“Improvements to Integrate High Pressure Alkaline Electrolysers for Electricity/H2 production from Renewable Energies to Balance the Grid”

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publishable summary report

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Authors:

Pablo Marcuello[1]

[1] Foundation for Hydrogen in Aragon, Walqa Technology Park, Spain

Author printed in bold is the contact person for this document.

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Main S & T results/foregrounds

Power Electronics

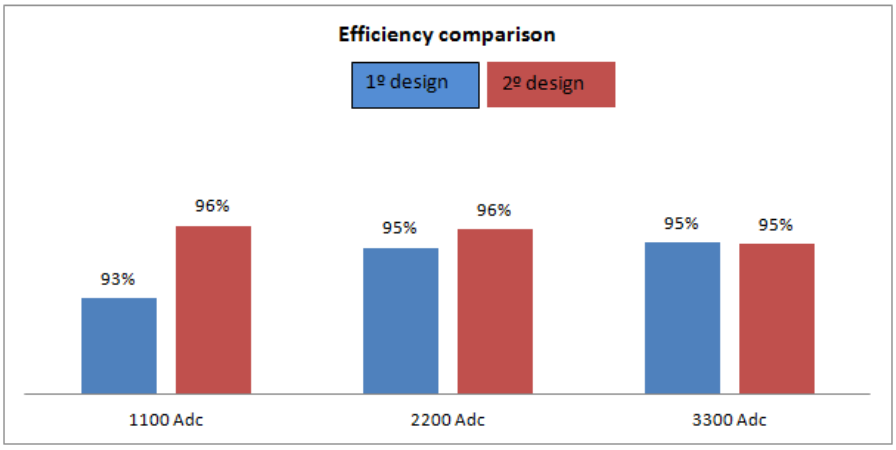

Figure 1 Efficiency comparison between conversion systems.

Figure 2 Power stack developed and test bench at Ingeteam labs

Membrane development and tests

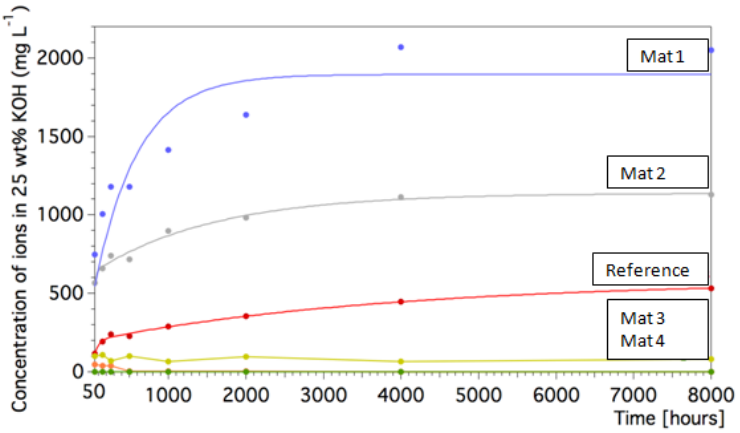

Figure 3: Concentration of ions in 25 wt% KOH after leaching the different filler powders at 85°C for up to 8000 hours.

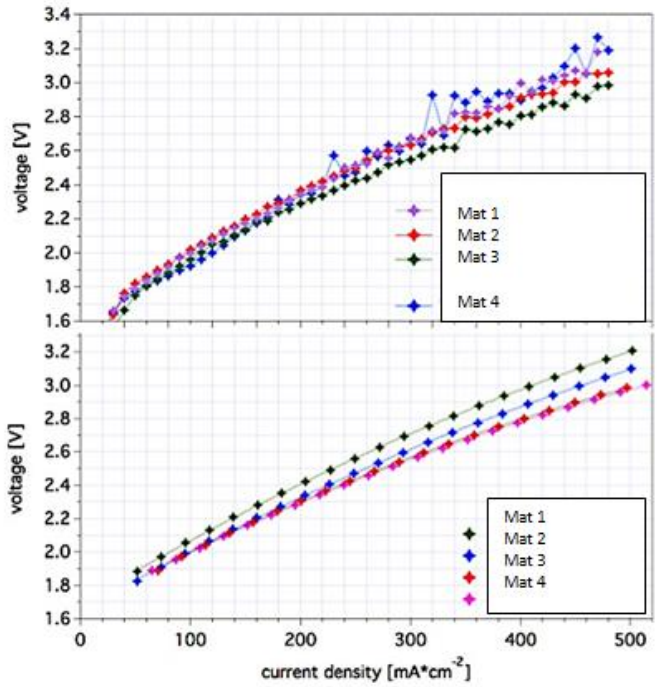

Figure 4 U/I characteristic curves measured with lab-electrolyser (Empa) for new developed separators (top) and reference separators (A1 – A4) with various porosities delivered by IHT (bottom).

