Issues affecting pre deployment of proposed projects – cross cutting issues

Deliverable 2.1

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Preface

The aim of **GREEN HYSLAND** is to **deploy a Hydrogen ecosystem on the island of Mallorca**. The initiative is receiving **10 Million Euros of funding** from the European Commission through the **Clean Hydrogen Partnership**. It is a 5-year-project that started on the 1st January 2021, and will end on 31st December 2025. The consortium is formed by **30 partners from 11 countries**, 9 from the European Union, as well as Chile and Morocco. The project will deliver the **first hydrogen valley of the Mediterranean**, developing a fully functioning hydrogen (H_2) ecosystem covering all the value chain, from the production to the distribution and consumption of, at least, 330 tonnes per year of green H_2, traced through a Guarantee of Origin System. This hydrogen will be used in six different applications, as follows:

- The **H_2 pipeline and the injection point** of part of the H_2 produced at the Lloseta plant into the island's natural gas network operated by Redexis.
- The **100 kWe fuel cell** that will supply electricity to the maritime station of the **Balearic Port**.
- The **50 kWe CHP** system to be located in the **Iberostar Bahía de Palma hotel** (4*), which will cover part of the hotel's energy demand.
- The **25 kWe CHP** system to be located at the **Municipal Sports Centre in Lloseta**, which will cover part of the site's energy demand.
- The integration of **5 hydrogen buses to the EMT** city bus fleet of Palma de Mallorca.
- The integration of **H_2 vans** in the Alfill Logistics vehicle fleet as well as the search for rental car companies to incorporate H_2 vehicles in their **rental car fleets**.

The infrastructures which will be developed within the project are:

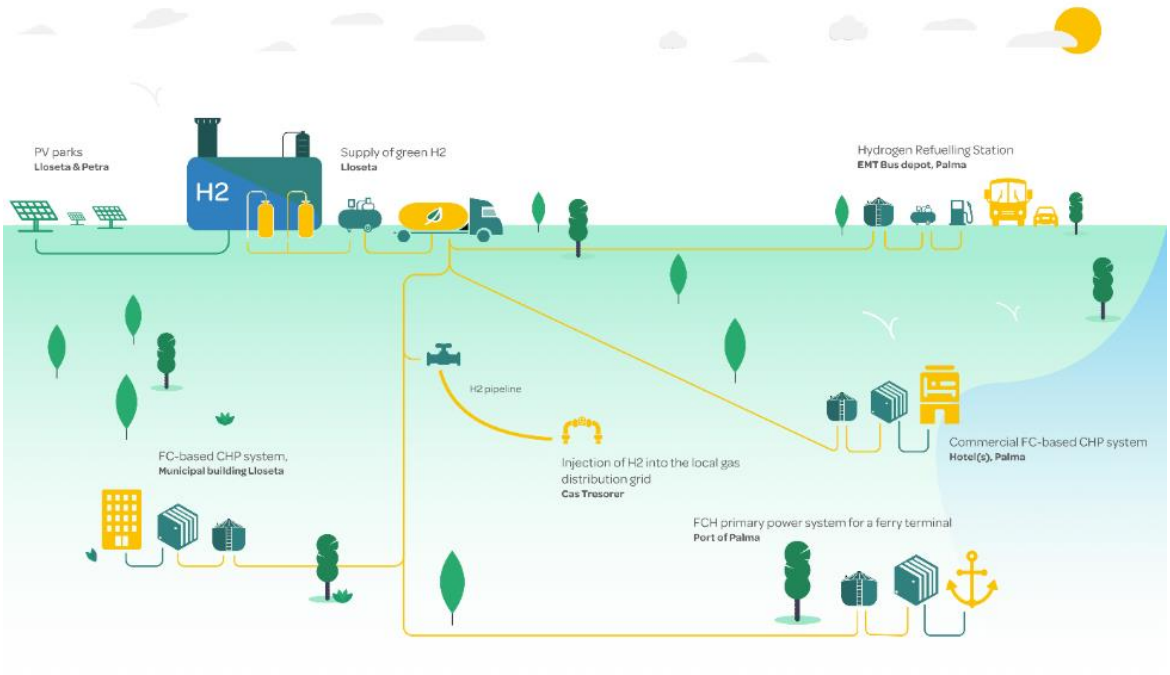
- The **green H_2 production plant** located on CEMEX land in Lloseta.
- The deployment of a **Hydrogen Refuelling Station** (HRS) at the EMT facilities.
- The development of tube trailers which will transport the H2 produced in Lloseta's plant to the different applications.

This initiative aims to reduce the CO_2 emissions of Mallorca up to 20,700 tonnes per year by the end of the project.

