
Hydrogen Valleys and their Importance for the Development of Innovation in Regions: An Empirical Research

Submitted 03/05/25, 1st revision 20/05/25, 2nd revision 11/06/25, accepted 30/06/25

Magdalena Kogut-Jaworska¹

Abstract:

Purpose: The green hydrogen innovation ecosystem in regions should include representatives of the quadruple helix – key stakeholders, government and local government administration, representatives of companies located in the region, and business environment institutions. The aim of this article is to analyse the current needs and decisions regarding the operation of hydrogen valleys in regions that are part of the innovation ecosystem, with particular emphasis on their importance in building economic potential.

Design/Methodology/Approach: The concept of hydrogen valleys has recently gained in importance and is increasingly supported by regions. The development of hydrogen technologies is now becoming a priority for both EU energy policy and national policies. Therefore, it seems interesting to present key issues related to the creation and functioning of hydrogen valleys, as well as to identify the potential benefits and challenges associated with their development. These issues were the subject of a survey conducted on a sample of energy sector companies involved in the creation and implementation of hydrogen technologies in Poland. The study used statistical analysis to identify and assess the significance of the determinants of the surveyed companies' activities in relation to the functioning of hydrogen valleys.

Findings: The study found that the approach to the hydrogen ecosystem, including the creation and operation of hydrogen valleys, is changing. The results indicate that hydrogen valleys are extremely important in the context of sectoral integration in the hydrogen-based economy, and through the process of entering the hydrogen technology market, they may begin to play an important role in the decarbonisation of the current energy system. This makes them one of the most important goals and challenges for the companies surveyed, which expect the development of regional H2 value chains and the integrated use of hydrogen technologies in various sectors and applications.

Practical Implications: The analysis and assessment of the importance of hydrogen valleys for companies operating in the energy sector indicates that there are many benefits, but also barriers that need to be overcome in relation to the development of hydrogen valleys and the further industrialisation of the sector. It is necessary to update the approach and improve the impact of the public sector on the technological potential of companies within regional economies. Hydrogen valleys can remain key players in creating grassroots acceptance of the transition to clean energy in regions, and can also become links supporting the development of regional economies, among other things by creating new jobs and through

¹University of Szczecin, Institute of Management, Poland, ORCID: 0000-0001-8812-374X, e-mail: [magdalena.kogut-jaworska@usz.edu.pl](mailto:magdalen.kogut-jaworska@usz.edu.pl);

cooperation aimed at exploiting synergies and providing products and services in regions.

Originality/Value: *The conclusions reached will enable new decisions to be made or existing ones to be revised in the direction of public support, which in turn should promote modern solutions stimulating the functioning and development of hydrogen valleys.*

Keywords: *Hydrogen Valleys, innovation, hydrogen technology, public support, public sector governance.*

JEL Code: *O31, L21, R11.*

Paper type: *Research article.*

Acknowledgement: *This research was co-financed by the Minister of Science under the "Regional Excellence Initiative.*



Ministerstwo Nauki
i Szkolnictwa Wyższego

1. Introduction

Recently, hydrogen and hydrogen technologies have been gaining in importance. Their development is now becoming a priority for both EU energy policy and national policies. They are becoming a key topic of discussion in the global energy transition away from fossil fuels in industrial processes, transport and the energy sector. The use of green hydrogen and the development of production, storage and distribution facilities depend on the functioning of an efficient system, including a legal framework, financing and promotion.

As the hydrogen economy is not yet sufficiently developed and the production of green hydrogen is very costly, the effectiveness of market development will be influenced by a variety of public measures and instruments related to financing, business environment institutions, and various forms of collaboration and cooperation. Undoubtedly, hydrogen valleys are becoming one of the basic tools for the development of the hydrogen economy at the regional level.

