

Bridging the Gap: Public Perception and Acceptance of Hydrogen Technology in the Philippines

Alvin Garcia Palanca*, Cherry Lyn V. Chao, Kristian July R. Yap, and Rizalinda L de Leon

Palawan State University, Philippines

*Corresponding author: Alvin Garcia Palanca, Palawan State University, Philippines, Email: agpalanca@up.edu.ph

Received date: 10-Sept-2024, Manuscript No. tspa-24-147696; Editor assigned: 12-Sept-2024, Pre-QC No. tspa-24-147696(PQ); Reviewed: 15-Sept-2024, QC No. tspa-24-147696(Q); Revised: 20-Sept-2024, Manuscript No. tspa-24-147696(R); Published: 30-Sept-2024, DOI. 10.37532/2320-6756.2024.12(9).335

Abstract

The study examines the effects of transitioning to hydrogen production in the National Capital Region (NCR) and Palawan Province, Philippines, focusing on technology, environment, and stakeholder impact. The research, conducted through a July 2022 survey, aimed to assess public awareness, knowledge, risk perception, and acceptance of hydrogen and its environmentally friendly variant, green hydrogen, infrastructure. Disparities were found between urban NCR and rural Palawan, with lower awareness in Palawan. Safety concerns were highlighted, with NCR respondents generally considering hydrogen production safe, while Palawan respondents had mixed feelings, particularly regarding nuclear-based hydrogen generation. The report emphasizes the potential ecological advantages of hydrogen technology but highlights potential issues concerning water usage and land impacts. It suggests targeted public awareness campaigns, robust safety assurance programs, regional pilot projects, and integrated environmental plans to facilitate the seamless integration of hydrogen technology into the Philippines' energy portfolio. This collective effort aims to help the country meet climate action obligations, foster sustainable development, and enhance energy resilience.

Keywords: Risk perception; Renewable energy; Climate

Introduction

Background of the study

The Philippines committed in 2015 to the 2016 Paris agreement to meet its pledge by implementing the national climate action plan by integrating climate change into national and local development plans for sustainable electricity production in the country [1]. Renewable Energy (RE) resources, such as solar and wind, need to expand their penetration into the country's national energy mix to attain its commitment to the 1.5 Paris agreement. However, solar and wind energy technology's intermittent output and mismatched peak production with peak demand pose a significant challenge for existing island grid integrations, resulting in grid instability and curtailment of electricity supplies to its end users [2]. The high generation cost of electricity during a peak-demand period is another fundamental concern in the electricity market. The price of electricity at peak-demand periods is higher than during off-peak periods. In peak periods, electricity consumption is higher than average, power supplies must complement the low-cost base-load power plants (coal and nuclear) with less cost-effective but more flexible forms of generation, such as diesel, bunker fuels, and gas-fired generators. During off-peak periods, when less electricity is consumed, costly types of generation can be stopped. This is the chance for the electrical energy storage systems to benefit financially by storing excess energy from low-cost energy sources such as solar and wind. When solar and wind energy conversion technology is not feeding the grid, electrochemical energy storage technologies such as batteries are used to store energy for later use which resolves the electricity production challenges faced by these RE technologies. But batteries have a low electrical energy return by a device over its lifetime ratio [3]. This makes batteries have low output energy from energy stored than the joule invested in

Citation: Palanca A G. Bridging the Gap: Public Perception and Acceptance of Hydrogen Technology in the Philippines. J Phys Astron. 2024;12(9):335.

©2024 Trade Science Inc.

manufacturing a battery system [4]. Another issue with battery storage is that it is difficult to dispose of safely [5]. In hydrogen storage systems, the catalyst can be reclaimed in a Hydrogen electrolyzer Proton Exchange Membrane (PEM) at the end of its life, which is not the same for batteries, thus reducing the impact on the environment [6]. Another pressing issue with batteries as a storage facility for the grid in support of RE is that existing commercial batteries developed today are for short-term energy storage and can only provide enough energy to support local grids for approximately four hours or less [7]. Grid-scale hydrogen energy storage system is another viable electrochemical energy storage technology that can be integrated into low-cost solar and wind energy conversion technologies to complement its variable nature and meet end-use requirements as a zero-emission massive energy storage capacity for the grid. As seen in nuclear power, public perception and acceptance of hydrogen, its utilization, and supply technologies are considered important factors for future hydrogen penetration. However, hydrogen utilization is an emerging technology and new to the public, so the current status of public acceptance is still unknown. It should also be noted that public perception and acceptance of the technology could be influenced by trends and incidents of the time. Such examples include the Hindenburg disaster in 1937 and the hydrogen explosion at the Fukushima nuclear plant in 2011, which can be associated with green hydrogen by the public. This study analyses the current status, public perception, and acceptance of green hydrogen infrastructure. The results will help facilitate communication when promoting hydrogen use all over the Philippines in the coming years as a sustainable grid-size energy storage system.