The project will also deliver **a roadmap towards 2050** that compiles a long-term vision for the **development of a widespread H_2 economy in Mallorca and the Balearic Region**, in line with the **environmental objectives set for 2050.** This long-term roadmap will be an evolution of the current regional roadmap for the deployment of renewable energies and the energy transition, and will involve local and regional stakeholders through public consultations.

In addition, GREEN HYSLAND contemplates the **development of replication experiences** in five other EU islands: Madeira (PT), Tenerife (ES), Aran (IE), Greek Islands and Ameland (NL) as well as Chile and Morocco. Within the project, the impact of deployment of H_2 technologies at regional level (Mallorca and Balearic islands) at technical, economic, energy, environmental, regulatory and socioeconomic levels will be analyzed. Additionally, detailed techno-economic studies for scaling-up renewable H_2 production, interconnecting infrastructure and local H_2 end-uses, both within the island of Mallorca and beyond, will be developed to facilitate and de-risk future sector investment.

The infrastructures for the hydrogen production and distribution, together with the end-users' pilot sites and the logistics required for the green hydrogen distribution will be developed as follows:



No	Participant Name	Short Name	Country Code	Logo
1	ENAGÁS S.A.	ENAGAS	ES	
2	ACCIONA ENERGIA S.A.	ACCIONA ENER	ES	
3	REDEXIS GAS S.A.	REDEXIS GAS SA	ES	
4	Empresa Municipal de Transports Urbans de Palma de Mallorca S.A.	EMT-PALMA	ES	
5	CALVERA MAQUINARIA E INSTALACIONES S.L.	CALVERA	ES	
6	AJUNTAMENT DE LLOSETA	Lloseta Council	ES	
7	AUTORIDAD PORTUARIA DE BALEARES	PORTS BALEARS	ES	
8	CONSULTORIA TECNICA NAVAL VALENCIANA S.L.	COTENAVAL	ES	
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20	FEDERATION EUROPEENNE DES AGENCES ET DES REGIONS POUR L'ENERGIE ET L'ENVIRONNEMENT	FEDARENE	BE	
21	NATIONAL UNIVERSITY OF IRELAND GALWAY	NUI GALWAY	IE	
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23	GASNAM - ASOCIACION IBERICA DE GASNATURAL Y RENOVABLE PARA LA MOVILIDAD	GASNAM	ES	
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25	ENERGY CO-OPERATIVES IRELAND LIMITED	En.Coop.Ireland	IE	
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27	GEMEENTE AMELAND	Gem.Ameland	NL	
28	DIKTYO AEIFORIKON NISON TOY AIGAIOU AE	DAFNI	EL	
29	ASOCIACION CHILENA DE HIDROGENO	H2 CHILE	CL	
30	Association Marocaine pour l'Hydrogène et le Développement Durable	AHMYD	MA	

Table of contents

Executive Summary

This document summarises the main issues identified regarding all the phases of GREEN HYSLAND: from pre-deployment to operation and replicability studies, including general risks that may affect the different activities involved.

Within the frame of this document, the reader is advised to note that the terms “issues” and “risks” are used interchangeably. Here, the term “risk” is taken to mean an issue that would cause the project to suffer a delay or some other circumstance that would have a negative impact.

There is a proposed mitigating measure for every risk identified in the analysis, both risks and corresponding mitigating measures have been reviewed by the Deployment Advisory Group members: Enercy, FHa, EMEC, HYE, HyCologne, NEC, Enagas, Calvera, Redexis, EMT Palma, Port Balear, LLoseta Council.

1. Introduction

An analysis has been developed to identify critical issues affecting the pre-deployment and deployment of proposed project assets of the three strands: green H2 supply, distribution and applications. In addition, general risks have also been considered, e.g. risks related to lack of financial resources, replicability, communication and dissemination tasks, etc.

Once critical issues have been identified, associated mitigation measures have been discussed with corresponding members. The analysis is divided in four different sections:

- Cross-cutting issues: general issues affecting all sites.
- Green H2 supply: issues related specifically to H2 production.
- Green H2 distribution: issues related specifically to H2 distribution.
- Green H2 applications: issues related specifically to H2 end-users.

This analysis has been led by Enagas, as WP2 leader, in collaboration with Deployment Advisory Group members: Enercy, FHa, EMEC, HYE, HyCologne, NEC, Enagas, Calvera, Redexis, EMT Palma, Port Balear, LLoseta Council.

Symbols and abbreviations

The following table provides an overview of abbreviations used in this document.