Currently, there is growing interest in hydrogen technologies in connection with policies to support innovation. Extensive research in this area has been presented by (Ortiz Cebolla and Navas, 2019). The paper indicates that economies are moving away from hydrocarbon-based energy, and hydrogen is an effective alternative for them, attracting the interest of policymakers who create innovation support policies. Similar observations can be found in the works of (Martínez de León *et al.*, 2025),

(Concas *et al.*, 2022) and (Petrolese *et al.*, 2022). It is also pointed out that the use of hydrogen technologies in modern economies is aimed at curbing the progressive greenhouse effect and is included in many strategic documents, including as one of the pillars of the European Green Deal (Green Deal), which aims to make Europe climate neutral by 2050.

It should be emphasised that the EU Hydrogen Strategy developed by the European Commission in 2020 (*Strategia w zakresie wodoru na rzecz Europy neutralnej dla klimatu*, 2020) considers the development of renewable, green hydrogen, produced by electrolysis using renewable energy sources, to be a priority (Ortiz Cebolla and Navas, 2019).

With the growing interest in hydrogen technologies, the concept of hydrogen valleys, which is supported by regions, is gaining importance. In this context, it seems interesting to present key issues related to the creation and functioning of hydrogen valleys, as well as to identify the potential benefits and challenges associated with their development.

The aim of the work was to analyse the current needs and decisions regarding the operation of hydrogen valleys in regions that are part of the innovation ecosystem, with particular emphasis on their importance in building economic potential.

The research tasks were therefore focused on issues related to the benefits, but also the barriers that need to be overcome in connection with the development of hydrogen valleys and the further industrialisation of the hydrogen industry. The analysis was conducted to assess the importance of hydrogen valleys for companies operating in the energy sector.

The rationale for this choice of research objectives and tasks was the need to update the approach and introduce improvements in the public sector's impact on the technological potential of companies within regional economies. The study assumed that hydrogen valleys could remain key players in creating grassroots acceptance of the transition to clean energy in the regions, and could also become links supporting the development of regional economies, among other things by creating new jobs and through cooperation exploiting synergies.

The survey was conducted on a sample of companies from the energy sector involved in the development and implementation of hydrogen technologies in Poland, and its scope was broader than the issues presented in this paper.

The aim of the entire research project was to collect and present data on the effectiveness of innovation management based on energy sources and hydrogen technologies within the framework of regional innovation strategies (RIS3). The study was a continuation of earlier research on the verification of public policy tools implemented in the context of entrepreneurs' needs (this issue is described in: Kogut-

Jaworska and Ociepa-Kicińska, 2023a; 2023b) and the current challenges of innovation development in the regions. The study used statistical analysis to identify and assess the significance of the determinants of the surveyed enterprises' activities in relation to the functioning of hydrogen valleys.

2. Literature Review

In the context of European regulations, including the European Union's Hydrogen Strategy, which points to the use of hydrogen as a means of achieving climate neutrality, hydrogen valleys are regional ecosystems that develop based on local hydrogen production transported over short distances, relying on decentralised energy production from renewable sources and local demand.

In this respect, hydrogen valleys are to become part of a full-scale European hydrogen ecosystem (Strategia w zakresie wodoru na rzecz Europy neutralnej dla klimatu, 2020). Polish regulations, in particular the Polish Hydrogen Strategy, define hydrogen valleys as ecosystems that enable the creation of a value chain related to the hydrogen economy, such as production, transport, storage and end use of hydrogen in industry.

Hydrogen valleys in Poland are to be part of the Polish hydrogen valley innovation ecosystem, which includes innovative industrial ventures and large-scale, long-term investment projects implemented within a specific geographical area. The activities of hydrogen valleys are to be based on projects that are selectively and purposefully chosen and coordinated in terms of innovation, technology, infrastructure, industry and nature (Polska Strategia Wodorowa Do Roku 2030 z perspektywą do roku 2040, 2021).

The creation and subsequent operation of hydrogen valleys should be coordinated at national level and consistent with the objectives of the international hydrogen economy, implemented, among others, within the European hydrogen system.

Hydrogen valleys are designed to integrate sectors within the hydrogen economy, optimise costs and benefits in the implementation of the energy and climate transition, and create infrastructure connecting as many links in the value chain as possible, with a particular emphasis on the development of the R&D&I segment.

