



Enhancing H₂ & CO Combustion Risk Management

Research and Innovation Action

NFRP-2019-2020

D6.2 - Website

WP6 - Task 6.1

Date [M6]

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 www.amhyco.eu

 @amhyco



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Abbreviations and Acronyms

Acronym	Description
WP	Work Package
SAMG	Severe Accident Management Guidelines
SA	Severe Accident
CMS	Content Management System
SEO	Search Engine Optimisation

Executive Summary

The AMHYCO public website was designed and developed to serve as a dynamic information and communication tool, as well as a platform for the project team. It acts as the main channel for news and updates with the aim to address the key questions that external visitors are expected to have, such as:

- what the project is about;
- what the project will deliver, and why;
- who the partners of the project are;
- where to find the latest news and events of the project;
- where to find more information on the topic or related topics.

The AMHYCO public website was officially launched in January 2021. It will be continuously updated and will evolve with the lifecycle of the project, according to the detailed communication and dissemination plan (D6.1) of the project.

Keywords

Nuclear, Combustion, SAMG, Safety, Risk Management, Website, Design, Communication, Dissemination.

1. Introduction

The AMHYCO public website (<http://amhyco.eu/>) was launched online in M4 (January 2021). The site was a joint collaboration between the communication task leader and coordinator, and then reviewed and approved by all partners. It was promoted on the AMHYCO social media and the partners were encouraged to share it with their networks.

The website will be the main point of information for the project for all audiences. Therefore it was designed, formatted and written with the aim of being as accessible as possible, while containing scientifically accurate information that will be important for research and industrial stakeholders. Moreover, it provides access to the private partner area for AMHYCO partners, allowing them to share documents and work in a collaborative way. The text was based on previously agreed material (the AMHYCO press release and the Grant Agreement) and some updated information was included meant to educate a wider audience.

The design is based on the visual identity created in M1 (October 2020) and described in D6.1 Dissemination & Communication Strategy & Plan. This gives the project a cohesive brand and aims to make the communication materials (including the website) attractive to external stakeholders and will help the project stand out amongst others.

2. AMHYCO Website

2.1. Homepage

The homepage is usually the first page seen by users, so it is important to have the logo and description of the project easily visible. A version of the project's tagline is shown over a photo of the Almaraz Nuclear Power Plant, so visitors quickly have an idea of what the project is about.

The Homepage features text describing the:

- project in general;
- project in numbers (12 partners, etc.);
- objectives;
- training and research initiatives.

Here users can also find the latest news and the logos of the consortium. Animations make the Homepage attractive and the icons help to quickly convey information about the project.

In the footer, users can find the funding acknowledgement, latest news and upcoming events, as well links to the project's LinkedIn page, newsletter, email and partner area.

AMHYCO ABOUT NUCLEAR SAFETY LATEST UPDATES RESOURCES

ENHANCING COMBUSTION RISK MANAGEMENT IN NUCLEAR POWER PLANTS

Alberto Nuclear Power Plant, Spain

In the event of a severe accident in a nuclear power plant, combustible gases can be released, leading to a potential explosion risk in the nuclear containment building. These gases, including **Hydrogen (H₂)** and **Carbon monoxide (CO)** need to be managed to avoid threatening the containment integrity, which can result in the release of radioactive material into the environment.

The **AMHYCO project** will improve experimental knowledge and simulation capabilities in an area that has not been explored sufficiently in previous EU and OECD projects: combustion risk management of hydrogen and carbon monoxide (H₂/CO) mixtures in severe accidents in nuclear power plants.

12 Partners
48 Months
7 Countries

THREE MAIN OBJECTIVES

- TO EXPERIMENTALLY INVESTIGATE PHENOMENA THAT ARE DIFFICULT TO PREDICT THEORETICALLY
- IMPROVE PREDICTABILITY OF NUMERICAL TOOLS USED FOR EXPLOSION HAZARD EVALUATION INSIDE THE REACTOR CONTAINMENT
- TO IMPROVE THE SEVERE ACCIDENT MANAGEMENT GUIDELINES

TRAINING AND RESEARCH

The project will host two technical workshops for industry partners, researchers and nuclear power plant owners and will support PhD student's research in related sectors.