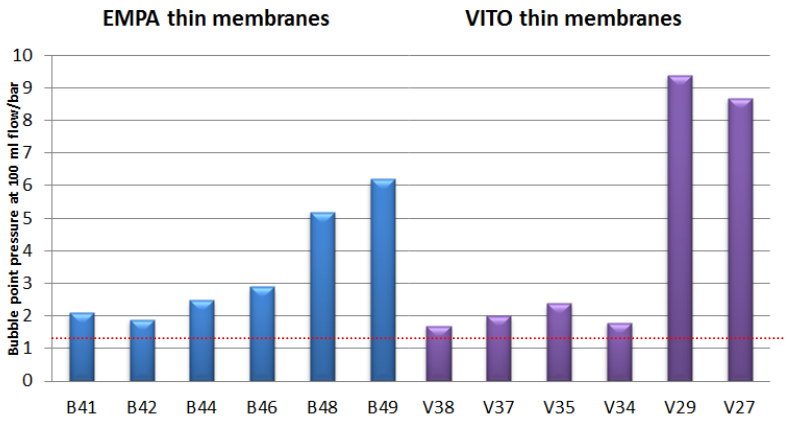

Figure 5: BP pressure for EMPA and VITO thin membranes. Red line: Reference value from Zirfon based reference membrane (ca 2)

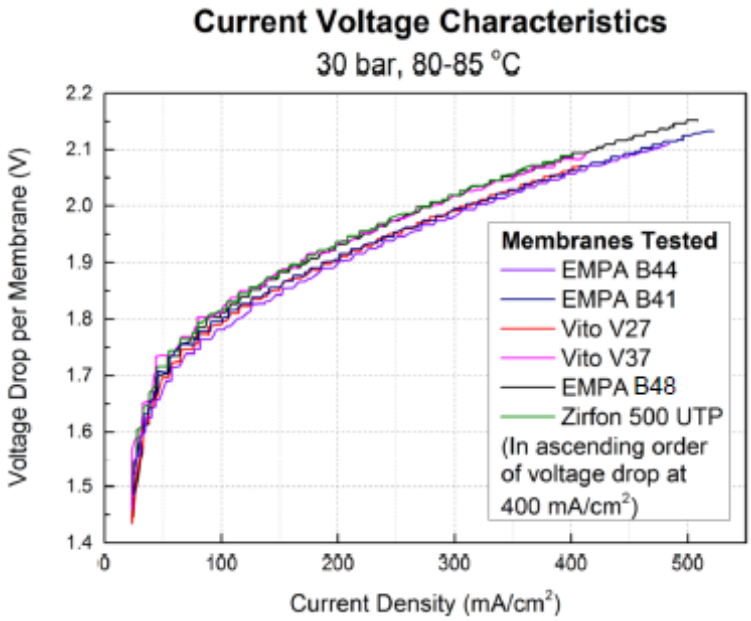

Figure 6: Comparison of voltage drop per cell for the selected thin specimens

Figure 7 Test bench electrolyser at EMPA - Voltiana

Balance of plant optimization

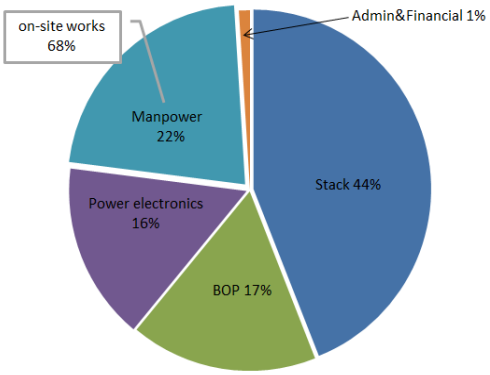

Figure 8: Cost breakdown for the reference 3.5 MW electrolyser [*IHT*]

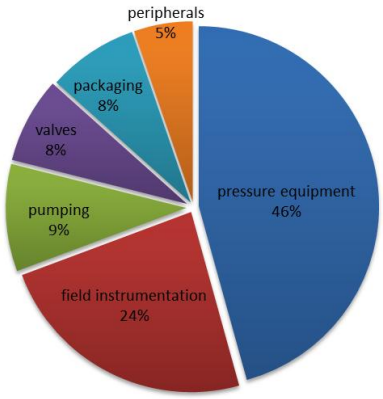

Figure 9: Cost BOP breakdown for the MW redesign [*FHA*]