Within the hydrogen valley ecosystem, R&D&I and investment projects are to be implemented that will contribute to cooperation between stakeholders at regional, national and international level, which will ultimately enable the exchange of information and experience between participants in the hydrogen valleys. A coordinated and integrated ecosystem of connections should enable the hydrogen industry to achieve critical mass in terms of technology, knowledge, research capital and experience.

A hydrogen valley is a geographical area and, in this sense, can be a city, region or, for example, an industrial area where hydrogen is embedded in the so-called supply chain from production, storage and distribution to its use, which in this context affects the competitiveness of a given specific area (Bałamut and Modrzewski, 2022).

Connecting individual projects and developing local hydrogen infrastructure is an important step in the long-term development of the hydrogen economy. Hydrogen valleys are also extremely important for demonstrating to decision-makers and the public the unique value that hydrogen offers in the broader context of the energy system (Go Global Group, 2021). Hydrogen valleys have five common characteristics (Krasuski, 2022) (Ficco *et al.*, 2022):

- large scale of the project, going beyond standard pilot and demonstration activities, which involves a significant budget and many projects forming the so-called ‘hydrogen valley portfolio’,
- a specific geographical area as a hydrogen ecosystem covering specific activities at local, regional, national or international level,
- a broad value chain: the geographical area of the hydrogen valley should include shared infrastructure for hydrogen production, storage and distribution by various means of transport,
- supply of hydrogen to various end-use sectors: hydrogen valleys should promote the interdisciplinary application of hydrogen by supplying it to multiple industries (energy, transport) in a specific geographical region using shared infrastructure. Hydrogen offers the possibility of large-scale decarbonisation of end-use energy applications.

In order to accelerate the development of the new hydrogen economy, i.e. the use of clean hydrogen to decarbonise heavy industry, long-distance and heavy transport, and energy, policies and regulations supporting this process have begun to be implemented. In addition to such “top-down” measures, it has become necessary to implement specific projects that will create a new hydrogen market “from the bottom up”. In this context, increasing emphasis is being placed on regionally integrated hydrogen ecosystems, known as hydrogen centres, hydrogen clusters or “hydrogen valleys” (Weichenhain *et al.*, 2021; Roddy, 2005; Weichenhain, 2021).

The involvement of government administration, local authorities, scientific institutions and many companies demonstrates the high level of interest in hydrogen technologies and the large scale of projects carried out in this area. Building a strong ecosystem of hydrogen valleys can stimulate the economy, increase the number of jobs, reduce environmental pollution, positively influence the development of science and innovative technologies, and contribute to improving the standard of living of the entire society (Krasuski, 2022). The hydrogen valley is based on established value chain archetypes, in which different objectives provide a short-

term business case. The three classic configurations observed are as follows: (Frankowska and Cheba, 2023):

- local, small-scale projects focused on mobility,
- local, medium-scale projects focused on industry,
- large-scale projects focused on international exports.

Recently, there has been a noticeable increase in the link between entrepreneurship support policies and hydrogen technologies. This view is shared by, among others, (Ortiz Cebolla and Navas, 2019; Martínez de León *et al.*, 2025; Li and Zheng, 2024; Concas *et al.*, 2022) arguing that economies are moving away from hydrocarbon-based energy and that hydrogen is an effective alternative for them, which is of interest to policymakers creating innovation support policies.

Furthermore, the use of hydrogen technologies in modern economies, mainly in the energy and transport sectors, is aimed at halting the progressive greenhouse effect and is included in many strategic documents (among others, it forms one of the pillars of the European Green Deal; Green Deal; Ale and Bade Shrestha, 2009).

Hydrogen valleys have become a global concept, with new integrated projects emerging around the world. Although they continue to dominate traditional leading hydrogen markets (Europe, Asia, North America), more and more projects are emerging on all continents. (Frankowska and Cheba, 2023; Aditiya and Aziz, 2021), including increasingly often in Poland.

