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Digitalization of Women and Renewable Energy in Improving Gender Equality Among Students in Cirebon, Indonesia

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Abstract

Digitalization and the utilization of New and Renewable Energy (NRE) are key drivers of socio-economic transformation in many countries, including Indonesia. Gender equality within the Sustainable Development Goals (SDGs) emphasizes women's empowerment in accessing and utilizing NRE. However, gender inequality remains a challenge in the renewable energy sector, including in Cirebon City, Indonesia, where female students face limited access, participation, and understanding of digitalization and NRE utilization. This study aims to analyze the contribution of digitalization and renewable energy utilization in improving gender equality among students, as well as identifying barriers and opportunities for implementation. A qualitative case study approach was employed using participatory observation, in-depth interviews, document analysis, and focus group discussions (FGDs) to obtain an in-depth understanding of the phenomenon. The findings indicate that digitalization significantly expands women's access to information and educational opportunities, thereby enhancing their skills and awareness of renewable energy. The integration of digitalization and renewable energy contributes to improved gender equality, reflected in increased participation of female students. However, structural and social barriers still exist. The study highlights the importance of strengthening women's access to

renewable energy to enhance their social, educational, and economic roles. **Keywords:** digitalization; gender equality; renewable energy; university students

1 Introduction

This research is underpinned by the legal background (formal legal and policy) that includes regulations on digitalization, renewable energy, and gender equality. The local policy of Cirebon Regional Regulation number 2 of 2018 concerning gender mainstreaming aims to improve gender equality in all aspects, such as technology and energy. At the national level, the 1945 Constitution article 28 D paragraph 1 guarantees individual rights to recognition, guarantees, protection and certainty of fair law and equal treatment before the law, Law no. 7 of 1984 concerning the Elimination of Forms of Discrimination against Women Gender Equality (CEDAW) that women must have equal access in various fields including education and technology. Law on Digitalization Policy, Presidential Regulation number 22 of 2017 concerning the National Energy General Plan. Sustainable Development Goals SDGs 2030 5 concerning Gender Equality encourages women's participation in all areas of life. Internationally, the Paris Agreement (2015) prioritizes the transition to clean energy with the involvement of women in environmentally sustainable areas (Hammond, 2021; Karim, Agus, et al., 2023).

Smart city in Cirebon, a smart city initiative, can use digital technology to increase the role of women in the SDGs. Big data and the Internet of Things (IoT) are utilized in analyzing the role of women in the renewable energy sector. All of these statements are current trends that support this article.

Philosophically, social philosophy calls technology a tool for women's emancipation. In the local context of Cirebon, digitalization can support independent female students in education, work, and renewable energy innovation. Technology allows women to escape structural limitations and play an active role.

Research refers to the grand theory of socialist feminism. Middle theory explains the specific mechanisms and social processes that produce gender inequality, focusing on women's access to EBT, referring to intersectional feminist theory, exploring the experience of gender inequality that arises driven by factors of race, class, ability with the support of a more complex and inclusive approach to fighting for aspects of justice and equality, (Cannon & Chu, 2021). Applied theory is oriented towards developing strate-

gies and practical interventions to anticipate gender inequality at local and national levels through environmental feminism.

Theoretical studies refer to Bourdieu and Putnam's social capital theory (2016), which prioritize social relationships and networks that can increase access to resources, including research contexts. Digitalization opens opportunities for women to build online social capital platforms, professional communities, and academic networks that encourage their involvement in EBT (Majid & Jaaffar, 2023).

Several theoretical perspectives are analyzed. The main perspective of digitalization and women's empowerment increases access to information, education, and economic opportunities. However, limited access barriers, algorithmic bias, and online harassment must be overcome.

Rationally, the global phenomenon gap seeks to increase the role of women in the EBT sector. However, gaps arise in access to STEM education and leadership positions. Nationally, in Indonesia, there are initiatives to empower women in the EBT sector, including the challenge of access to clean energy sources, but minimal roles in determining policies.

Locally, Cirebon students have the opportunity to increase awareness and the role of women through programs focused on education and training.

Preliminary, Cirebon, as a developing city, faces the challenge of achieving gender equality among students. Digitalization and renewable energy have the potential to empower women by increasing gender equality.

The results of initial observations and interviews in the field showed that renewable energy problems include a lack of infrastructure, public awareness, and human resources. Although women play an important role in access and utilization of energy, they have not been represented by the renewable energy sector due to gender stereotypes, lack of access to education and training, financial support, involvement in policy making, and double workloads; those are important requirements for achieving sustainable development (Kurniati, 2021; Karim et al., 2022).

Cirebon has enormous renewable energy potential. Solar energy (solar power) with an average solar radiation of 4.5 kWh/m2 per day as a renewable energy source has high potential to be developed, namely: (1) a 1 MW rooftop Solar Power Plant (PLTS) for household needs; (2) for industry and business, there is Solar Power Water Pumps Solar (PATS), a water pump system that utilizes solar energy in fields, gardens and rice fields;

(3) Solar Street Lighting (PJU-TS), a solar energy street light as a source of power to illuminate the road; (4) Solar Home System (SHS) Solar Power Generation System that supplies electricity in areas that have not been reached by the electricity network, turning on fans, lights and other electronic equipment (Wulandari, 2022; Karim, Purnomo, et al., 2020). Solar energy reduces greenhouse gas emissions and air pollution, increases energy security and community welfare, saves electricity costs, and creates jobs (Bappenas, 2021; Karim, Faiz, et al., 2020). Policies and initiatives that encourage gender equality in the campus environment tend to be inclusive to support women and build collaboration between universities, local governments and the private sector to create an ecosystem that encourages women (Plumwood, 2023; Karim, Fathurrohman, et al., 2023).

