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H2YDEA

Boosting the hydrogen transition in the Atlantic Area ports

Deliverable D 5.1.1

HYDEA case studies framework and modelling

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EXECUTIVE SUMMARY

The objective of this deliverable D5.1.1 HYDEA "*Case studies framework and modelling*", is to establish a common foundation for HYDEA partners to develop their case studies.

Being the main objective of the project to boost the hydrogen transition in the Atlantic Area ports, the project is tasked to develop a Decision Support Tool (DST) for hydrogen (H_2) applications in ports. This tool will ultimately support future decision-making and the evaluation of individual hydrogen technologies in different scenarios.

The DST will be developed using data and conclusions gathered from the technical, economic, environmental and societal assessment of different case studies in the Atlantic Area. Project HYDEA has outlined the case studies of interest for each of the ports in the project under the D.4.4.1 Opportunities of H_2 application in HYDEA ports. This deliverable sets a starting point for the selection process of case studies in WP5. As a result, each partner has settled for a case study, based on the partner´s expertise and the port of application's interest.

This framework aims to provide a standardized structure that ensures all critical topics are addressed in the case studies. Ultimately, the information gathered will feed the DST, hence the importance of consistency in their content. This framework is developed in agreement with the DST developer partner (University of Galway) to ensure that the visions are aligned.

The complete model of the case study is the following:

- Case study description
- Technical assessment
- Economical assessment
- Environmental assessment
- Social assessment

This document focuses on the first bullet point, the case study description, which is explained below in detail.

Even though this document outlines the framework for developing case studies, the specific content will have to be tailored to the case study itself. The reason for this is the wide-ranging nature of the case studies within the project. This ensures that relevant local factors, technological constraints, and economic feasibility are adequately considered.

While this methodology is created within the HYDEA project, it has a general applicability for future studies created outside the project.

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ABBREVIATIONS AND ACRONYMS

DST – Decision Support Tool

H_2 FC- Hydrogen fuel cell

NUI – National University of Ireland

H_2 - Hydrogen

1 Introduction

The HYDEA project aims at accelerating the deployment and integration of green hydrogen-based technologies with marine and other renewable energies in the Atlantic Area ports, with the ultimate goal of energy efficiency and contributing to a decarbonised energy economy. This change in direction proves pivotal, considering the maritime industry is a keystone for the worldwide logistics network.

Along the HYDEA project individual steps are taken to achieve the development of a Decision Support Tool (DST) that will aid in the decision-making process of introducing hydrogen-based technologies in ports of the Atlantic Area.

This methodology constitutes one of those steps. With the objective of evaluating, developing and promoting the use of hydrogen-based technologies, different case studies are assessed by the project partners. The results of this evaluation will feed the DST tool, helping in the logic of the tool when it comes to hydrogen-based technologies.

The proposed framework aims to establish a common methodology applicable to all individual case studies ensuring consistency and enabling the extraction of the relevant information for the DST.

Ultimately, the information gathered will feed the DST, hence the importance of consistency in their content. This framework is developed in agreement with the DST developer partner (University of Galway) to ensure that the visions are aligned.

Notice that the topics selected for each partner´s case study are based on the outcome of D.4.4.1 "*Opportunities of H_2 application in HYDEA ports*". This deliverable was an exercise to gather the interests and challenges experienced on the HYDEA partners facilities related to H_2 based technologies. The following table provides a summary of the key areas of interest identified in HYDEA ports:

PORTS	COUNTRY	PRODUCTION	DISTRIBUTION	MOBILITY	LOGISTICS	STORAGE
Vigo	Spain	●	●	●	●	●
Seville	Spain	●	●	●	●	●
Bilbao	Spain	●	●	●	●	●
Gijón	Spain	●	●	●	●	●
Leixões	Portugal	●	●	●	●	●
Viana do Castelo	Portugal			●	●	
Douro	Portugal			●	●	
Brest	France		●	●	●	●
Galway	Ireland		●	●	●	

Table 1 Summary of interests of the HYDEA partners

2 Case study development process

A brief procedure has been established in order to maintain uniformity in the development of the case studies within the project. Likewise, this procedure ensures consistency in the contribution to the development of the Decision Support Tool (DST), which is the primary objective of this work.
To begin with, the leading partner must prepare an overview/proposal of the case study. This overview should include a general description of the case study along with the key parameters intended to be analysed. This should be done on the early stages of the activity, before commencing the case study development and assessment. Bear in mind this is not a detailed case study, but a general overview. The purpose is to align expectations and ensure the case study effectively serves the DST.
This overview of the case study must be presented to the partner in charge of the development of the DST, the National University of Ireland (NUI), being the main contact for this Haresankar Jayasankar.
This meeting will be used to agree on the proposal for the case study. The leading partner and NUI will determine if any modifications to the initial proposal are required. This will ensure the framework remains relevant and contributes meaningfully to the DST.
Once the proposal has been agreed, the leading partner may proceed with the development of the case study. The details of the case study are covered from Section 3 onwards.