3. Research Methodology

Issues related to the creation and functioning of hydrogen valleys, as well as the identification of potential benefits and challenges associated with their development, were the subject of a survey conducted on a sample of energy sector companies involved in the creation or implementation of hydrogen technologies. The study used statistical analysis to identify and assess the significance of the determinants of the surveyed companies' operations.

The survey was conducted using the CATI survey technique (Computer-Assisted Telephone Interview) and CAWI (Computer-Assisted Web Interview). The questionnaire, which was also pre-tested, consisted of a total of 12 closed and semi-open questions, which were either single or multiple choice. The study used a Likert scale to measure information conveyed by extreme values (e.g., on a scale of 1 to 5, 1 means 'no challenge' and 5 means 'very big challenge').

The survey was conducted using a random quota sampling method, and the database developed for the survey contained 200 records. During the survey, the database was expanded by 50 records in order to achieve the desired number of respondents, i.e., n=150 business entities representing the energy sector (according to PKD). The

sample distribution reflected the distribution of the general population, i.e. energy sector companies in Poland, and data from the Kompas International and Business Navigator databases were used to determine the research sample. This provided a basis for generalising the results to the entire population.

Descriptive statistics summarised the characteristics of the data. For numerical variables, they included: central tendency and measures of location. The median (Mdn) was reported as a measure of central tendency that was resistant to outliers and skewed distributions. The first (Q1) and third (Q3) quartiles were presented to describe the spread of the data and identify the central 50% of values.

4. Research Results and Discussion

The study provided information on the development of regional hydrogen infrastructure. The assessment of public support for stimulating innovation in hydrogen technology companies is a multi-faceted issue and may be the subject of extensive decision-making analyses. The study focused on key aspects, including the role and importance of integration and cooperation between different entities for the development or use of hydrogen technologies. In addition, the study provided information on interest in activities within the hydrogen valley and an assessment of the benefits that hydrogen valleys bring or may bring to the companies surveyed.

The green hydrogen innovation ecosystem in the regions is designed to include representatives of the quadruple helix – key stakeholders, government and local government administration, representatives of companies located in the region and business environment institutions. The research shows that clusters play the most important role among the preferred forms of cooperation (Table 1).

They were rated by the surveyed companies as quite important (median 4.00), with a wide range of responses (from 2.00 to 5.00). This suggests that, depending on the specific nature of the company's activities, their impact may vary, but is generally positive. It should be emphasised that it is precisely the form of clusters or associations that is most often used in the functioning of hydrogen valleys.

Business incubators, on the other hand, were rated as less important (median 2.00), which may indicate that companies do not perceive them as a key factor in the development of hydrogen technologies.

The importance of development agencies in stimulating the potential of hydrogen technologies is rated as average (median 3.00), which indicates their moderate importance for the development of energy companies. The role of research centres in cooperation and sectoral integration in the hydrogen-based economy is perceived as moderately important (median 3.00), although the range of responses indicates differences in the perception of their impact. This may indicate that the respondents had limited awareness of their potential.

Table 1. *Assessment of the importance of business environment institutions for the company's operations (answer on a scale of 1 to 5, where 1 means 'completely irrelevant' and 5 means 'very important')*

Characteristics	N	Overall sample ¹
Clusters	150	4.00 (2.00, 5.00)
Business incubators	150	2.00 (2.00, 3.75)
Development agencies	150	3.00 (2.00, 3.00)
Research centres	150	3.00 (2.00, 4.00)
Higher education institutions	150	2.00 (1.00, 3.00)
Technology, industrial and technology-industrial parks	150	3.00 (2.00, 4.00)
Loan and guarantee funds	150	2.00 (1.00, 3.00)
Total score for the above questions	150	19.50 (17.25, 22.00)
¹ Mdn (Q1, Q3)		

Source: *Own study based on conducted research.*

Universities were rated at a similar level to incubators (median 2.00), which may mean that their potential to support innovation and technology, particularly in the field of hydrogen, is not being fully exploited by businesses. Technology parks are perceived as moderately important (median 3.00), with potential significance for certain segments of the hydrogen and energy business.