TWO AMHYCO WORKSHOPS

A series of workshops and courses will be organised by the AMHYCO project to disseminate knowledge and train the industry partners and researchers in reducing combustion risk in severe accidents (SAs), including a one-day course for fundamental "H₂/CO safety for nuclear power plants".

DOCTORAL THESIS SUPPORT

Some of the research performed in the AMHYCO project will be performed by PhD students. The partners will help PhD students researching relevant areas by supporting their doctoral dissertations.

STUDENT MOBILITY

The project will also enhance student mobility and allow PhD students to perform research at another partner organisation to promote synergy between the organisations. This action will give the students the opportunity to research in different partner organisations for their own and work with multiple European experimental platforms.

LATEST NEWS

04 MAR: REPORT ON FUKUSHIMA DAIICHI 10 YEARS ON

12 MAR: AMHYCO STUDENT TUCK-OFF EVENT

14 DEC: AMHYCO IS FEATURED ON BNET Sustainable Nuclear Technology Platform

AMHYCO PARTNERS

LATEST POSTS

SAY HI AND FOLLOW US

PARTNER AREA

Access the project's internal platform (restricted to partners only)

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Figure 1. AMHYCO homepage



ENHANCING COMBUSTION RISK MANAGEMENT IN NUCLEAR POWER PLANTS



Almaraz Nuclear Power Plant, Spain

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Months



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02 – IMPROVE PREDICTABILITY OF NUMERICAL TOOLS USED FOR EXPLOSION HAZARD EVALUATION INSIDE THE REACTOR CONTAINMENT

03 – TO IMPROVE THE SEVERE ACCIDENT MANAGEMENT GUIDELINES



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Figure 2. Zoom-in of Homepage text

2.2. About

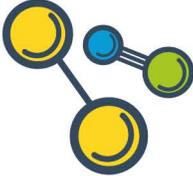
2.2.1. The AMHYCO Project

This page presents the project, its objectives, impacts and the context of how the idea for the AMHYCO project came to be.

ABOUT

Context

Severe accidents in nuclear power plants are costly (IRSN estimated the total cost of a Fukushima-scale accident in France to reach nearly €166 billion) and are potentially dangerous to both humans and the environment.



The AMHYCO project is here to help

The AMHYCO idea came from discussions held in another project: SAMHYCONET when some partners identified that there were some areas of safety that could be further investigated. The AMHYCO research teams will conduct experiments and simulations in order to best replicate realistic conditions of severe accidents (SAs) in order to respond to practical questions, such as the right timing and mode for actuation of containment safety systems (i.e., FCVS, sprays, fan coolers) regarding combustion risk management. Cutting-edge tools (i.e., LP, 3D and CFD codes), experimentation and the best use of engineering judgement will be combined to produce recommendations that accurately reflect those realistic SA scenarios.

The AMHYCO project idea and program have been supported by the NUGENIA Executive Committee, receiving the NUGENIA label, awarded to projects that show a high level of quality in their research proposal.



To prevent and/or reduce the impact of these accidents, nuclear power plants must have adequate accident management measures in place.

During a severe accident, combustible gases can be released, leading to a potential explosion risk in the nuclear containment building. These gases — including hydrogen and carbon monoxide — need to be managed to avoid threatening the containment integrity, which can result in the release of radioactive material into the environment.

AMHYCO has three main project objectives:

- 1 To experimentally investigate phenomena that are difficult to predict theoretically: H₂/CO combustion and PARs (Passive Autocatalytic Recombiners) behaviour under realistic accidental conditions, taking into account their interaction with safety systems.
- 2 To improve the predictability of analysis tools - Lumped Parameter (LP), 3D and Computational Fluid Dynamic (CFD) codes - used for explosion hazard evaluation inside the reactor containment and providing support to Severe Accident Management Guidelines (SAMGs) design and development.
- 3 To improve the Severe Accident Management Guidelines for both in vessel and ex-vessel phases with respect to combustible gases risk management, using theoretical, simulation and experimental results.