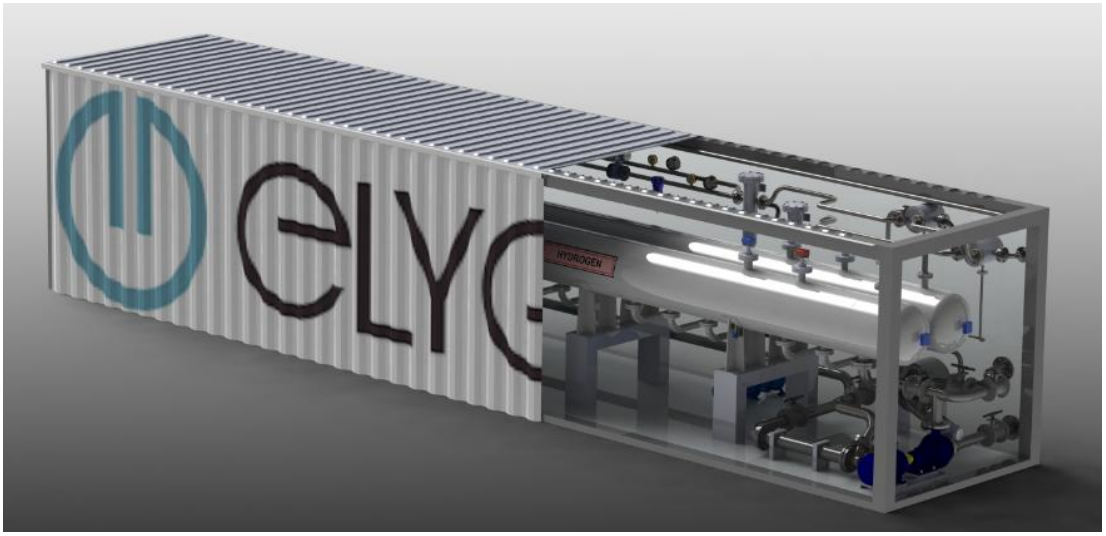

Figure 10. Final design. 3D view.

Improved control system

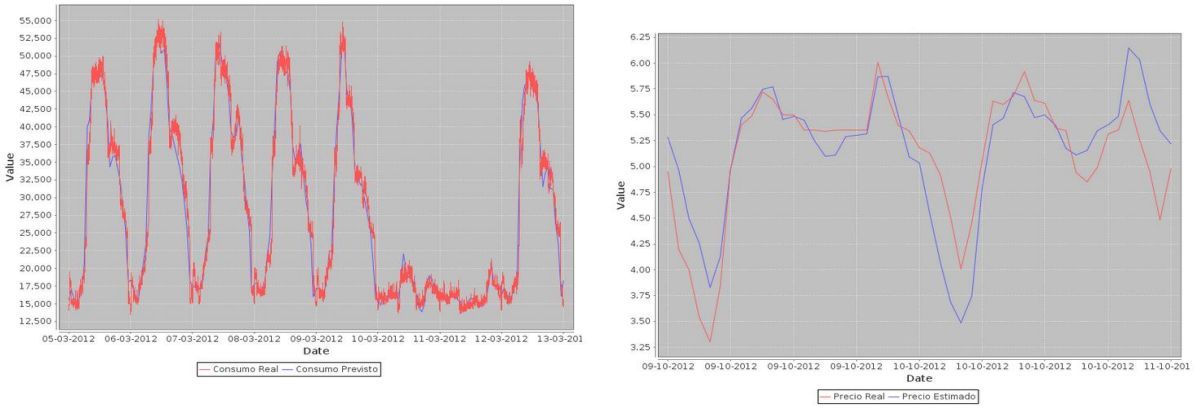

Figure 11. Consumption (left) and price forecasting (right) neural network (red=real, blue=forecast)