Related literature

Outside of the Philippines, there has been considerable research on the societal acceptability of hydrogen and its usage methods. There are two major academic approaches to such studies: the economic and the social-psychological. The former researches social acceptability from an economic standpoint, primarily via consumer surveys of devices and equipment, concentrating on "willingness to pay" for, e.g., hydrogen reformers used as backup power in cell sites, to provide recommendations for legislators and the marketing profession. The latter evaluates societal acceptability and risk awareness of facility placements, such as hydrogen stations and pipelines, to guide facility location choices in communications and dialogues, but not from an economic standpoint. When combining the two methodologies outlined above in a single research project, the social-psychological approach is prioritized, while the economic approach is partially utilized. Hydrogen is seen as an essential component of future low-carbon energy systems. However, social acceptance must be considered to apply hydrogen technology broadly. Studies on the acceptability of hydrogen technology have shown neutral to favourable results. Reports build on prior research by concentrating on large-scale hydrogen infrastructure in countries like Germany. Quantitative data on acceptability was acquired among the German people as part of the reported study. The findings support the widespread good impression of hydrogen. However, acceptability is dwindling regarding infrastructure deployment in one's neighbourhood, examining which socio-psychological and communal elements influence opposition to Green Hydrogen, including, but not limited to, perceived procedural and distributive justice, as well as investigating the origins of the Not in My Backyard (NIMBY) notion and proposing alternatives based on what may influence the rollout of Green Hydrogen [8].

Some problematic aspects of prospective hydrogen futures include hydrogen generation from nuclear power, massive onshore wind, and solar farms, or fossil fuels with carbon capture and storage [9]. Therefore, public familiarity with hydrogen technology applications, attitudes toward safety, and the capacity of hydrogen technologies to satisfy desired affordability, convenience, and performance are expected to be crucial factors in its broad adoption; consider the dissemination of these technologies is viable and ready for mass commercialization. In that case, the public must be informed about hydrogen technologies' possible uses and consequences and be involved in their early manifestations in various places.

To assess how social acceptance of green hydrogen changes with economic development, a panel data methodology was used by Bing Wang *et al.* in their research to examine the forces encouraging hydrogen-based renewable energy use in a group of 32 nations [10]. The main findings over the research of Bing Wang *et al.* show that:

- GDP per capita is a significant positive contributor to renewable energy consumption, whereas oil prices do not have a

strong relationship with renewables.

- Social awareness about climate change and concerns about energy security are insufficient to motivate the switch from traditional to renewable energy sources.
- The role of urbanization in renewable energy consumption is dependent on the different stages of urbanization.

These findings indicate that the market mechanism is not to blame for increasing the use of renewables. Instead, future research should expand energy security concerns in renewable use and should be extended further on social acceptance of Hydrogen-renewable energy. The prospects of using hydrogen energy in electricity production pose a substantial challenge. Nonetheless, despite much study and knowledge on the benefits of hydrogen energy, it is fraught with controversy in many nations. Moreover, globally, there is a lack of awareness of the hydrogen energy generation process and its benefits, raising worries about its consistency [11]. Therefore, an innovative questionnaire must be employed as a research method in this study to examine residents' attitudes toward nations where hydrogen energy is underused and the infrastructure for hydrogen energy is inadequate. Respondents discussed their environmental attitudes and their understanding of hydrogen energy and the utilization of hydrogen fuel. The findings reveal that society is not satisfied that the safety requirements for hydrogen-derived energy are appropriate. Furthermore, it is a fact that information regarding Hydrogen as an energy carrier and its product safety and storage techniques is quite limited, especially in countries where Hydrogen is in its infancy. Therefore, negative attitudes against hydrogen energy can significantly impede its growth in many nations, including the Philippines.

Statistical analysis

In the works of Lapham *et al.* on the perception of safety to park use, they first assessed the characteristics of survey participants using descriptive statistics. Then they used chi-square tests to see if there were significant differences across their four identified sites. Following this, they performed statistical modeling for the binary and categorical outcomes of park visitation. Finally, they use statistics to model park visitors' binary and categorical consequences. Their research generated outcome variables from the primary inquiry, "How often do you visit this park?" (Answers ranged from 'everyday' to 'never'), and 'What do you often do in this park?' Next, using a logistic regression model, they analyzed the binary outcome, 'ever visited your park.' When the 'felt safety' variable emerged as a crucial predictor of park utilization, they studied its related components in further detail. Finally, they performed a mediation study on the model examining the elements associated with ever visiting the park, using 'felt safety' as a possible mediator for the influence of neighborhood physical incivilities on the models using the traditional mediation analyses from Baron and Kenny (1986) [12]. This method of interpreting Likert data is an excellent way to visualize and analyze the collected data.