AMHYCO IMPACTS

<p>01 – IMPROVE THE UNDERSTANDING OF H₂/CO COMBUSTION THROUGH A DATABASE OF EXPERIMENTS</p>	<p>02 – STRENGTHEN THE QUALITY OF FUTURE EVALUATION AND DESIGN OF COMBUSTION MITIGATION SYSTEMS</p>	<p>03 – ENHANCE THE COMBUSTION RISK MANAGEMENT IN NUCLEAR POWER PLANTS</p>	<p>04- CONTRIBUTE TO LONG TERM OPERATION UPGRADES OF GEN II AND III REACTORS</p>
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Figure 3. About the project

2.2.2. AMHYCO Partners

Here users can find a list presenting the partners, linking back to their own websites and including a short description.

AMHYCO PARTNERS

The AMHYCO consortium consists of **12 organisations** from **6 European countries** and **one from Canada** and is led by the **Universidad Politécnica de Madrid (UPM)**.

The consortium consists of:



UNIVERSIDAD POLITÉCNICA DE MADRID

Coordinator
Universidad Politécnica de Madrid (UPM) is the largest Spanish technological university specialised in all engineering fields and architecture. The research group on Advanced Nuclear Fission Systems has large expertise in research projects both at national and international level. The intense collaboration with governmental bodies and industry guarantees that research at UPM offers real solutions to real-world problems.



CIEMAT

CIEMAT has been involved in several domestic and international projects within the field of nuclear safety. CIEMAT belongs to the Committee on the Safety of Nuclear Installations (CSNI), developing coordination activities in the Working Group on Analysis and Management of Accidents (WGAMA).



IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLEAIRE

IRSN groups together more than 1700 experts and researchers. IRSN carries out research, analysis and work in the fields of nuclear safety, protection against ionising rays, control and protection of nuclear materials and protection against acts of malevolence. IRSN plays an active role in providing information to the public within its fields of expertise: nuclear and radiological risks.



cnrs

The **CNRS** (National Centre for Scientific Research) is a government-funded research organisation under the administrative authority of French Ministry in charge of research. As the largest fundamental research organisation in Europe, CNRS is involved in all fields of knowledge. Interdisciplinary programs and actions offer a gateway into new domains of scientific investigation and enable CNRS to address the needs of society and industry.



JÜLICH
Forschungszentrum

Forschungszentrum Jülich (FZ) pursues cutting-edge interdisciplinary research on pressing issues facing society today. With its competence in materials science and simulation, and its expertise in physics, nanotechnology, and information technology, as well as in the biosciences and brain research, Jülich is developing the basis for the key technologies of tomorrow. In the area of nuclear safety research FZ investigates experimentally relevant Severe Accident (SA) containment phenomena and processes.



framatome

Framatome is a major international player in the nuclear energy market recognized for its innovative solutions and value-adding technologies for designing, building, maintaining, and advancing the global nuclear fleet. The company designs, manufactures, and installs components, fuel, and instrumentation and control systems for nuclear power plants and offers a full range of reactor services. Framatome helps its customers to improve the safety and performance of their nuclear plants and achieve their economic and societal goals.



RUB

The **Ruhr-Universität Bochum (RUB)** with its 20 faculties and more than 43,000 students from over 130 countries strongly encourages and facilitates inter-disciplinary research. The RUB's Plant Simulation and Safety Group (PSS) is involved in teaching at the Faculty of Mechanical Engineering with a focus on reactor physics and nuclear power plant technology.



Jozef Stefan Institute

The **Jozef Stefan Institute (JSI)** is an internationally highly regarded research institution in the fields of natural and technical sciences. JSI also acts as a Technical Safety Organisation for the Slovenian Nuclear Safety Administration, the Krško Nuclear Power Plant and the utility company GEN energija. As such, the Department of reactor engineering is involved in expertise and safety analyses, including topics related to severe accident management.



NRG

NRG is an internationally operating nuclear service provider. The mission of NRG is to respond to the social need for high-quality nuclear research and innovation, safe and reliable nuclear isotope production and services to organisations working with nuclear technology. NRG is a world market leader in the production of medical isotopes and operates the 45 MW High Flux Reactor (HFR) owned by the European Union.



ENERGORISK

ENERGORISK Ltd is a nuclear service oriented company, founded in 1992, which provides services on nuclear facilities safety analysis, risk assessment, design works and associated peer review activities. Energorisk, Ltd. was one of the first companies in Ukraine that obtained a license for safety-related engineering works for nuclear facilities. It is included in the list of recommended suppliers of the National nuclear operator, NNEGC "Energoatom". The company products are expert and consulting services; research and developments; design works; analytical and computational studies in the area of safety.