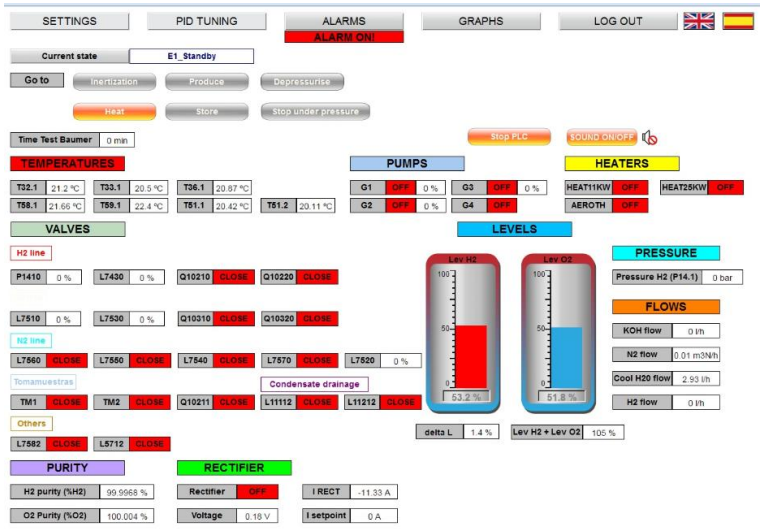

Figure 12. Main view web interface

System modeling and simulation integrated with RE

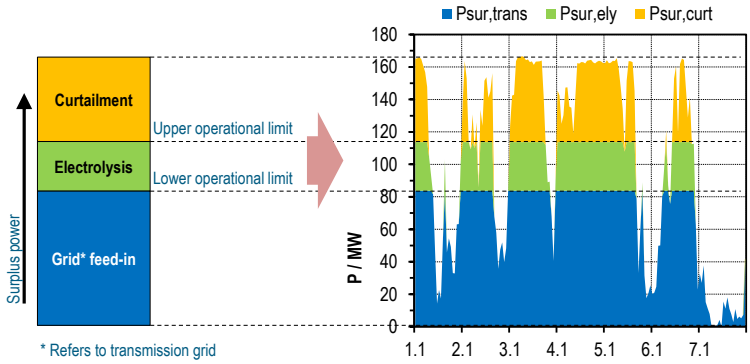

Figure 13: Utilization of surplus power. "Psur,trans": transferred to transmission grid; "Psur,ely": utilized for electrolysis; "Psur,curt": curtailed power.

Lower limit of electrolysis power*	H_2 production [t/a]	$E_{e,total}$ [GWh/a]	t_{H2prod} [h/a]	t_{off} [h/a]	η_{sys} [-]
5 %	1 104	57	5 934	1 015	65 %
10 %	998	52	5 358	1 411	64 %
25 %	766	40	4 106	2 452	65 %
50 %	541	28	2 904	3 369	64 %
75 %	362	19	1 953	4 585	64 %
* related to the maximum surplus powe					

Table 1. Results from scenario calculations

Field tests (1600 mm diameter stack)