Senlier *et al.* conducted an Urban Audit of 31 European cities using subjective indicators. Satisfaction related to urban Quality of Life (QoL) was measured from the perspectives of employment opportunities, housing costs, urban safety, cleanliness of cities, satisfaction with public transport, air quality, and integration of residents, and comparisons were made between the cities. Based on the Urban Audit surveys, 300 perception questionnaires were conducted with Kocaeli residents for this research. Researchers utilize techniques and methodologies in these studies like ANNOVA, NULL hypothesis, LISREL, SEM, and Regression Analysis. Utilizing SPSS (Statistical Package for the Social Sciences) statistical analysis software, the survey findings were analyzed using factor analysis and regression analysis. In addition, Kocaeli's urban QoL indicators were subjected to factor analysis, a form of multivariate analysis, to determine their factor structure. The purpose of factor analysis is to reduce the number of interconnected data structures to a smaller number of unconnected data structures and to uncover common factors by grouping the variables. The Linear Regression Analysis exposes the causal connection between one connected and one unrelated set of variables to discover the functional relationship between the variables. Consider, for instance, that variable X is unconnected and variable Y is related. The operative connection between the two variables may thus be expressed as $Y=f(X)$. Y may be generated by giving the value X_i to X [13].

The Mann-Whitney U test is another well-known nonparametric test for comparing outcomes between two independent groups.

The Mann-Whitney U test, also known as the Mann-Whitney Wilcoxon Test or Wilcoxon Rank Sum Test, is used to determine whether or not two samples were likely drawn from the same population (i.e., that the two populations have the same shape) [14-16]. According to some academics, this compares the populations' medians. The parametric test, for instance, compares the means of independent groups ($H_0: \mu_1 = \mu_2$). This test is often administered as a two-sided test; hence, the study hypothesis suggests that the populations are unequal rather than identifying their direction. A one-sided study hypothesis is used whenever finding a positive or negative change in one group relative to the other is relevant. The process for the test consists of combining the observations from the two samples into a single sample, keeping account of which sample each observation is from, and then rating the observations from lowest to highest, from 1 to $n_1 + n_2$, respectively. A similar but different way of analyzing our proposed study is using a Nonlinear (categorical) principal component analysis, or CATPCA is a statistical technique that simultaneously quantifies categorical variables and reduces the dimensionality of the data. It may also be used to interpret Likert data. The main components analysis aims to facilitate an initial collection of variables to a smaller group of uncorrelated components that capture most of the information in the original variables. The approach is especially beneficial when several variables prevent a practical understanding of the connections between items (subjects and units). Lowering the dimension allows you to comprehend a few components instead of many variables. The conventional principal component analysis assumes linear correlations between numeric variables.

In contrast, the optimal scaling method permits variables to be scaled to various values. As a consequence, categorical variables are optimally quantified in the dimension given. Thus, Likert data can easily be described between variables in this method.

Methodology

Implementation of the survey: Here, we studied the public's awareness, knowledge, risk perception, and acceptance of hydrogen and green hydrogen infrastructure in the National Capital Region (NCR) and Palawan, Philippines. A quantitative analysis of the societal acceptability of green hydrogen technologies was conducted using a socio-psychological methodology. The questionnaire was developed to support the development of a green hydrogen storage infrastructure in Palawan and NCR, Philippines.

The poll was performed online using a Google form in July 2022. Using an online Google form makes it very simple to collect a small sample in a short amount of time during the pandemic. However, the drawback of utilizing a Google form survey online is that response rates are often low, and respondents are voluntary participants. Table 1 displays the implementation of fundamental data and the characteristics of the survey sample. Cochran's sample size (n_0) formula was adopted to calculate the desired sample size of the survey.

Analytical method

We use cross-tabulation to compare the survey results to those of NCR and Palawan. To find the influence of respondents' awareness, knowledge, and perception of green hydrogen and hydrogen infrastructure on their acceptance of hydrogen as a grid-scale hydrogen energy storage system, we use a stepwise backward regression method to include or exclude variables, adopting 0.05 for inclusion and 0.10 for exclusion in the significance level of F-statistics (TABLE 1).

TABLE. 1 Data implementation of the survey and the characteristic of the sample.

	NCR	Palawan	PPC	Narra
N	22	72	61	11
Average response rate	42.31%	45.86%	47.66%	36.67%

Results and Discussion

Awareness

The survey findings reveal the current state of hydrogen technology awareness and its immense potential. Notably, there are disparities in awareness between the metropolitan National Capital Region (NCR) and the rural regions of Palawan. Within the

NCR, almost 40% of the participants exhibited knowledge of hydrogen energy; however, in Palawan, just 30% of the respondents possessed this awareness. The initial data suggested that respondents predominantly linked hydrogen with electric automobiles rather than broader energy applications, indicating the untapped potential of hydrogen technology.

The Philippines Department of Energy (DOE) is not just a participant but a leader in the country's energy transition. The Green Energy Option Program (GEOP) and large-scale battery energy storage projects are critical elements of their strategy to integrate Renewable Energy (RE) into the national energy mix by 2024 [17]. This underscores the DOE's authority and responsibility in driving the adoption of grid-size energy storage, such as green hydrogen technology and other renewable energy sources.

The study results underscore the necessity of tailored policy-making to address the regional disparities in hydrogen technology awareness. In the NCR, where awareness levels are relatively higher, policymakers should focus on promoting the broader applications of hydrogen technology beyond electric vehicles (**FIG. 1**). The DOE can achieve this by implementing public communication campaigns, such as social media awareness drives and community forums, organizing seminars with industry experts, and fostering collaborations with educational institutions to include hydrogen technology in their curriculum. This localized approach is crucial for highlighting the importance of hydrogen in energy storage and grid stability maintenance.