Abbreviation	Description
BoP	Balance of Plant
CA	Consortium Agreement

Abbreviation	Description
CHP	Combined Heat and Power
DAG	Deployment Advisory Group
FAT	Factory Acceptance Tests
FC	Fuel Cell
FCEB	Fuel Cell Electric Bus
GA	General Agreement
GHG	Greenhouse Gases
GOs	Guarantees of origin
HRS	Hydrogen Refuelling Station
IP	Intellectual property
IPR	Intellectual Property Rights
NG	Natural Gas
O&M	Operations and Maintenance
PV	Photovoltaics
SCRM	Supply chain risk management

2. Cross-cutting issues: general issues affecting all sites

Description of risk	Implications	WP	Probability	Impact	Mitigation measures
Current situation related to COVID-19 restrictions limits activities (e.g. subcontractors meetings, face-to-face meetings, travelling to the sites, etc).	Temporary interruption of project activities; Coordination amongst all participants can be affected, there might be delay in the decisions related to the location of the equipment, delivery, commissioning, etc.	2,3,4	High	High	- Site leaders to take into account potential delays in their provisional planning, especially for the tasks included in WP2, where COVID restrictions can have a higher impact. - Discuss with FCH JU whether they would accept a reduction of project deployment activity due to COVID restrictions. - If needed, a potential extension will be analysed. - Implications to be discussed individually with all deployment leaders and with the main partners involved on a case-by-case basis. Points for discussion: Site 1 / Lloseta-Cemex site: 1) Review schedule & status of prep for deployment of H2 trailer fill facility (site design, permitting and procurement of trailers). 2) Review with CALVERA schedule & status of prep for procurement of trailers. 3) Discussion with REDEXIS re status of preparations for deployment of H2 pipeline (see Site 3). 4) Status of engineering design and permitting for the electrolyser electrical infrastructure. Site 2 / Lloseta: 5) Discussion with LLOSETA re schedule & status of preparations for deployment of the CHP system (site selection & conceptual design, detailed engineering design, permitting). 6) Assess potential delay in procurement & deployment of fuel cell, storage and all BoP. Site 3 / Cas Tresorer: 7) Review with REDEXIS schedule & status of prep for deployment of H2/NG mixing & injection system (preliminary implementation study and design, site layout, permitting and procurement). 8) Discussion with REDEXIS re deployment of pipeline (preliminary implementation study, final layout, site design, permitting). Site 4 / Palma:

					9) Discussion required with REDEXIS re schedule & status of prep for deployment of FC CHP system at hotel/s in Palma, including electrical, gas and water infrastructure (site selection & preliminary design, utility connection study, detailed engineering design, permitting). 10) Assess potential delay in procurement & deployment of fuel cell, storage and all BoP. 11) Review with CALVERA links with H2 trailer supply Site 5 / Palma-EMT depot 12) Review schedule & status of prep for deployment of HRS (site selection & design, permitting and procurement). 13) Assess potential delay in procurement of all components. 14) Review with CALVERA links with H2 trailer supply. Site 6 / Port of Palma: 15) Discussion required with PB re schedule & status of prep for deployment of FC CHP system at the Port, including electrical, gas and water infrastructure (site selection & preliminary design, utility connection study, detailed engineering design, permitting) 16) Assess potential delay in procurement & deployment of fuel cell, storage and all BoP. 17) Review with CALVERA links with H2 trailer supply
Infrastructure and equipment deployment are independent in each location, losing the integrated approach	No integrated approach	2,3,4	Low	High	- The preparation and deployments are structured not as individual sites but to be grouped as clusters not only by location or use, but as set of interrelated activities. - Specific tasks for technical coordination of the deployment activities to ensure alignment and integration via DAG are included in the workplan (Tasks 2.1 and 3.1), in order to keep the alignment developed at project level during the execution of WP2 and WP3. - Ensure project governance & decision making structure is followed, particularly regarding WP2 and WP3 leader (i.e. Enagas) and the individual Task Deployment Leaders. - Ensure the business case and future roll-out will be also coordinated as a whole (specific tasks in WP5, WP6).
Unforeseen regulatory barriers which could restrict activities	Restrictions which prevent one or more planned activities	2	Medium	Medium	- A regulatory analysis will be undertaken in WP6 to identify any potential barriers or challenges which would restrict project activity. If barriers are identified, early engagement with regulators and authorities will be undertaken.