Below is a summary of the proposed procedure:

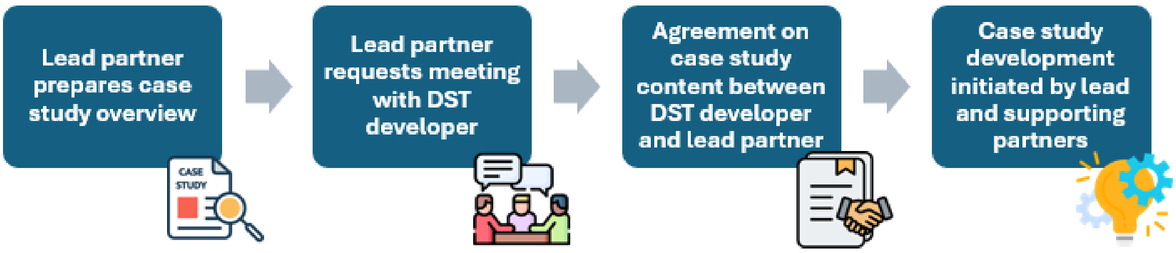

Figure 1 Procedure for case study development

3 Case study description model

This section presents a structured framework for developing the case study, focusing on the implementation of hydrogen-based (H_2) technologies in port environments, ensuring alignment with HYDEA's strategic objectives.

To begin with, it is crucial for the partner to understand the concepts of "use case" and "case study". A **use case** is a description of the ways in which a user interacts with a system or product. It typically establishes success scenarios, failure scenarios, and any critical variations or exceptions. The level of information provided in a use case is usually kept at a fairly high level, allowing the same use case to be applied in multiple scenarios.

On the other hand, a **case study** is a detailed and specific analysis of a situation, project, or application in a real or simulated environment, designed to understand the behavior and outcomes of a process or technology within a particular context.
It is important to note that "case study" and "use case" are different concepts. While they both relate to the implementation of technological solutions, they have different objectives and approaches. The difference between a "use case" and a "case study" lies in their focus: a use case is the strategy for building solutions; it's the idea of how something will work, while a case study is the embodiment of the solution.

In the context of the HYDEA project, the case studies primarily aim to assess the applicability and feasibility of hydrogen-based solutions in ports. The goal is to generate data that allows comparing the performance of these solutions against alternatives (fossil fuels, electricity or others), thus establishing a reference framework for the future adoption of these technologies in other ports or regions.

3.1 Location

Identify the location where the case study will be conducted, ensuring it aligns with HYDEA's focus on ports of the Atlantic Area (Ireland, Spain, France and Portugal). This should include a map and describe any singularities of the geography and climate of the place that may impact the deployment of hydrogen technologies. Each port's geographical and climatic conditions can influence hydrogen production, storage, and usage. Coastal weather patterns, temperature variations, and natural energy resources such as wind or solar availability will be considered to determine the viability of local hydrogen production. These environmental conditions are crucial in shaping each location's most suitable hydrogen strategies.

Provide a detailed description of the port: location and activity wise. Specifically, include relevant statistics on energy consumption, transportation activities regarding energy consumption, transportation activities, and overall port operations. This data will include annual energy demand, fuel mix, vessel traffic, and key logistical operations that could benefit from hydrogen solutions. Understanding the port's existing energy profile is essential to assessing the feasibility of hydrogen adoption and identifying opportunities for efficiency improvements.

- Identify the location of application of the case study, including maps and geographical features that may affect H_2 technologies deployment.
- Specify the port of application of the case study.
- Provide relevant statistics on energy usage, transportation activities, and any other significant operational details.

3.2 Partners

Each case study will have at least a leading partner responsible for overseeing the management and execution the development of the case study. In the case of having additional partners working on the case study, they will be considered supporting partners, whose role will be to contribute to certain sections of the case study, with the direction of the leading partner. The expertise of both the leading and supporting partners will be outlined in relation to the case study.

If external stakeholders are contacted during the development of the case study, they will be specified in this section too. These stakeholders may include other institutions like technology providers, government bodies or regulatory agencies amongst others.