More significant efforts are needed to establish a solid foundation for raising awareness in Palawan. The key to this lies in community participation, which should be the primary focus of policies. By utilizing local leaders and influencers, who are trusted and respected figures in the community, we can effectively communicate the advantages and potential ecological consequences of hydrogen technology. Customized educational initiatives that are adapted to specific local circumstances can play a crucial role in clarifying the intricacies of hydrogen technology and fostering public confidence, making the community feel involved and important in this process.

Consciousness is crucial in accepting and implementing novel technology [18]. The elevated levels of awareness in the National Capital Region (NCR) indicate preparedness for conducting pilot projects and demonstrations of hydrogen technology. These initiatives can demonstrate the tangible advantages of hydrogen energy, such as its high energy density, zero greenhouse gas emissions when used in fuel cells, and its potential to be produced from diverse, locally available resources, promoting broader recognition and implementation.

In Palawan, the limited awareness levels emphasize the necessity for smaller-scale, community-based initiatives that engage local stakeholders from the beginning. These programs should prioritize showcasing hydrogen technology's safety, dependability, and ecological advantages, progressively fostering public trust. People in Palawan have never heard of using green Hydrogen for electricity production, and they associate Hydrogen only with electric vehicles. On the other hand, people in Palawan associate hydrogen with fuels derived freely in the water and perceive it as a long-term solution based on their direct experience with the extremely high cost of petroleum products in the entire province of Palawan.

Regarding awareness of PPC, there is still have an upward trend in green hydrogen used as an energy carrier with application to the transport sector by about 30% of respondents. However, there is a downward trend of awareness among residents of PPC and Narra for green Hydrogen in providing electricity for communication, residential, industrial, and commercial sectors despite the fact most telecommunication companies have been using Hydrogen as backup power for their cell towers for decades though none for commercial generation of electricity [19-21].

Integrating hydrogen technology with renewable energy sources can effectively decrease greenhouse gas emissions, which aligns with the Philippines' climate action obligations [22]. However, it is important to openly and honestly address the potential environmental issues associated with hydrogen production, including water use and land effects. For instance, hydrogen production through electrolysis can lead to increased water consumption, and large-scale hydrogen storage facilities may require significant land area. Rest assured, policy-making and project implementation will incorporate thorough environmental assessments and sustainable practices, giving you confidence in the proposed strategies.

The poll revealed a need for more comprehension of hydrogen technology, specifically in rural regions such as Palawan (FIG. 1). Lack of knowledge and misunderstanding about hydrogen in general are some of the identified obstacles. To tackle awareness issues, educational efforts should prioritize the dissemination of scientific knowledge and the advantages of hydrogen energy, employing language that is both comprehensible and easily understandable.

Developing the essential infrastructure for hydrogen technology necessitates substantial expenditure. Enacting policies encouraging private sector involvement and offering financial assistance for hydrogen projects might address this obstacle. Public-private partnerships and international cooperation are also essential in contributing significantly.

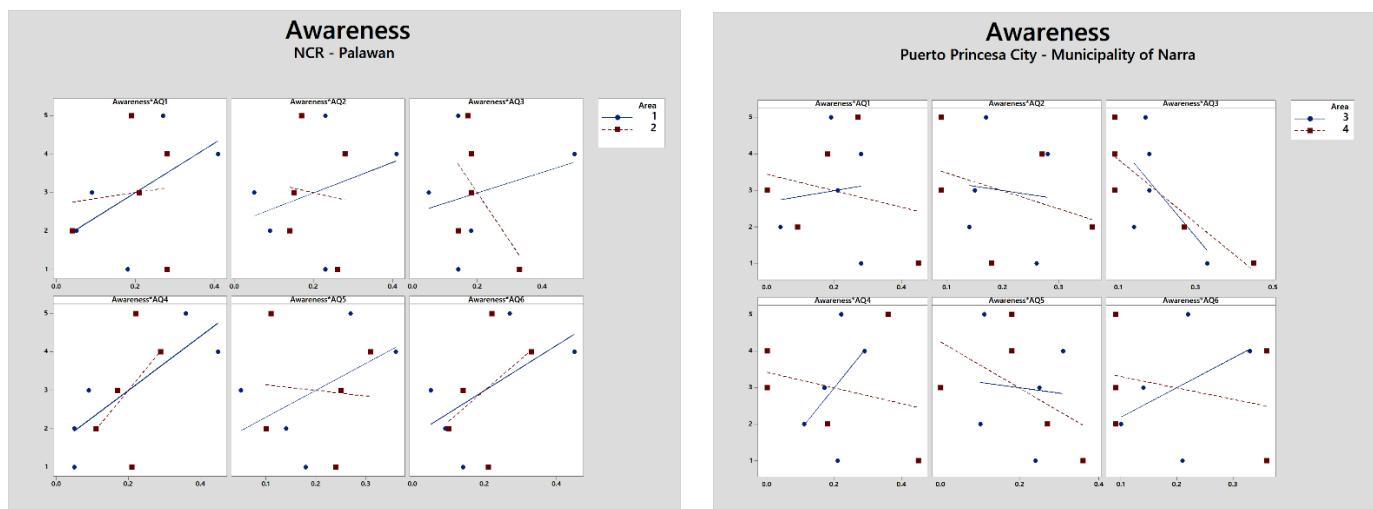


FIG.1. Awareness of green hydrogen and hydrogen infrastructure for NCR (1), Palawan (2), Puerto Princesa City (PPC) (3), and Narra (4).