Lack of normative regarding the construction of new H2 infrastructure	Delays in construction, commissioning and operation of the H2 infrastructure (Plant, pipeline, injection installation and HRS)	2,3,4	High	High	- Continuous communication with regional government to define authorization procedure for the different infrastructures.
Overspent in the deployment phase	It could mean less financial resources for the project operation and maintenance phase	2,3,4	Medium	High	- Several options: use partners own resources, proper financial planning to avoid overspent, apply to additional funds (local, regional, national, EU, etc.).
Scada-based data & monitoring system unable to collect data from all the equipment (control systems not compatible)	Unable to monitor data from the different sites once operation begins	2,3,4	Medium	Medium	- Monitoring system specification shall take into account a detailed list of all the parameters per site that need to be monitored. - Tendering specifications of the equipment developed in WP2 shall meet requirements specified in the monitoring system.
Permitting: different time for obtaining operational permits per site could affect the development of subsequent tasks	Delays in construction, commissioning and operation of the equipment	2,3,4	Medium	Medium/ High	- Site leaders will be requested to try to progress as quickly as possible on related activities. DAG members can provide support to site leaders on the resolution of issues.

Safety Review of the sites takes longer than planned adding delay to installation or changes required to site	Delays in the execution and final commissioning of sites	2,3,4	Low	Medium	- To avoid delays all needed resources will be put in place in this task.
Incidents associated to the operation	Physical or chemical hazards could cause physical harm to personnel or equipment	4	Low	High	- Safety will be the first priority always in the project. A safety emergency protocol should be added so that people who will be operating the equipment on a day-to-day basis know how to act in case of an accident or hydrogen leak. - Plan emergency developed within the project activities to be implemented in all sites.
Tendering and purchasing: different time for the issue of the PO per site could affect the development of subsequent tasks	Delays in construction, commissioning and operation of the equipment	2,3,4	Medium	Medium/ High	- Site leaders will be requested to try to progress as quickly as possible on related activities. DAG members can provide support to site leaders on the resolution of issues. - Ensure regular tender monitoring activities are undertaken of the different equipment suppliers. - If delays occur, assess alternative 'short term' mitigation measures and how these are triggered. In particular, for the production plant: - Ensure close/regular interaction with PV Plant, to align with the deployment timescales of FCH applications in GREEN HYSLAND. - Consider deployment of alternative electrolyser capacity e.g. "splitting" projected capacity at Lloseta site or deploying additional capacity (contingency).

FCH applications, equipment and systems deployed in GREEN HYSLAND don't comply with technical specifications and requirements	Hydrogen and electricity/heat supply can be affected	3, 4	Medium	Medium	- To overcome technical barriers, measures will be taken from the design and specification steps, regarding delivery of engineering documents and designs in Task 3.1 and at task level (Tasks 3.2 to 3.4). (WP2 Lead to coordinate with Deployment Task Leaders). - Pre commissioning testing plans will be put in place in order to have the equipment tested before installation. WP3 also includes detailed commissioning planning and provision of commissioning and start up tests to detect as many potential failures and barriers before starting normal operation. - In WP4, task 4.2 will define the indicators that will be monitored during the cluster operation, in order to check periodically potential deviations from the expected behaviour and goals. - Maintenance contracts with providers and specific provisions regarding the fulfilment of specifications will be included in the tendering process on each deployment task (Tasks 2.2-2.4). - Factory Acceptance Tests (FAT) prior to delivery of equipment are also included in all deployment tasks (Tasks 3.2-3.4), to minimize the risks of non-compliance. - Include appropriate maintenance contracts and specific provisions regarding the fulfilment of specifications in the tendering process in Tasks 2.2 to 2.5. - Operationally audit each supply chain design to ensure sufficient operational capability. - WP3 also includes detailed commissioning planning and provision of commissioning and start up tests to detect as many potential failures and barriers before starting normal operation. - Clearly define in Task 2.1 all the indicators/parameters that will be monitored during the operation of each site, in order to check periodically potential deviations from the expected behaviour and goals. The overall goal is to ensure that all the systems and equipment delivered to the project comply with the main WP and project delivery requirements defined in WP2.
Failure on integration of electrolyser with delivery of H2, piping and connection to H2 storage (engineering integration and connectivity)	Interrupted supply of H2 to all end-user applications	3	Low	High	- Ensure adequate support during the procurement process. Integrate high-level knowledge from technical experts on electrolysers and their integration with storage and distribution of H2 (trailer loading/unloading facilities, storage, compression, piping and materials). - Integrate knowledge from other projects e.g. BIG HIT, HEAVENN. - De-couple heating and mobility applications and consider alternative H2 supply to end-user applications.