- List the partners involved in the case study, specifying their roles (lead/supporting).
- Outline each partner's expertise in relation to the case study.
- Highlight any collaboration with external stakeholders.

3.3 Use cases that the case study covers

Select the most relevant use cases covered in the case study. The case study should focus on one or more of the following use cases:

USE CASES	DESCRIPTION
Import/Export of H_2, ammonia and methanol	Handling logistics, storage, transport and distribution for hydrogen-based products
H_2 storage, distribution and infrastructure: H_2 refuelling station	Development of storage and refuelling infrastructure for port operations
H_2 FC application for vehicles and equipment	Use of hydrogen fuel cells for port vehicles and equipment
Production of H_2 from marine and other renewable energies	Hydrogen production from renewable energy sources, such as offshore wind or solar power
Supply of alternative green fuels from H_2 (methanol, ammonia)	Production of green fuels (methanol, ammonia) from hydrogen for maritime decarbonization
Hydrogen based fuels for vessels	Use of hydrogen-based fuels (ammonia, methanol) for powering vessels.
H_2 based electrical power production for port consumption	Hydrogen used for electricity generation to meet port energy needs

Table 2. Most relevant use cases of the project.

3.4 Topic

This section will describe the topic addressed in the case study. This will comprise of an overview of the implementation of the H_2-based technology in the chosen scenario, a detailed description of the H_2 technology to be implemented, as well as a description and a comparison with the technology that is currently deployed for that activity.

It is expected to have an outline of the potential implications of adopting the H_2 technology alternative, for example: energy efficiency, emissions reduction, costs… It will also assess the motivation and feasibility of the transition to this new technology, expected benefits, operational changes in comparison to the currently used technology and the integration requirements.

- Detail the H_2-based technology to be implemented in the case study and the technology currently in use for the identified activity.
- Compare the H_2-based and current technology by describing the expected benefits, operational changes, and integration requirements of the hydrogen technology.
- Analyse the operational implications of both the current system and H_2-based technology.
- Provide an overview of the motivation/feasibility of transitioning to the H_2-based technology.
-

3.5 Objectives and scope

Identify the goals that the case aims to achieve by transitioning to a H_2-based technology. These goals may include reducing emissions, enhancing energy efficiency, improving economic feasibility of hydrogen adoption, scaling up the hydrogen infrastructure, amongst others. These goals should ideally be quantified in terms of expectations (the actual result might be obtained on the assessment of the case study).

In addition, identify the key elements that the study seeks to evaluate or enhance.

- Clearly define the goals of the case study.
- Describe the specific aspects the study aims to assess/improve.
- Explain how adopting hydrogen-based technology contributes to sustainability and technological progress.
- Provide some comparison indicators for the analysis between the 'reference case' (current technology) and the H_2-based case study (case study). Those indicators may include the following:
    - Techno-economic indicators
        - Annual volume of energy consumed/produced (depending on the case study) (ktH_2 vs tons of other fuel for example),
        - CAPEX/OPEX of the H2-based solution with regards to the reference case
        - LCOH when relevant
    - Social indicators
        - Employment (highly recommended indicator): Number of jobs needed to operate the H2-based solution compared to current jobs for the reference case technology
        - Qualitative effects on local residents (local jobs, health, pollution, safety)
        - Qualitative effects on workers (safety, logistics, new regulations, specific training)
    - Environmental indicators
        - Green House Gas emissions
        - Volume of water when relevant
    - To be completed with additional case-specific indicators

- If there is no reference case (e.g. new service that involves H2), then the indicators of the H2-based solution should still be provided, and the interest of the new service should be highlighted.

For example, consider a case study on H_2 refuelling stations in Dublin. The objective of this case study is to compare the cost and environmental impact for different end-use cases, such as H_2 trucks and buses, with conventional diesel-powered trucks and buses. It is essential to identify the parameters of the case study with proper justification. This case study will include parameters such as the region of consideration, electricity source for electrolysis, electrolyser size, H_2 storage type, refuelling station setup, H_2 transportation mode, demand and end users.

3.6 Case study implementation timeline (if applicable)

Provide a detailed timeline of the case study implementation, in line with the port's expectations and goals. This timeline should include each stage of the project, highlighting key milestones and expected dates for the completion of the project. The following phases are suggested:

- Feasibility Study: Initial research and data gathering.
- Design & Planning: Technical design and regulatory approvals.
- Implementation: Infrastructure development and deployment of H_2 technologies.
- Evaluation & Reporting: Performance monitoring and feedback analysis assessing the operational effectiveness of the deployed technology.

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