A well-defined and facilitative regulatory framework is crucial for advancing and implementing hydrogen technology. Regulations guarantee the preservation of safety, the safeguarding of the environment, and the promotion of technical advancement. Consistent updates and conversations with stakeholders can assist in refining these policies to tackle growing difficulties and capitalize on new opportunities effectively.

Establishing public trust and acceptance is crucial for effectively implementing hydrogen technology. By utilizing participatory methodologies, ensuring transparency in project planning, and addressing local issues, hydrogen projects can effectively engage local communities and create a favorable climate.

By overcoming these obstacles and implementing the suggested remedies, the Philippines may bolster public consciousness and backing for hydrogen technology, thus advancing its sustainable development objectives and climate action obligations.

Knowledge

The survey revealed significant knowledge of hydrogen technology differences between respondents in the metropolitan National Capital Region (NCR) and those in the rural districts of Palawan. In the NCR, over half of the participants demonstrated a fundamental understanding of hydrogen energy and its potential uses, while in Palawan, this percentage decreased to approximately 30%. These disparities highlight the need for focused educational programs to bridge the information gap and promote a consistent understanding of hydrogen technology across different geographical areas.

We conducted a survey with questions covering various aspects of hydrogen, including efficiency, flammability, cost, emissions, water impact, sustainability, technology viability, and the need for other energy sources to produce hydrogen. Most respondents provided neutral answers to most questions, except for question KQ2, where respondents viewed hydrogen as a volatile and flammable fuel similar to fossil fuels. Additionally, most respondents expressed skepticism about the sustainability of green hydrogen. Recent concerns about hydrogen's safety and sustainability and its association with the Fukushima nuclear accident influenced respondents' views. Moreover, due to the increase in natural gas terminal infrastructure projects, respondents

mistakenly associated hydrogen with natural gas. We also provided a brief description of how hydrogen is produced from splitting water molecules in the survey materials. About 40% of respondents expressed concerns about the potential impact of hydrogen production on local water supplies in the event of a large-scale hydrogen economy. Despite their knowledge of hydrogen, most respondents are unfamiliar with how green hydrogen infrastructure operates (FIG. 2).

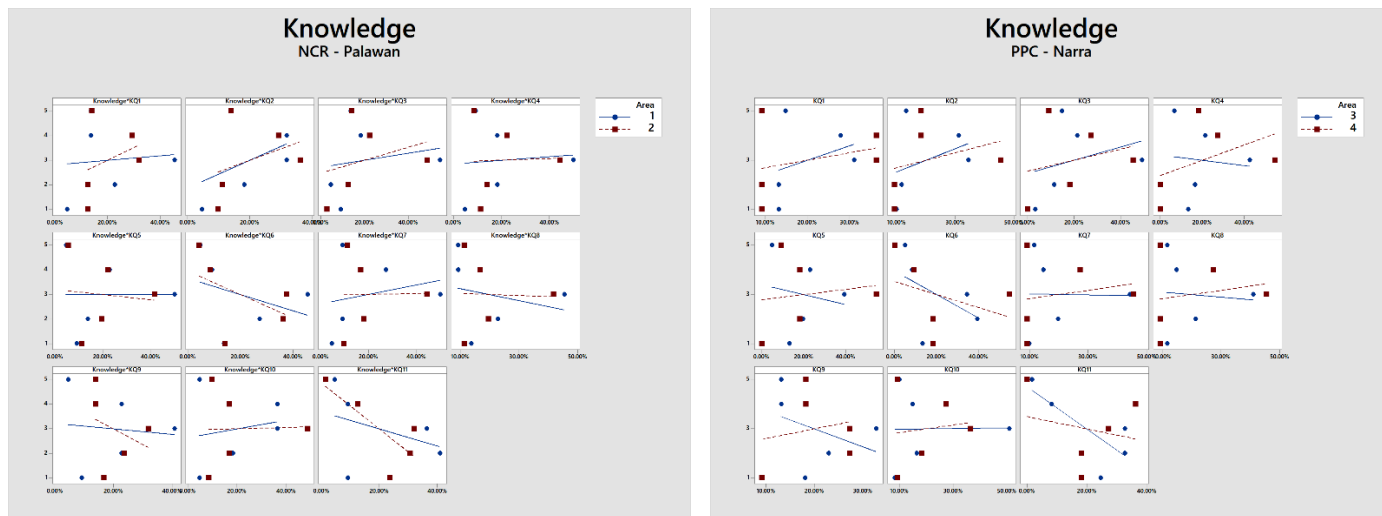


FIG. 2. Knowledge of green hydrogen and hydrogen infrastructure for NCR (1), Palawan (2), Puerto Princesa City (PPC) (3), and Narra (4).