Failure in the maintenance of the equipment and H2 infrastructure	Hydrogen supply can be affected	4,7	Low	High	- Monitoring plan put in place in WP4 will be also oriented to detect and prevent failures in the FCH systems and infrastructure. - Tendering specifications in WP2 will include provisions on maintenance plans detailed by the equipment providers. - Training activities are also included in GREEN HYSLAND to be directed to end-users and local technicians both in Task 7.3 and on specific cluster subtasks in WP2. - Dedicated effort from project partners, with extensive knowledge not only in design but also in operation of H2 systems will be of key importance in the design of the training courses. - Ensure each infrastructure owner has sufficient local data to manage operation and maintenance activities. - Ensure support to WP4 leader for the implementation of the data monitoring system developed in Task 2.1, in order to detect and manage failures in all FCH systems, equipment and infrastructure. Coordinate with Task Deployment leaders. - Include appropriate maintenance contracts and specific provisions regarding the fulfilment of specifications in the tendering process in Tasks 2.2 to 2.5. - Ensure training activities are developed as part of WP7, in close cooperation with partners FHa and CNH2, project partners and all end-users (including local technicians and subcontractors where appropriate), both in Task 7.3 and on specific subtasks in WP2. For traning purposes, identify who will be the most in-demand workers in the hydrogen sector in the coming years. - Take into account exchange with local experts, universities and training centres as part of training activities in WP7 to ensure continuation of the training and education activities for the continued maintenance and future exploitation of the infrastructure developed in GREEN HYSLAND.
Lack of reliable primary data for the environmental impact assessment and techno-economic study	Delays in the preparation of the studies	5	Low	High	- The coordinator will monitor the progresses directly with the task leaders ahead of deliverable deadlines. If lack of reliable data is identified as an issue during the development of these studies, DAG can provide support both on technical issues and on coordination of the different parties involved.

Problems with the IPR management	-	1	Low	Medium	- The IPR issues will be established within the CA, which will be signed by all partners involved. IPR and Exploitation will be discussed at each exploitation methodology meeting and in the framework of WP5, WP6 to identify and exploit IP. - WP leaders as part of their responsibilities will be in charge of reviewing and to compile potential novelties and IP that could be generated in the framework of each WP.
Lack of financial resources from one partner	Partner cannot fulfil its commitments as per the GA	1	Low	Medium/ High (depending on the partner)	- The solvency of partners has been assessed. - All the partners have already participated in national and/or European projects, having a wide experience and background, which reduces this risk. Deployment activities and non-technical project activities are closely related to additional co-funding and national, regional funds to complete the financial resources. In case of every measure failing, each partner will use their own funding (if required) to achieve its part of the objectives.
Delays in deliverables	-	1	Medium	Low	- The coordinator will monitor the progresses directly with the task leaders ahead of deliverable deadlines. Project structure ensures that WP leaders are clearly responsible on deliver progress management, reviewing and approving deliverables. - A quality management plan will be delivered covering the review process, responsibilities and recommended schedule for the process.
Partner systematically does not fulfil its commitment	Breach of GA	1	Low	Medium/ High (depending on the partner)	- The coordinator will maintain close vigilance on failing partners, and in case of critical failures, an exclusion and replacement of the partner will be negotiated with the rest of the Consortium and the FCH JU, following the rules provided by the GA and the specific provisions of the Consortium Agreement.
Confidential information disclosed	Breach of GA	1	Low	Medium	- Confidentiality clauses and implications of breach are considered in the CA, signed by all parties. In case of breach, clauses in the agreement will be applied.

Replicability and future roll out are not possible as the cases in the region are too location-specific	-	6	Low	Medium	- Dedicated tasks to study replicability of the "valley concept" are included in the work plan, in task T6.2. - Impact of replicability has been assessed at proposal stage and a draft idea to widening replicability of the project and how to approach the study is already in place at the current project stage. - At consortium level, a significant number of followers are part of the GREEN HYSLAND consortium, to mitigate replicability issues or very regional-local oriented solutions to the GREEN HYSLAND concept (WP1).
Cases developed are not included in feasible business plans	-	5,7,6	Low	High	- WP5 will deal with the identification of the most attractive business cases, completing the business models that are provided in the proposal stage and in the actual roadmap for deployment of H2 technologies in the region. - The exploitation plan is put in place at proposal stage, together with its update in Task 7.2, to facilitate that business cases are aligned with stakeholders, with region interests, and with the findings and decisions on future roll-out (WP6).
Low interest in goals, results and progress of the project by stakeholders and general public	-	7	Low	Medium	- Comprehensive dissemination, awareness and communication plans are drafted at proposal stage. - In WP7 they will be updated to identify possible stakeholders to reach within the dissemination and communication plan. The information compiled will provide feedback regarding stakeholders and awareness situation in order to develop a successful exploitation, dissemination and communication of the project. - Awareness measures are included in the communication plan to engage partners, stakeholders and general public to generate the required interest on following, and get information from the project. - Local activities are also included in WP7 to assure that the local-regional public is fully invested in the deployment of the H2 ecosystem in the region. - To maximise project impact, especially at local or regional level, each partner can promote and contribute to communication and dissemination activities.