Furthermore, loan and guarantee funds were rated similarly to incubators (median 2.00), which in turn indicates that their role in the development of hydrogen technologies is not seen as a priority by the surveyed companies.

The results indicate that there is significant variation in the perception of the role of business environment institutions in the context of sectoral integration in the hydrogen-based economy among the surveyed companies. This may suggest a need to adapt cooperation strategies to the individual needs of companies and their areas of specialisation.

Low ratings for some institutions, such as loan and guarantee funds, indicate the potentially untapped potential of these organisations in the process of developing hydrogen innovation and technology.

The study highlights the importance of hydrogen valleys for the development of regional economies and their perception by companies as necessary centres for stimulating innovation and development. The high level of interest in activities in this area is promising, but active support is needed to transform interest into real business engagement and accelerate the development of the hydrogen ecosystem (Table 2).

Table 2. *Characteristics of the status of business activity within the hydrogen valley*

Characteristics	N	Overall sample ¹
The company operates in the hydrogen valley environment	150	37.00 (24.67%)
The company is interested in operating in the hydrogen valley environment	150	104.00 (69.33%)
The hydrogen valley's activities are irrelevant to the company's operations	150	9.00 (6.00%)
¹ n (%)		

Source: *Own study based on conducted research.*

The survey showed that 24.67% of the responding companies already operate in the hydrogen valley environment. This may indicate the existence of a significant economic entity that is actively involved in the hydrogen ecosystem. The majority of the surveyed companies, as many as 69.33%, expressed interest in future activities in the hydrogen valley environment.

This may indicate a high level of awareness and development potential of this specialisation among entrepreneurs. A small percentage of companies, only 6%, believe that the activities of the hydrogen valley are not of great importance to their business and are not interested in joining such an association. This may suggest that for this group of companies, the hydrogen industry is outside their main area of interest or activity.

In summary, it should be noted that there is a high level of interest in activities within hydrogen valleys, which may signal that entrepreneurs see hydrogen technologies as a promising direction for development. Hydrogen valleys are attracting the attention of companies, potentially due to the prospects for growth and innovation in this field, as well as the development of local and regional supply chains.

However, there is a difference between companies that are currently operating and those interested in joining, which may indicate barriers to entry or varying degrees of readiness to adopt hydrogen innovations.

Undoubtedly, the development of a hydrogen-based economy represents a great opportunity for businesses, but it is also a challenge. Although green hydrogen technologies are often still in the early stages of adoption and regulations are insufficient, the benefits of operating within a hydrogen valley cannot be overestimated.

Based on the data collected on the assessment of the benefits of the hydrogen valley for businesses, an analysis was carried out which showed which aspects are most valuable for companies in the context of their involvement in the hydrogen ecosystem (Table 3).

Table 3. *Assessment of the benefits for the company from the hydrogen valley initiative*

Characteristics	N	Overall sample ¹
Integration of industrial potential	150	50.00 (33.33%)
Education and dissemination of knowledge on hydrogen and energy efficiency	150	20.00 (13.33%)
Easier access to qualified employees and the opportunity to recruit qualified staff	150	34.00 (22.67%)
Access to broadly understood consulting, services and development work in the field of hydrogen technology utilisation	150	60.00 (40.00%)
Development of internationalisation and cooperation within cooperative networks	150	6.00 (4.00%)
Increased access to sources of financing, including EU grants and repayable instruments	150	23.00 (15.33%)
Strengthening the competitiveness of enterprises within a strong local economy based on hydrogen specialisation	150	69.00 (46.00%)
Financial arrangements within the framework of joint large-scale research, development and investment projects	150	3.00 (2.00%)
¹ n (%)		

Source: *Own study based on conducted research.*

There is a widespread belief that hydrogen valleys offer many opportunities to entrepreneurs operating in their area, including, among others, the possibility to strengthen cooperation in order to create a business and technological environment, utilise scientific and research potential to take on innovative technological

challenges, support the development of joint hydrogen economy value chains, and enable the exchange of experiences in the field of hydrogen development research potential to take on innovative technological challenges, support the development of joint hydrogen economy value chains, and enable the exchange of experiences in the area of economic development in the regions.