The study findings suggest that policymakers should develop tailored educational initiatives to enhance public awareness and understanding of hydrogen technology in specific regions. In the NCR, where basic knowledge is already advanced, policies should concentrate on improving understanding and highlighting the practical uses of hydrogen in daily life and industrial settings. In Palawan, the primary focus should be on providing comprehensive education about hydrogen technology, including its benefits and significance in promoting sustainable energy transitions.

Acquiring knowledge is crucial for successfully implementing new technology. The elevated level of foundational knowledge in NCR indicates readiness to participate actively in and embrace hydrogen technology. Therefore, public demonstrations, seminars, and partnerships with educational institutions may enhance the acceptance and utilization of technology in this area. Conversely, in Palawan, it is imperative to implement educational programs that establish a solid knowledge base and rectify any misunderstandings regarding hydrogen technology.

Integrating hydrogen technology with renewable energy sources can significantly reduce greenhouse gas emissions in line with the Philippines' climate action objectives [22]. However, effectively conveying the environmental benefits of hydrogen technology to the public is crucial in obtaining support and facilitating its adoption. Emphasizing successful case studies and tangible benefits can help cultivate a favorable attitude and widespread adoption of hydrogen technology.

To address the significant knowledge gaps, particularly in rural regions like Palawan, specific educational programs focusing on the scientific aspects, benefits, and practical uses of hydrogen technology are necessary. Partnerships with nearby educational institutions and community leaders can enhance the scope and effectiveness of these efforts.

Developing the necessary infrastructure for hydrogen technology requires substantial investment. Enacting policies encouraging private sector involvement and offering financial assistance for hydrogen initiatives will help overcome this obstacle. Public-private partnerships and international cooperation are also essential for making significant contributions.

Establishing a distinct and supportive regulatory framework is crucial for advancing and implementing hydrogen technology. Regulations should be designed to ensure safety, protect the environment, and promote technological advancement. Regular updates and discussions with stakeholders can help improve these regulations and effectively address new challenges and opportunities.

Community engagement: Establishing public trust and acceptance is crucial for the effective implementation of hydrogen technology. By implementing participatory methodologies, ensuring transparency in project planning, and addressing local issues, hydrogen projects can effectively engage local communities and create a favorable climate.

By overcoming these obstacles and implementing the suggested remedies, the Philippines can enhance public awareness and endorsement of hydrogen technology, thus advancing its sustainable development objectives and climate action obligations.

Risk perception

Our survey found that the perception of risk associated with hydrogen generation differs dramatically between the urban National Capital Region (NCR) and the rural districts of Palawan. Respondents from the National Capital Region (NCR) generally perceive hydrogen as safe, regardless of the energy source. On the other hand, respondents from Palawan have a more neutral position, especially when it comes to using nuclear energy for hydrogen generation. This discrepancy is crucial in comprehending geographical variations in the adoption of hydrogen technology. Initially, the data revealed from our survey questions on risk perception that approximately 40% of Puerto Princesa City (PPC) participants and 80% in Narra maintained a neutral stance toward utilizing nuclear energy for hydrogen production. Furthermore, 40% of respondents in PPC and 50% in Narra had neutral risk views about using coal and petroleum for hydrogen production. PPC and Narra exhibited an optimistic attitude toward green hydrogen, indicating an increasingly favorable perspective on reducing reliance on fossil fuels and mitigating global warming.

By 2024, the energy landscape in the Philippines is undergoing significant changes as renewable energy sources are being more extensively integrate. The goal is to meet the country's climate action goals by substantially cutting greenhouse gas emission. This situation underscores the importance of tailored policies that specifically address regional perspectives and promote the development of hydrogen technology. Metropolitan regions like the National Capital Region (NCR) show greater receptiveness, indicating readiness for rapid implementation of hydrogen infrastructure, while remote areas like Palawan require targeted educational initiatives to foster understanding and confidence. The survey has highlighted environmental challenges such as land usage and hazardous waste management, emphasizing the need for comprehensive environmental measures. Leveraging positive perceptions of hydrogen's potential to reduce reliance on fossil fuels can enhance acceptability. However, addressing safety concerns and ensuring thorough environmental evaluations is crucial to maintaining public confidence and support for hydrogen projects (FIG. 3 and TABLE 2).