Certain activities included in the project are perceived as unsafe by general public	Delays, lack of acceptance of the technologies	7	Low	Low	- Communication plans to include comprehensive information on safety. Available information on this topic to be included in the dissemination actions (e.g. in the different surveys, webinars or workshops held during the project).
Narrow scope of dissemination action, project actions do not reach stakeholders	-	7	Low	Medium	- WP7 will deal with exploitation activities and align the WP5 business plans (to carry out market oriented exploitation and when decided, dissemination), and with the general communication activities, including all target publics and stakeholders. - Business plans and future roll out are specifically addressed in respective WPs (5/6) in the work plan to ensure that the dissemination and exploitation plan has the appropriate material to widen the impact of the project.

3. Green Hydrogen supply: issues affecting the H2 production plant

Description of risk	Implications	WP	Probability	Impact	Mitigation measures
Lack of information regarding the expected H2 consumption for each site could be a bottle neck for the design, construction and implementation of the H2 production plant	Integration of all the operations is not optimal and there could be problems in the operation	2,3,4	Medium	Medium	- Periodical meetings shall be organised between H2 production plant leader and each site leader. - DAG members can provide individual assessment on the issues that may arise on the interrelation of the H2 production plant and the rest of the sites, with special attention on the issues during the design phase.

Electrolyser system not able to operate according to specifications	Hydrogen supply can be affected	3,4	Medium	High	Ensure close/regular interaction with the "Power to Green Hydrogen Mallorca" project: - Have appropriate support to include high level of knowledge from engineers and technical experts on H2 electrolysis, their integration with the electrical and gas infrastructures and end-user applications (access support from GREEN HYSLAND partners as appropriate). - Include appropriate maintenance contracts and specific provisions regarding the fulfilment of specifications in the tendering process in Tasks 2.2 to 2.5. - Put in place pre-commissioning testing plans including FAT in order to have all equipment tested before installation and operating according to specifications. WP3 also includes detailed commissioning planning and provision of commissioning and start up tests to detect as many potential failures and barriers before starting normal operation. - Clearly define in Task 2.1 all the indicators/parameters that will be monitored during the project operation, in order to check periodically potential deviations from the expected behaviour and goals. - Closely monitor with deployment task leaders ACCIONA, CALVERA, REDEXIS the design and lay out to deliver appropriate integration of the ENAGAS electrolyser site with the electrical and gas infrastructure to be deployed. - Assess alternative 'short term' mitigation measures and how these are triggered. The overall goal is to ensure that the supply of hydrogen from Site 1 to all end-users is in accordance with the project delivery requirements defined in WP2. - Assess the possibility to include additional storage capacity in the plant.
Interconnection-system integration: Electrolyser not able to cope with connection to electricity grid-local PV farms-Renewable generation systems	Hydrogen supply can be affected	2,3,4	Medium	High	- From the engineering point of view, one of the main challenges and risks on deployment activities is regarding on final integration, connectivity of the subsystems. Tendering specification will be specifically designed to include high level of knowledge from engineers and technical experts on H2 electrolysis, piping, materials and on the details of connection to the electricity and gas grid to ensure that the systems provided are in compliance with the latter production, storage and delivery requirements (WP2). - Specific activities on each deployment task will follow design and lay out to provide detailed studies on connections specifications (Subtasks in 2.2 to 2.4).

H2 production is compromised due to problems in the critical components of the H2 plant (electrolyser, compressors).	Hydrogen supply can be affected	4	Medium	High	- Assess the possibility of introducing redundancy in the electrolyser and/or compressors. - Electrolyser: Assess with provider flexibility on the delivery.
Lack of PV production or PPAs in place to supply the electrolyser, which derives in producing less H2 than expected	Green Hydrogen supply can be affected	4	Low	Medium	- GREEN HYSLAND relies on providing the deployment applications with green H2, produced by electrolysis connected to PV. The PV farms are commercial – well proven systems, so no high failure ratios are expected in any of the PV generation sources. The sites are not located in areas with high expectations of climate catastrophic events. Furthermore, initial assessments have been carried out already to estimate the amount of PV resource and electrical output expected at the location of Lloseta. - Ensure that there is close engagement with ACCIONA and with the selected electrolyser manufacturer for the development of the electrical infrastructure design and upgrade provisions required to connect both electrolysis plants to the electrical PV infrastructure in Lloseta. - Ensure close engagement with ACCIONA (TBC) for the contractual arrangements required to deliver PV electricity output to the electrolyser. - Ensure close engagement with ACCIONA for the monitoring of GHG and GOs for H2 production (CertifHy Green compliant as per GA Task 4.3).
Water connection in the hydrogen production site not available, or failure in the demineralization unit	H2 production chain can be affected	2,3,4	Low	High	- Site leaders to identify a demi water provider that can solve the problem in a short period of time.