The survey shows that entrepreneurs consider strengthening competitiveness within the local economy to be the greatest benefit. As many as 46.00% of enterprises identify strengthening competitiveness as a benefit, which is the highest result and emphasises the importance of building a competitive advantage at the national or international level.

Slightly fewer, 40.00% of enterprises, consider the possibility of using consulting, services and development work as an important benefit. This shows that technical and expert support is crucial for companies that operate or want to operate within the hydrogen valley. The integration of industrial potential is a benefit perceived by 33.33% of the surveyed companies.

This indicates that companies recognise the importance of industrial synergies and the opportunities for development through cooperation. On the other hand, for 22.67% of companies, access to skilled workers is a key element that highlights the need to invest in human capital.

It should be noted that only 13.33% of the surveyed companies consider education and dissemination of knowledge about hydrogen and energy efficiency to be important for them. This suggests that educational activities are ranked lower than other benefits.

Furthermore, the survey results show that the development of internationalisation within cooperative links is the least attractive benefit, with only 4.00% of respondents agreeing with this statement. This may signal the limited presence of enterprises in the integration of activities on international markets, low interest in cooperation within valleys, or a preference for foreign cooperation but within individual projects. 15.33% of enterprises see increased access to financing as a benefit, which indicates the importance of financial support in the development of hydrogen-related activities.

Only 2.00% of enterprises see the benefits of financial arrangements within large projects, which may indicate difficulties in implementing or accessing such projects.

As the above analysis shows, hydrogen valleys have the potential to generate significant benefits for enterprises, but this requires coordinated action both from the public sector, which often initiates their creation, and from enterprises themselves. Cooperation to enhance competitiveness, consulting, education and innovation are

key to fully exploiting the opportunities offered by hydrogen valleys, as well as to accelerating the energy transition and achieving sustainable development goals.

5. Conclusions and Recommendations

As previously indicated, regional initiatives related to the creation and development of hydrogen valleys form common value chains for the hydrogen economy. At the same time, support for the development of innovative scientific, technological, industrial and investment projects contributes to the development of hydrogen valleys.

In this context, it is important to continue and increase support for clusters or partnerships for the development of the hydrogen economy, given their positive assessment and impact on business development. It is also important to raise awareness among businesses about the benefits of hydrogen valleys and other business environment institutions, universities and loan and guarantee funds, which can be a source of their economic development.

The results of the study indicate that activities within hydrogen valleys should be adapted to current market challenges, which will allow for more effective use of hydrogen technologies and related innovations. It is also important to promote and facilitate cooperation between enterprises, research centres and technology parks in order to accelerate the transfer of knowledge and technology. Such activities will not only contribute to supporting the competitiveness of enterprises, but will also lead to faster development of innovative solutions on the market.

Understanding the specific requirements of enterprises in the context of hydrogen valleys is key to adapting the offer of business environment institutions. It is necessary to conduct educational and informational activities that will raise entrepreneurs' awareness of the benefits of cooperation with business support institutions. Business support service providers should strive to offer more personalised and flexible solutions that respond to the diverse needs of enterprises.

Regular monitoring and evaluation of the effectiveness of these solutions, in terms of their impact on development, will allow for the ongoing adaptation of the operating strategies of hydrogen valleys, which will ensure the integration of entities from many different sectors. The creation of networks ensuring the development of the hydrogen economy value chain should be the overarching goal here.

The analyses carried out suggest that it is also important to promote cooperation between existing companies and those interested in order to accelerate the transfer of knowledge and technology. Support (e.g., information, financial, consulting) should be offered to companies that are interested but not yet involved in hydrogen-related activities.