Canadian Nuclear Laboratories
Laboratoires Nucleaires Canadiens

Canadian Nuclear Laboratories (CNL) is Canada's premier nuclear science and technology organisation. CNL is a world leader in developing peaceful and innovative applications from nuclear technology through its expertise in physics, metallurgy, chemistry, biology and engineering. It delivers a range of nuclear services – ranging from research and development, design and engineering to specialised technology, waste management and decommissioning. Today, CNL continues its commitment to ensure that Canadians and the world receive energy, health, and environmental benefits from nuclear science and technology with confidence that nuclear safety and security are assured.



LGI
sustainable innovation

LGI Consulting is a European innovation-driven business consultancy founded in 2005. LGI has coordinated a number of European projects, and regularly leads work packages dealing with the company's areas of expertise such as innovation management, market, exploitation, economic analyses, technology assessment, and public engagement.

AMHYCO will also benefit from the worldwide experts in combustion science, accident management and nuclear safety in its Advisory Board.

Figure 4. AMHYCO Partners page

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2.2.3. Project Organisation

In order to allow the user to see the roadmap of the project activities, the work packages and their key tasks are described in order.



Figure 5. Project Organisation page

2.3. Nuclear Safety

A challenge of this project (and nuclear projects in general) is to raise awareness of the nuclear sector. A dedicated page shows how international guidelines and projects like AMHYCO are helping make nuclear facilities as safe as possible when a severe accident (SA) does take place. Since the project is focused on combustion during an SA this phenomenon is also described in the same page.

NUCLEAR SAFETY

According to the [International Energy Association](#), nuclear power plants can be a safe and clean source of energy, playing a role in the transition to low-carbon energy.

However this does not mean that accidents are impossible. When an accident does happen, there are many processes and guidelines that are followed to ensure that the people and surrounding areas are safe, i.e. that the danger is contained.

AMHYCO will contribute to this objective by improving the understanding of H₂/CO combustion and incorporating this knowledge into SAMGs.

SEVERE ACCIDENT MANAGEMENT GUIDELINES



Some of these guidelines that are in place to help ensure safety in nuclear plants are called the **Severe Accident Management Guidelines (SAMGs)**. These are a set of guidelines which provides recommendations to mitigate the consequences of beyond design basis accidents, including severe accidents. The SAMGs, which guide the reactor operators on how to handle the response of the nuclear power plant against severe accidents, are not set in stone and are in a living document that needs to be regularly updated and filled with knowledge gained from international efforts, including recent and ongoing research projects (you can read more about the EU's efforts on nuclear safety [here](#)).

AMHYCO will help to update the SAMGs, contributing the expertise and data generated during the lifetime of the project.

COMBUSTION IN SEVERE ACCIDENTS



During a severe accident, a large amount of hydrogen gas (H₂) can be produced from a process called "exothermal oxidation" of metallic components, e.g. fuel cladding or fuel assembly canisters, and released into the containment vessel.

If the core damage is not confined within the pressure vessel, further large releases of combustible gases will occur as a result of molten corium-concrete interaction (MCCI), where the melted core reacts with the concrete of the surrounding structure. The release of a gaseous mixture including carbon monoxide (CO), carbon dioxide (CO₂), H₂ and steam (H₂O) will depend on the materials present, such as metals which can react to form these compounds. If the gases are not diffused and are concentrated heavily in one area this can lead to a combustion or explosion risk.

AMHYCO is the first project to deal with H₂/H₂O/CO heterogeneous mixtures under realistic containment conditions. AMHYCO will explore that unknown region to improve nuclear safety.

Figure 6. Nuclear Safety page

2.4. Latest Updates

This section of the website will host the latest news and events related to AMHYCO. Here the user can see the latest news and events related to the project and the partners.