H2 production is compromised due to excess of salinity in the air affecting the electrolyser	Hydrogen supply can be affected	2,3,4	Low	High	- To be checked with the provider(s) of the H2 production plant.

4. Green Hydrogen distribution: issues affecting H2 distribution

Description of risk	Implications	WP	Probability	Impact	Mitigation measures
Delays in the deployment of the new H2 pipeline infrastructure	Interrupted supply of H2 to the local gas distribution grid	3,4	Medium	Medium	- Ensure close/regular interaction with REDEXIS and CALVERA, to align the hydrogen supply (site 1), trailer deployment and pipeline deployment timescales with the requirements of the gas grid injection at Cas Tresorer (Site 3). - Assess alternative 'short term' mitigation measures and how these are triggered i.e. the bringing forward, if possible, of the deployment/procurement of H2 mobile storage/trailers (to be discussed with CALVERA).
Delays in the deployment of the H2 trailer filling facility (and/or in the procurement of the trailers) at Lloseta	Interrupted supply of H2 to all end-user applications	3,4	Medium	Medium	- Ensure close/regular interaction with CALVERA (and other partners involved as appropriate) to align with the deployment of the trailer filling site and trailer procurement timescales with the requirements of the end-user applications at sites 2, 4, 5 and 6. - Assess alternative 'short term' mitigation measures and how these are triggered i.e. the bringing forward, if possible, of the deployment/procurement of H2 mobile storage/trailers (to be discussed with CALVERA).
Interconnection-system integration: delivery of H2, piping and connection to H2, natural gas pipelines and storage	Hydrogen supply can be affected	2,3,4	Medium	High	- From the engineering point of view, one of the main challenges and risks on deployment activities is regarding on final integration, connectivity of the subsystems. Tendering specification will be specifically designed to include high level of knowledge from engineers and technical experts on H2 electrolysis, piping, materials and on the details of connection to the electricity and gas grid to ensure that the systems provided are in compliance with the latter production, storage and delivery requirements (WP2). - Specific activities on each deployment task will follow design and lay out to provide detailed studies on connections specifications (Subtasks in 2.2 to 2.4).

A failure of the H2 supply chain will result in a lack of heating and electricity in the commercial-building applications	Hydrogen supply can be affected	3,4	Low	High	- Motives and causes for H2 supply chain will be analysed (SCRM process, supply chain risk management assessment) during engineering and coordination of deployment activities by means of Failure Tree analysis, to fully detect potential sources of shortage in the supply chain in the specific deployments to be carried out in the project. - Monitoring activities in WP4 will have dedicated sections to detect any deviations from the expected behaviour, goals, targets and supply key indicators. - On the commercial CHP deployments, a roll-out plan will be designed to foresee any previous testing and start-up process before the cold season starts. - Ensure there is clear allocation of tasks (and contractual arrangements in place) to ensure that the supply of H2 to heating & power applications in Lloseta and Palma is in place. - Develop a supply chain risk management (SCRM) assessment during engineering and coordination of project deployment activities (e.g. via by Failure Tree analysis). Include methods to fully detect potential sources of shortage in the supply chain in the specific deployments to be carried out at all sites. - Seek and facilitate support from external experienced O&M subcontractors/key stakeholders as appropriate. - Ensure activities in Tasks 4.1 and 4.2 include dedicated sections to detect any deviations from the expected behaviour, goals, targets and supply key indicators. - Ensure that the deployment plan at sites 2, 4 and 6 is designed to foresee any previous testing and start-up process before the cold season starts, and includes a back-up system in case of interruption of the H2 supply chain.
Failure in the H2 supply chain results in a lack of power at the FC deployment site at the Port	Hydrogen supply can be affected	3,4	Low	High	- Motives and causes for H2 supply chain will be analysed (SCRM process, supply chain risk management assessment) during engineering and coordination of deployment activities by means of Failure Tree analysis, to fully detect potential sources of shortage in the supply chain in the specific deployments to be carried out in the project. Monitoring activities in WP4 will have dedicated sections to detect any deviations from the expected behaviour, goals, targets and supply key indicators. - At the port, H2 will be gradually used in the process while the location (ferry terminal) remains grid-connected, to ensure that the electricity supply is not suddenly stopped due to unexpected shortage in gas supply. Back-up grid power supply will be maintained to avoid operation unplanned downtime.