Figure 14 Picture of the electrolyser of IHT at FHA facilities

Techno economic analysis

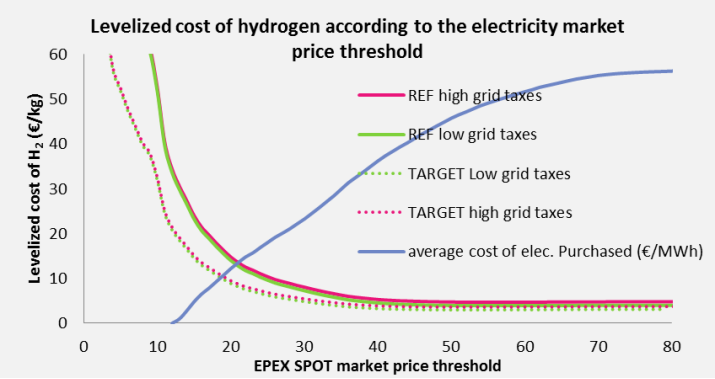

Figure 15. Cost of H2 according to electricity market

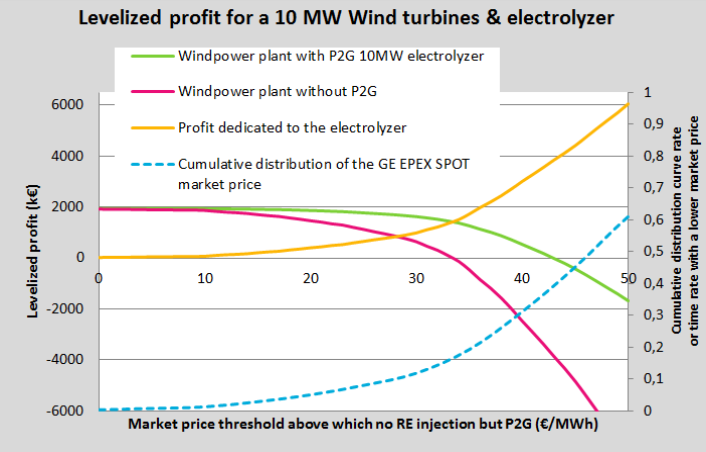

Figure 16. levelised profit. PtG scenario

Life Cycle Assessment

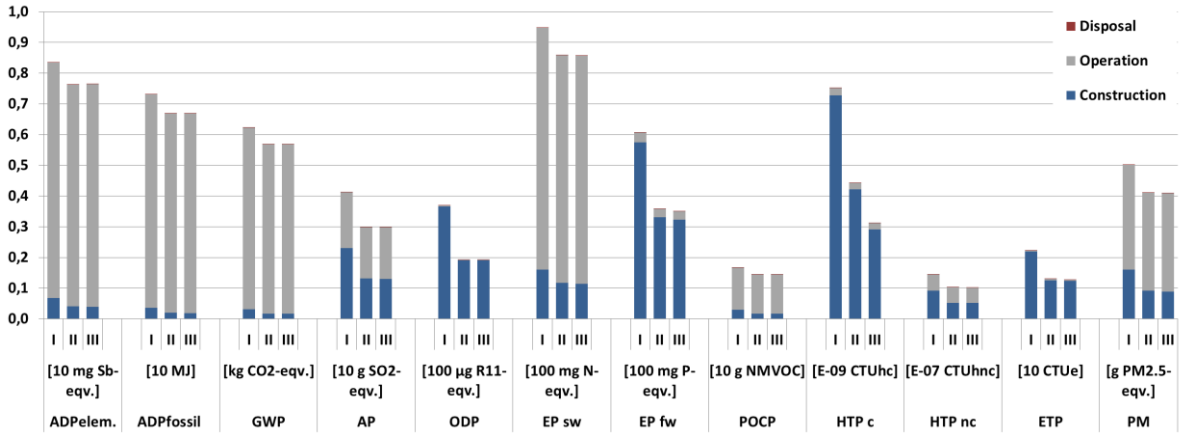

Figure 17 Environmental impacts of entire electrolysis systems and single life cycle stages per kg H2 produced – operation with wind power

Potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and the exploitation of results

Market applications		Time response	Energy ratings	Lifetime cycles	Size of units
Electric grid and system	System balancing	Minutes to second / millisecond	Seconds to Minutes	>> 100 000	>20 MW in the US > 2 MW in Europe
	Generation / Supply economic optimization	Minutes	Minutes to weeks Average: few hours	5 – 10 000	
	Grid investment optimization	Millisecond to Minutes	Minutes to hours	10 – 50 000	10 kW to 2 MW
Back-up / reliability	Micro-grids & Island systems	Millisecond to Seconds	Seconds to hours Average: hours	10 – 50 000	Up to 2 MW
	Energy management – Industrials	Minutes	Minutes to hours Average: hours	5 – 10 000	
Decentralized energy prod. & consumption	Sustainable / Smart city – Building level	Minutes	Minutes to hours	> 5000	10 to 100 kW
	Self-Consumption – Residential level	Seconds to Minutes	Hours	> 5000	
Transport Individual & Collective (incl. Infrastructure)	Public Transportation & Heavy Duty Vehicles	Minutes	Up to several hours 10 to 30 minutes	5 – 10 000	
	Individual Transportation	Seconds to Minutes	Several hours	>5 000	