Barriers that prevent or hinder companies from entering hydrogen valleys should be identified and understood so that they can be effectively eliminated. It is necessary to conduct educational activities that will increase awareness and knowledge about the opportunities offered by hydrogen and the hydrogen economy.

Innovation in hydrogen technologies should be stimulated to attract even more companies and increase the competitiveness of regions. It is worth investing in the development of infrastructure supporting activities in hydrogen valleys to facilitate the entry of new companies into the ecosystem.

The development of hydrogen production technologies increases green energy production and stimulates the creation of new businesses in special economic zones. It is also important to introduce environmentally friendly technologies in the field of transport and logistics in the regions. Hydrogen valleys should become an integral part of regional development policy, allowing economic, environmental and social aspects to be taken into account.

As the analyses have shown, companies perceive strengthening competitiveness as a key benefit of hydrogen valleys, which suggests that these companies expect not only direct financial benefits, but also long-term effects resulting from innovation and improved operational and technological efficiency. Often emphasised in the literature on the subject (Weichenhain *et al.*, 2021) and (Guzzini, Pellegrini and Saccani, 2021), the barriers and typical challenges identified in the study can be divided into three groups:

- obtaining financing for projects creating a hydrogen valley, both public and private financing,
- the successful launch of a hydrogen valley project, such as business justification, technological readiness and effective management,
- external factors affecting the hydrogen valley project, such as regulatory provisions, political support and public acceptance. Niskie wyniki w tych kategoriach wskazują nie tylko na bariery dotyczące złożoności projektów, ale również trudności w nawiązywaniu międzynarodowych partnerstw, przeszkody regulacyjne lub po prostu niewystarczające informacje o możliwościach finansowania. To może być sygnał dla organizatorów doliny wodorowej do stworzenia lepszych platform współpracy i poszukiwania jasnych ścieżek finansowania.

The low rating of the benefits associated with education and knowledge dissemination may indicate insufficient awareness among entrepreneurs of the importance of these activities. Therefore, hydrogen valley managers may consider intensifying promotional activities that emphasise the value of access to knowledge and improving employee qualifications. In order to effectively assist in the creation and successful development of more hydrogen valleys, a favourable organisational and legal environment should be created to ensure business certainty and appropriate incentive and support systems, and then communicated.

As access to finance is important but not the most important factor for businesses, managers may consider introducing additional support and information programmes to help companies raise funds for the development of hydrogen technologies.

Managers may also seek new ways to facilitate cooperation between companies, e.g. through B2B platforms, networking events or cooperation within research and development projects. Although the integration of industrial potential is valued, there is a need to activate it for further development.

The answer to these needs seems to be actively functioning hydrogen valleys, which can remain key players in creating grassroots acceptance of the transition to clean energy in regions, and also become links supporting the development of regional economies, among other things by creating new jobs and through cooperation aimed at exploiting synergies and supplying products based on hydrogen technologies.

References:

- Aditiya, H.B., Aziz, M. 2021. Prospect of hydrogen energy in Asia-Pacific: A perspective review on techno-socio-economy nexus. *International Journal of Hydrogen Energy*, 46(71), pp. 35027-35056. doi: 10.1016/J.IJHYDENE.2021.08.070.
- Ale, B.B., Bade Shrestha, S.O. 2009. Introduction of hydrogen vehicles in Kathmandu Valley: A clean and sustainable way of transportation. *Renewable Energy*, 34(6), pp. 1432-1437. doi: 10.1016/j.renene.2008.10.015.
- Bałamut, A., Modrzewski, A.F. 2022. Hydrogen use in Poland in the light of EU policy to move away from coal: the concepts of hydrogen valleys and smart and sustainable cities. *Bezpieczeństwo. Teoria i Praktyka*, XLVII(2), pp. 61-73. doi: 10.48269/2451-0718-BTIP-2022-2-004.
- Concas, G., et al. 2022. Life Cycle Analysis of a Hydrogen Valley with multiple end-users. *Journal of Physics: Conference Series*, 2385(1), 012035. doi: 10.1088/1742-6596/2385/1/012035.
- Ficco, G., et al. 2022. Development of a Hydrogen Valley for Exploitation of Green Hydrogen in Central Italy. *Energies*, Vol. 15, 8072, 15(21), 8072. doi: 10.3390/EN15218072.
- Frankowska, M., Cheba, K. 2023. Exploring the research landscape of Hydrogen Valleys: A bibliometric analysis. *Journal of Sustainable Development of Transport and Logistics*, 8(2), 348-359. doi: 10.14254/jsdtl.2023.8-2.27.
- Go Global Group. 2021. Światowy łańcuch dostaw i wartości gospodarki wodorowej. Available at: <https://h2wielkopolska.pl/baza-wiedzy/analiza-swiatowy-lancuch-dostaw-i-wartosci-gospodarki-wodorowej/>.
- Guzzini, A., Pellegrini, M., Sacconi, C. 2021. Green hydrogen valleys: a preliminary case study for the industrial area of Ravenna. In: *CIRI Edilizia e Costruzioni (CIRI EC)*, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy: AIDI - Italian Association of Industrial Operations Professors. Available at: <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85124675826&partnerID=40&md5=92810b0833aa359debee1395acal73f>.
- Krasuski, K. 2022. Polski Ekosystem Dolin Wodorowych jako impuls dla transformacji polskiej energetyki. *Inżynieria Elektryczna*.
- Li, W., Zheng, X. 2024. Development mechanism and technological innovation of hydrogen

- energy: evaluating collaborative innovation based on hydrogen patent data. *International Journal of Hydrogen Energy*, 52, 415-427. doi: 10.1016/j.ijhydene.2023.05.310.
- Martínez de León, C., et al. 2025. Green hydrogen production's impact on sustainable development goals. *International Journal of Hydrogen Energy*, 142, pp. 642-653. doi: 10.1016/j.ijhydene.2024.12.355.
- Ortiz Cebolla, R., Navas, C. 2019. Supporting hydrogen technologies deployment in EU regions and Member States: The Smart Specialisation Platform on Energy (S3PEnergy). *International Journal of Hydrogen Energy*, 44(35), pp. 19067-19079. doi: 10.1016/j.ijhydene.2018.05.041.
- Petrollese, M., et al. 2022. Techno-economic assessment of green hydrogen valley providing multiple end-users. *International Journal of Hydrogen Energy*, 47(57), pp. 24121-24135. doi: 10.1016/j.ijhydene.2022.04.210.
- Polska Strategia Wodorowa Do Roku 2030 z perspektywą do roku 2040. 2021. Available at: <https://www.gov.pl/web/klimat/polska-strategia-wodorowa-do-roku-2030-z-perspektywa-do-roku-2040-opublikowana-w-monitorze-polskim>.
- Roddy, D. 2005. Renewables and hydrogen projects lead Tees Valley regeneration. *Energy World*, (332), pp. 18-19. Available at: <https://www.scopus.com/inward/record.uri?eid=2-s2.0-24944527815&partnerID=40&md5=132556fa62e2227b9d64ccf132eebe34>.
- Strategia w zakresie wodoru na rzecz Europy neutralnej dla klimatu (2020). Bruksela, dnia 8.7.2020 r. COM(2020) 301 final.
- Weichenhain, U. 2021. Hydrogen Valleys: first elements of the new hydrogen economy | Roland Berger, Roland Berger. Available at: <https://www.rolandberger.com/en/Insights/Publications/Hydrogen-Valleys-first-elements-of-the-new-hydrogen-economy.html>.
- Weichenhain, U., et al. 2021. Hydrogen Valleys. Available at: https://www.h2v.eu/hydrogen-valleys?populate=&field_ch_1_q_10_value=IT.

Online sources:

- Green Deal. 2023. Communication From The Commission To The European Parliament, The European Council, The Council, The European Economic And Social Committee And The Committee Of The Regions A Green Deal Industrial Plan for the Net-Zero Age COM/2023/62 final, <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52023DC0062>.