Failure in the H2 supply chain induces a shortage in refuelling stations	Hydrogen supply can be affected	3, 4	Low	Medium	- Motives and causes for H2 supply chain will be analysed (SCRM process, supply chain risk management assessment) during engineering and coordination of deployment activities by means of Failure Tree analysis, to fully detect potential sources of shortage in the supply chain in the specific deployments to be carried out in the project. Monitoring activities in WP4 will have dedicated sections to detect any deviations from the expected behaviour, goals, targets and supply key indicators. - Bus and vehicle fleets in GREEN HYSLAND are sized to be progressively substituting current diesel/gas vehicles. Shortage in H2 supply will be overcome by daily updated logistics operations of the vehicles. - Determine how the EMT's mobility activities are supported by external project developments and current facilities. - Explore "redundancy of supply" and arrange for alternative delivery of H2 to the HRS at the EMT site. - Ensure there is clear allocation of tasks (and contractual arrangements in place) to determine whether the supply of H2 to the HRS is in place. - Develop a supply chain risk management (SCRM) assessment during engineering and coordination of project deployment activities (e.g. via by Failure Tree analysis). Include methods to fully detect potential sources of shortage in the supply chain in the specific deployments to be carried out at Site 5. - Align with task leader EMT to ensure that daily vehicle logistics/operations are arranged with the end-users in order to mitigate the implications of an interruption in H2 supply.

5. Green Hydrogen applications: issues affecting end-users

Description of risk	Implications	WP	Probability	Impact	Mitigation measures
Changes in the use of the site and therefore changes in the expected H2 consumption	H2 logistics might need to be adapted	2,3,4	Low	Medium	- DAG members can provide an assessment to try to reorganize the logistics of the H2 and give the go-ahead.
Shut Down of the Compressors within the HRS	No fuelling or only partly fuelling of the FC vehicles	4	High	High	- Redundancy within the compressor management will be assessed. - The operating hours indicated by the provider between each maintenance operation can be reduced to avoid potential problems that could arise (as compressors are not designed to operate non-continuously).
Break of membrane of the HRS compressors.	Oil is going to the HRS equipment and to the FC vehicles, affecting HRS equipment and maybe FC vehicles	4	Medium	High	- Redundancy of membrane within the compressors and right choice of the HRS compressors e.g. oil-free or with adequate oil management systems in case of incident, using diaphragms or oil seals. - Oil leakages detection system can be considered if necessary for compressors technology.
Failure in the Hydrogen Chain. No or less delivery of H2 to the HRS	No fuelling or only partly fuelling of the FC vehicles	4	Low	High	- H2 Logistics will need to be adapted in case of H2 shortage in the HRS. An increase of the storage capacity in the HRS will be assessed (e.g. 250 kg storage capacity which would be enough for 5 FCEBs).

The Data Collection and the interface to the FCEBs with the standard (SAEJ2799a) does not work	Lack of Data	4	Low	Low	- Technical Standards of interfaces and interconnections between HRS and FC vehicles will be defined before the start of the construction of the HRS. - Staff at the site will be provided with instructions how to handle technical difficulties regarding the interface and interconnection.
Quality measurement of the H2 for the fuelling and the safety of the FC vehicles does not work	No quality Control of H2	4	Low	Low	- Measurement methods for H2 to be defined in detail. - Sampling of the hydrogen supplied to be done at the nozzle (outlet of the dispenser) according to Annex K ISO/FDIS 19880-1. Additionally, regular test-samples at the buffer storage or other steps in the supply chain can be undertaken. To be checked with HRS supplier the inclusion of sampling points where H2 samples can be taken, as they could be helpful to determine the source of contamination.

6. Summary and conclusions

This document outlines some of the main issues that could be encountered while implementing the project, leading to delays or unsatisfactory performance.

Overall, the main cross-cutting issues have to deal with lack of applicable regulations for construction and permitting. At the time of this writing (end of year 2), we can indeed confirm that this has been a source of delays, since public officials charged with giving approvals for various steps of the project are not knowledgeable about hydrogen technologies. This typically leads to such officials being extra careful with providing the necessary permits and approvals, thereby translating into longer than expected time frames for obtaining the necessary paperwork. Regarding hydrogen supply, ensuring reliability of the main components is paramount. Mitigating this potential risk by carrying out due diligence on component providers and having clarity on technical specifications is key to project success.

On hydrogen distribution, one of the main challenges and risks on deployment activities is regarding on final integration and connectivity of the subsystems. Tendering specifications must be designed to minimise this risk.

Final applications again depend to a large degree on component reliability. The hydrogen sector has reported numerous instances of failure of certain key components such as compressors at the HRS. Redundancy may be considered as well as providing due diligence on component manufacturers.

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