2.4.1. News

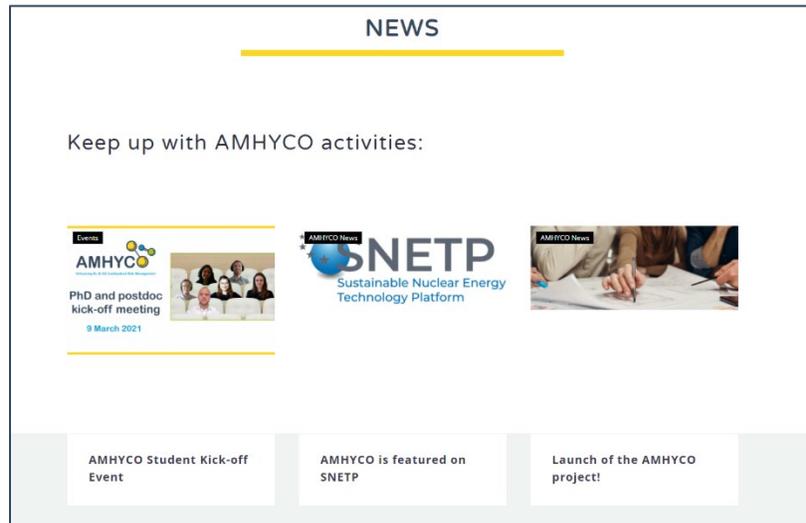


Figure 7. News page

2.4.2. Events Calendar

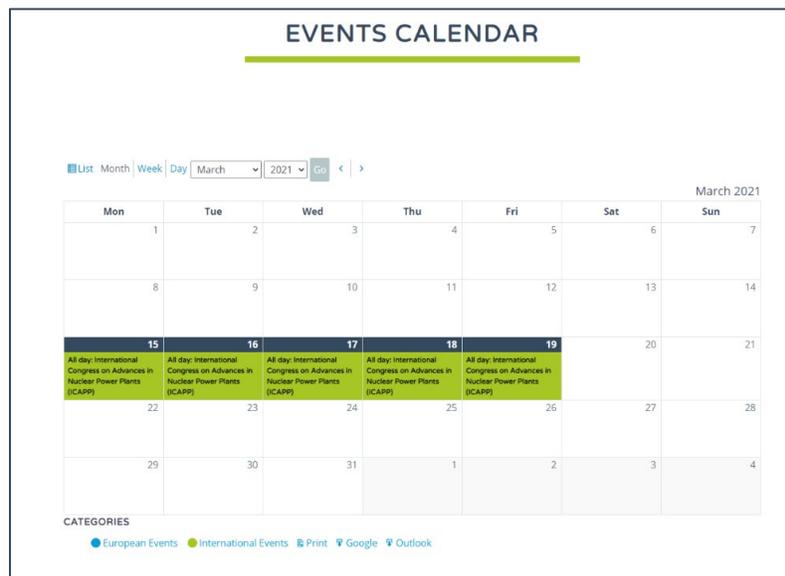


Figure 8. Events page

2.5. Resources

The Resources page will host public deliverables, promotional media (press releases, the poster, etc.), electronic newsletters and scientific publications created during the AMHYCO project.

