UK). The event has generated a lot of input from the perspective of the market, which gave a good overview of the market potential of the QualyGridS project. Moreover the attendants of the symposium may be information and review sources for valuable input in the future to the project. On the basis of the event, possible trends, scenarios and potential future opportunities will be included in the research.

It has become clear that the (potential of) markets for ancillary/grid services are very different for each country in Europe. As discussed, the technology and markets are there. However it's not quite sure how to bring those together. Somebody should take the lead. It has become clear that market stakeholders are not likely to take the lead. As long as a business case can be realized,

taking into account the regulatory environment, markets are open though to the introduction of electrolyzers. There is consensus in Europe that flexibility is key for the future of European energy grids. Electrolyzers may play a part providing this flexibility. The research project QualyGridS intends to be a first step to bring technology and markets for grid services together.