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



Grant agreement no.: 278824

Pictures final

publishable summary report

Status: **F** (D-Draft, FD-Final Draft, F-Final)

Dissemination level: PU (PU – Public, PP – Restricted to other programme participants, RE – Restricted to a group specified by the consortium, CO – Confidential)









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Date of this document:

22.01.2015





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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 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 | | | | | | | |

* 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



Figure 18 Potential market applications



Figure 19. Changing role of electrolysis as reported by stakeholders

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| 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 |
| | | , , . | Low Carbon Vehicle | | | Delivering the wider benefits of renewable energy into |
| 11 | FHa | 25/06/2014 | Partnership | Website | International | 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