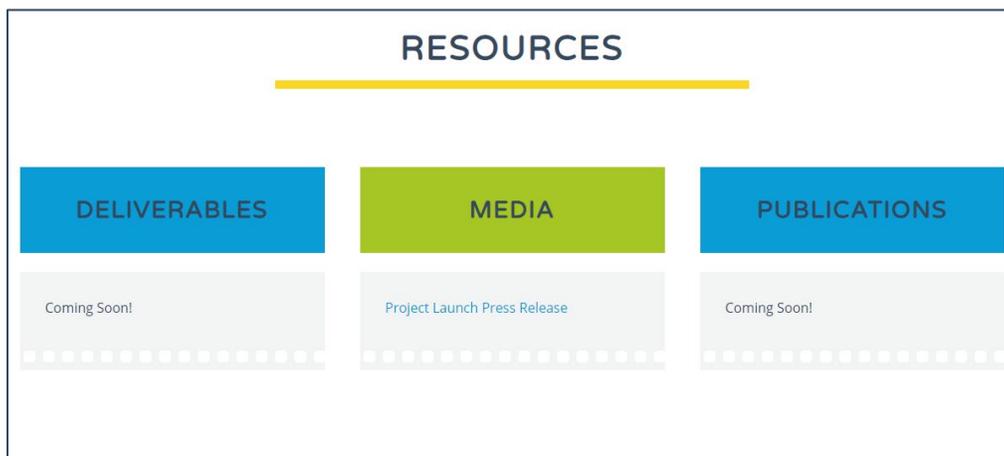


Figure 9. Resources page

3. Partner Area

An area of the website links to the "Partner Area" which is dedicated to the AMHYCO partners. This platform allows them to share documents and work in a collaborative way. It provides an online repository for information about the management of the project, contacts, results from the meetings, as well as internal work documents related to the different WPs, that are required to be shared. All documents and files are saved and organised in one place, and can be shared at any time, and from any location or device.

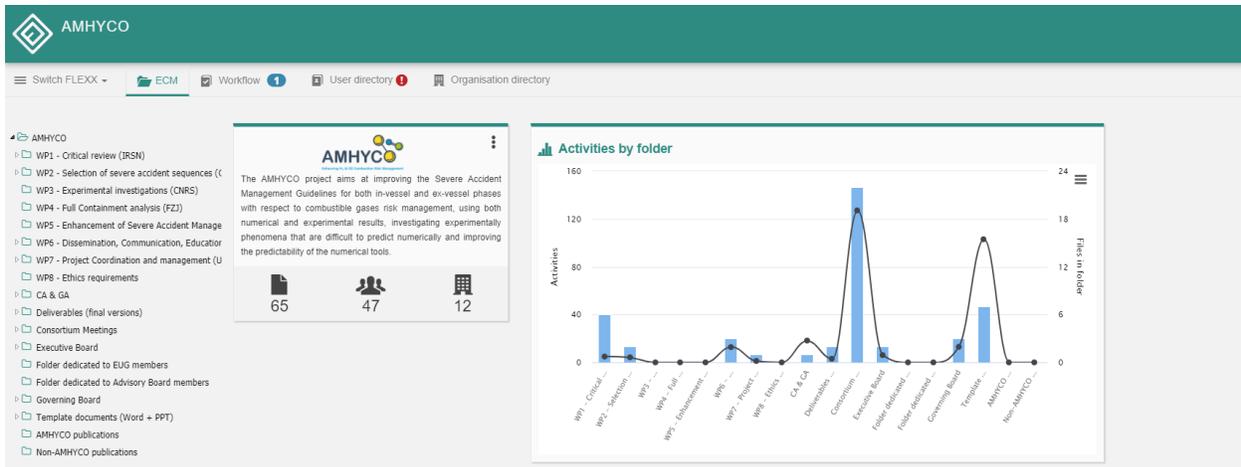


Figure 10. Partner Area homepage

4. Technical specifications

4.1. Responsiveness

Depending on the sources consulted¹, around 20-50% of website traffic comes from mobile devices. In order to make the site accessible to all devices, certain sections of pages were formatted to have a vertical layout for mobile, allowing the user to read the sections more easily on a smaller screen.



Figure 11. AMHYCO page view on computer screen (left) and mobile (right)

¹ <https://gs.statcounter.com/platform-market-share/desktop-mobile-tablet/europe>

4.2. Compatibility

The AMHYCO website is running on Wordpress CMS. The website is compatible with the common web browsers on all common operating systems. These include various versions of Internet Explorer, Firefox, Safari, and Chrome. Updates will be made on a regular basis so that it continues to adapt to the important milestones. This is to ensure that the website remains a dynamic and useful tool to promote and disseminate the knowledge acquired during the project.

4.3. SEO

Plugins are used to ensure that the website makes use of good SEO practices including using keywords, outbound links and metadata descriptions for each page.

4.4. Analytics

WebStat by IONOS is currently being used to analyse website statistics which will help monitor the traffic on the website. A banner informing the user that the website is collecting this information and with a button to accept is present when they visit the website.



Figure 12. Number of visitors in February 2021

5. Conclusions

The AMHYCO website has been prepared during the first stage of the project, and was launched in January 2021, according to specific needs and aims to maximise the impact of the project. It also aims to boost awareness of the results and milestones to be accomplished during the project's lifetime.

The AMHYCO website will be continuously updated, remaining a flexible tool with content and structure that may evolve if necessary.