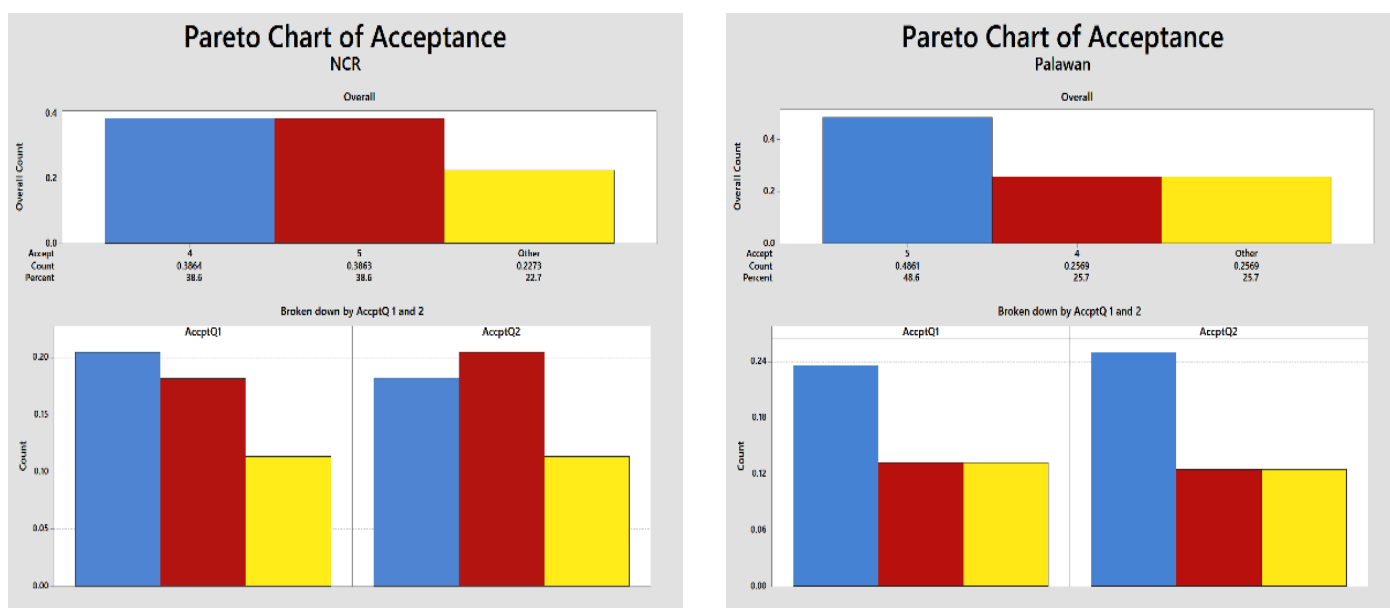


FIG. 3. Acceptance of green hydrogen and hydrogen infrastructure for NCR (1), Palawan (2).

TABLE. 2 Results of regression analysis (Backward Elimination) using endogenous variable in the survey.

Variable	p-Value
----------	---------

Knowledge	Do you think a viable hydrogen transition in the Philippines would take 30 years-50 years or more to complete, and hardly anything worthwhile could be done sooner than 10 years-20 years?	0.045
Risk Perception	How safe do you think the Hydrogen Production is operated using energy from Solar?	0.011
Risk Perception	How safe do you think the Hydrogen Production is operated using energy from Hydropower?	0.005

Dependent Variable: Would you support Green Hydrogen Production for power generation in your locality?

The adjusted R-squared value: 0.3179

□ to remove = 0.10

In summary, we find a significant negative effect of negative risk perception on green Hydrogen and Hydrogen infrastructure, as well as a significant positive effect of the recognition of the necessity of green Hydrogen and Hydrogen infrastructure on acceptance of placement of Hydrogen production facilities close to the respondents' locality or residence to reduce the dependence of our country to fossil fuel.

It is essential to tackle the possible obstacles to the widespread use of hydrogen. The poll revealed a need for more awareness and understanding of hydrogen technology, particularly in Palawan. Awareness of issues in hydrogen technology is crucial to creating focused educational programs to enlighten the public about the advantages and security of hydrogen generation. The Palawan respondents have raised environmental concerns regarding the impact on water resources and land usage. These issues emphasize the necessity of conducting thorough ecological impact assessments and effectively communicating the results to the public. Furthermore, a substantial allocation of funds to infrastructure is needed to implement hydrogen technology effectively. Policies encouraging private sector investment and offering financial assistance for hydrogen projects can effectively address this obstacle. Ultimately, it is crucial to establish a transparent and encouraging set of regulations that prioritize safety and environmental preservation and promote technological advancement.

Recommendations

- Implement focused public awareness initiatives in Palawan to enhance knowledge and comprehension of hydrogen technology and its advantages.
- Safety Assurance Programs aim to execute safety demonstration projects and establish transparent communication channels to effectively resolve safety concerns, specifically about hydrogen production based on nuclear energy.
- Policy assistance for experimental initiatives: Promote localized pilot initiatives in urban and rural regions to showcase the feasibility and security of hydrogen technologies.
- Implement Integrated Environmental Strategies to create thorough environmental management strategies specifically targeting land use and waste management concerns related to hydrogen generation.

Conclusion

This study aimed to evaluate the technological, environmental, and stakeholder effects of shifting to hydrogen production in the National Capital Region (NCR) and Palawan Province, Philippines. The July 2022 study uncovered discrepancies in public awareness, understanding, perception of danger, and willingness to embrace hydrogen technology across different locations. Within the National Capital Region (NCR), 40% of participants exhibited awareness of hydrogen energy, but in Palawan, only 30% showed such awareness. This discrepancy underscores the necessity for customized educational endeavors to address the knowledge disparity and foster comprehension.