Figure 18 Potential market applications

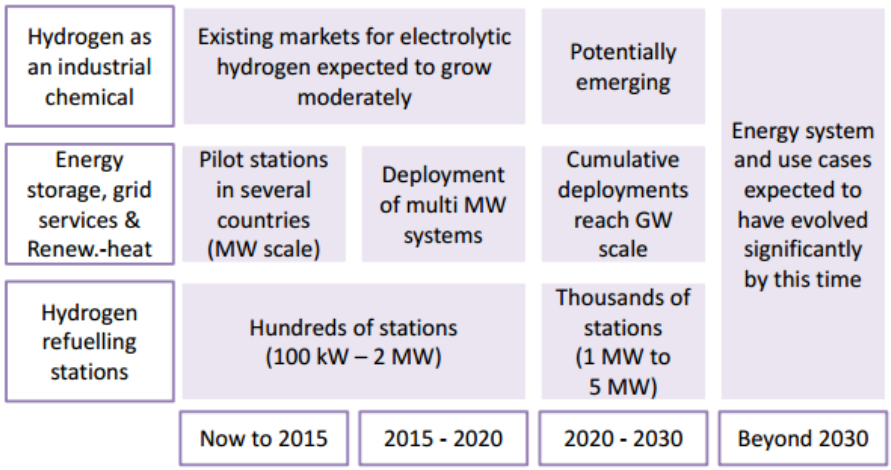

Figure 19. Changing role of electrolysis as reported by stakeholders

Number	Partner	Date	Mass Media	Type of Media	Scope	Summary
1	FHa	25/04/2012	Silo Breaker	Website	International	Elygrid project launches the website
2	FHa	25/04/2012	Fuel Cell Today	Website	International	Elygrid project launches the website
3	FHa	26/04/2012	Aragon_Hoy	Website	Regional	Elygrid project launches the website
4	FHa	26/04/2012	Aragon Liberal	Website	Regional	Elygrid project launches the website
5	FHa	26/04/2012	Energelia	Website	National	Elygrid project launches the website
6	FHa	26/04/2012	InfoPower	Website	International	Elygrid project launches the website
7	FHa	26/04/2012	HyER	Website	International	Elygrid project launches the website
8	FHa	02/05/2012	Fuel Cell Works	Website	International	Elygrid project launches the website
9	Inycom	18/10/2013	Inycom Innovation Technologies	Website	International	Fourth bi-annual tracking meeting of Elygrid Project
10	FHa	24/06/2014	Sustainable Energy Week	Website	International	Delivering the wider benefits of renewable energy into transport for cities and communities
11	FHa	25/06/2014	Low Carbon Vehicle Partnership	Website	International	Delivering the wider benefits of renewable energy into transport for cities and communities
13	FHa	16/12/2014	Expansion	Website	Nacional	Elygrid final event
14	FHa	16/12/2014	Aragon Hoy	Website	Regional	Elygrid final event
15	FHa	16/12/2014	Radio Huesca	Website	Regional	Elygrid final event
16	FHa	16/12/2014	Zaragoza Buenas Notici	Website	Regional	Elygrid final event
17	FHa	16/12/2014	El Periodico de Aragon	Website	Regional	Elygrid final event
18	FHa	16/12/2014	Europa Press	Website	Nacional	Elygrid final event
19	FHa	16/12/2014	Iberoamerica.net	Website	Internacional	Elygrid final event
20	FHa	16/12/2014	Elygrid.com	Website	Internacional	Elygrid final event

Table 2 List of appereances on mass media

Number	Date	Title	Organize	Venue	Summary	Attendants (Nº)
1	03/04/2014	Water Electrolysis Day	FCH JU, NOW GmbH	Brussels	The central objective of the workshop is to identify technology gaps of electrolysers and to define improvements needed for different water-electrolysis techniques in order to compete with other hydrogen production devices. The identification of the current status and future potential of electrolyser technology applications, such as wind-hydrogen-systems, is another important goal. To this end running, or recently completed, demonstration projects and studies funded by FCH JU and NOW are reported about and available findings are compared. ELYGRID project is presented during the workshop	80
2	15/12/2014	Stakeholder FHA meeting	FHA	Zaragoza	The Elygrid project will be presented to the general assembly of the FHA satakeholder governing board. This stakeholder is composed by more than 60 companies. Specifically, the following 9 companies have been indentified with potential interest in the technology developed in the Elygrid project: RWE Innogy Aersa, Wind Energy Association, Aragon Wind Energy Association, Endesa, Gamesa Energy, Enhol Group, Iberdrola Renewable, Taim Weser and Vestas Energy	50
3	16/12/2014	Meeting with RESelyser project	FHA	Brussels	The main objective of the meeting is to present the results of both projects and try to look for for potential further collaborations between the different partners. Especial further collaboration could be done in terms of electrode development between the technology developed in RESelyser project and the electrolyser manufacturer of Elygrid Consortium.The information provided in the meeting will be no confidential in order to follow the rules defined in the CA.	20

Table 3 List of Elygrid events

	Year				
	2012	2013	2014	TOTAL	%
Europe	3161	7594	8682	19437	29.7%
North America	3569	11174	12628	27371	41.8%
Asia	1937	7424	6328	15689	23.9%
South America	1937	352	204	2493	3.8%
Australia	18	195	93	306	0.5%
Africa	9	150	51	210	0.3%
TOTAL	10631	26889	27986	**65506**	

Table 4 Number of visits to Elygrid website