The data analysis revealed a significant correlation between risk perception and the uptake of hydrogen infrastructure. A higher perception of risk negatively influenced the acceptance of hydrogen production. Generally, respondents from NCR considered hydrogen production safe, whereas respondents from Palawan had more neutral or ambivalent views, particularly regarding nuclear-based hydrogen generation. The acceptance levels differed among respondents, as 39% of those in NCR supported local hydrogen production. In comparison, 38% of respondents in Palawan preferred these projects to be situated elsewhere due to environmental concerns.

The environmental profiling conducted in this study underscores the potential of hydrogen technology to significantly reduce greenhouse gas emissions and mitigate the effects of global warming. However, addressing potential environmental concerns, such as water consumption and land impacts, is crucial through thorough environmental evaluations and sustainable practices. The active involvement of stakeholders and the public through targeted educational initiatives and participatory methods is essential to building public confidence and effectively implementing hydrogen technology.

The report suggests the implementation of focused public awareness campaigns in Palawan, the establishment of safety assurance programs, the promotion of regional pilot projects, and the formulation of comprehensive environmental strategies. These measures will tackle deficiencies in information, apprehensions over safety, and adverse effects on the environment, facilitating the smooth incorporation of hydrogen technology into the energy composition of the Philippines. This strategic maneuver will bolster the nation's efforts to address climate change, foster sustainable economic development, and strengthen energy independence.

REFERENCE

1. Palanca AG, Chao CL, Yap KJ, et al. Bridging the Gap: Public Perception and Acceptance of Hydrogen Technology in the Philippines
2. Duić N, da Graça Carvalho M. Increasing renewable energy sources in island energy supply: case study Porto Santo. *Renew Sustain Energy Rev* 2004;8(4):383-99.
3. Pellow MA, Emmott CJ, Barnhart CJ, et al. Hydrogen or batteries for grid storage? A net energy analysis. *Energy Environ Sci*. 2015;8(7):1938-52.
4. Barnhart CJ, Dale M, Brandt AR, et al. The energetic implications of curtailing versus storing solar-and wind-generated electricity. *Energy Environ Sci* 2013;6(10):2804-10
5. Carmo. Water Electrolysis: Innovative Approaches Towards Catalyst Separation, Recovery And Recycling. *Int J Hydrog Energy*. 2019;44(7):3450-55.
6. Schönauer AL, Glanz S. Hydrogen in future energy systems: social acceptance of the technology and its large-scale infrastructure. *Int J Hydrog Energy*. 2022;47(24):12251-63.
7. Ekins P, editor. *Hydrogen energy: economic and social challenges*. Earthscan; 2010.
8. Wang B, Mi Z, Nistor I, et al. How does hydrogen-based renewable energy change with economic development? Empirical evidence from 32 countries. *Int J Hydrog Energy*. 2018;43(25):11629-38.
9. Ingaldi M, Klimecka-Tatar D. People's attitude to energy from hydrogen—from the point of view of modern energy technologies and social responsibility. *Energies*. 2020;13(24):6495.
10. Lapham SC, Cohen DA, Han B, et al. How important is perception of safety to park use? A four-city survey. *Urban Stud*. 2016;53(12):2624-36.
11. Senlier N, Yildiz R, Aktaş ED. A perception survey for the evaluation of urban quality of life in Kocaeli and a comparison of the life satisfaction with the European cities. *Soc Indic Res*. 2009;94:213-26.
12. Nachar N. The Mann-Whitney U: A test for assessing whether two independent samples come from the same distribution. *Tutorials in quantitative Methods for Psychology*. 2008;4(1):13-20.
13. Apanada MJ, Kaldjian E. Why the Time Is Right for Renewable Energy in the Philippines. *World Resour Inst*. 2021.
14. Shahzad MF, Xu S, Lim WM, et al. Cryptocurrency awareness, acceptance, and adoption: the role of trust as a cornerstone. *Humanit Soc Sci Commun*. 2024;11(1):1-4.
15. Palanca AG, Chao CL, Yap KJ, et al. Bridging the Gap: Public Perception and Acceptance of Hydrogen Technology in the Philippines.
16. Sarker AK, Azad AK, Rasul MG, et al. Prospect of green hydrogen generation from hybrid renewable energy sources: *Rev Energ*. 2023;16(3):1556.

17. IRENA, Water for hydrogen production. International Renewable Energy Agency: BlueRisk, Abu Dhabi, United Arab Emirates.
18. Hurwitz Z, iB MT, Daza E, et al. Key aspects for managing the environmental and social risks of green hydrogen.
19. Anderson T, Singh H. Participatory methodologies enable communities to assess climate-induced loss and damage. APN Sci Bull. 2020;10(1)
20. Tachev, V. Renewable Energy in the Philippines – Current State and Future Roadmap, in Energy Tracker Asia. Energy Tracker Asia
21. Benita5/Pixabay. Cut Global Emissions by 7.6 Percent Every Year for Next Decade to Meet 1.5°C Paris Target - UN Report, in United Nation Climate change. 2019, United Nation.
22. Colthorpe, A. Philippines: Scatec-Aboitiz Power JV begins operation of battery storage at hydroelectric plant, in Energy Storage News. 2024, Energy Storage News.