Data from five previous studies strengthens the indication of the problem with the proposed solution. First, a study on women and EBT by Srikandi Lestari (2018) discusses gender mainstreaming in the development of EBT. Second, a study on gender and EBT by the Indonesian Women's Coalition in 2019 examined the impact of the availability and unavailability of clean renewable energy on men and women. Third, the Portrait of Energy Transition in Indonesia AEER in 2022 examined the practice of energy transition and found that the involvement of women in the planning and implementation of EBT projects was still low. Fourth, a study titled "Empowering Women in a Just Energy Transition: Retraining and Retraining Initiatives for a Sustainable Future" by Laura Becerra (2024) examines the challenges of women in the energy sector and the limited access to technical education and bias in hiring practices, prioritizing the importance of retraining initiatives specifically designed for women to equip them with skills in the renewable energy sector. Fifth, Reflection on International Woman's Day: Women in the Energy Transition by the Purnomo Yusgiantoro Center in 2023 examines the representation of women in the renewable energy sector globally at around 3%, emphasizing the importance of policies that accommodate gender equality and social inclusion (GESI) in the energy sector. The solution: policy making ensures women's participation in the planning and implementation of renewable energy projects and investments to increase women's capacity and skills. The sixth study prioritizes the need to integrate gender perspectives in developing renewable energy and digitalization with solutions to increasing women's access to technical education and training, active involvement in the renewable energy sector, and policy development to promote gender equality and social inclusion.

Problem indications include the gap in access and digital literacy of male and female students; lack of female participation; gender norms and stereotypes that hinder women's progress in technology and energy; and limited access to information and resources re-

lated to renewable energy.

The main research problem is how digitalization and renewable energy increase gender equality among Cirebon students. The solutions offered by researchers: development of women-oriented digital literacy training programs, increasing access to technology and digital infrastructure for female students, providing a digital platform for sharing renewable energy information and knowledge, empowering female students to participate in renewable energy projects, and policy advocacy to encourage gender equality in digitalization and renewable energy.

Previous research in accordance with the solution offerings includes research related to the role of digital technology in empowering women, studies on women's participation in the renewable energy sector, research on the impact of digital literacy training programs on gender equality, the second series of ACCESS seminars on Women and Renewable Energy, Exploring Potential and Empowering Women in the Energy Sector, Integration Model of Local and Rural Women in the Mainstream Labor-Intensive Industry in the context of Poverty Alleviation and Gender Equality towards Achieving Sustainable SDGs in Indonesia, and Increasing Professionalism through PPL at DP3APPKB Cirebon City: Synergy for Women's Empowerment and Child Protection.

The formulation of the problem includes: how digitalization and renewable energy help women achieve gender equality?, what is the right strategy to increase digital literacy and women's participation in the field of renewable energy? And what is the role of female students in promoting digitalization and renewable energy? The objectives of the study are to find out: how digitalization and renewable energy help women achieve gender equality, the right strategy to increase digital literacy and women's participation, and the role of female students in promoting digitalization and renewable energy.

The study offers a new perspective in the study of gender equality by linking three main aspects that have not been widely discussed together, namely the digitalization of women's EBT and increasing gender equality among students in Cirebon. This study contributes to policy and education to provide new insights regarding how the integration of digital technology and EBT can be a tool for empowering women academics including recommending more inclusive and sustainable education policies.

A study on gender and clean renewable energy by the Indonesian Women's Coalition in 2019 examined the relationship between gender issues and the development of clean renewable energy, discussing the problem of the lack of gender mainstreaming in energy

policies.

Recommendations for developing gender-inclusive policies support the creation and implementation of renewable energy sector policies, especially accommodating GESI, ensuring women's participation at every stage of decision-making and implementation of energy projects, and empowering women through education and entrepreneurship to play a role in the renewable energy sector.

2 Methodology

The object of research referred to the group or phenomenon studied to understand how digitalization and EBT played a role in increasing gender equality among students. The object of research is women's digitalization, EBT, and gender equality.

The qualitative approach of the case study model analyzed research results with a specific context orientation, namely students in Cirebon. It explored experiences and perceptions of digitalization and EBT in promoting gender equality. On the other hand, the approach has the opportunity to explore the fields of technology, social, and culture that influence women's participation (Karim et al., 2025).

The qualitative method aimed to describe in detail and in-depth the experiences, perceptions and challenges faced by female students. The data were collected using in-depth interviews involving female students in Cirebon active in digitalization and EBT. Interviews were conducted with lecturers, gender equality activists, practitioners in the field of EBT and experts at the Ministry of Energy and Mineral Resources. To obtain a broader perspective,the researchers conducted participatory observation, directly observing student involvement in digitalization and EBT activities such as seminars, community projects and training. The documentation was done through collecting academic document data, campus policies related to gender, technology and relevant literature studies to strengthen the analysis through a thematic analysis approach based on data reduction steps, thematic categories and drawing conclusions (Sahrodi et al., 2025).

The descriptive explorative research with a qualitative case study aimed to explore the phenomenon of women's involvement in digitalization and EBT and the impact on gender equality of students in Cirebon. The descriptive method aimed to describe conditions and phenomena in depth. The exploratory method explored new aspects related to the rela-

tionship between digitalization, EBT, and gender equality of female students. The study focused on specific cases of female students based on observation data, interviews and document studies of gender policies, technology and green energy. The study observed the phenomenon of female academics adapting through the development of digitalization and EBT. Qualitative was oriented towards understanding the meaning, experience, and perception of research subjects through observation, interviews and document studies so that researchers can provide new insights into how digitalization and EBT can improve gender equality, including the opportunities and challenges faced by female students (Muhajir et al., 2025).

Data sources included primary data and secondary data. Primary data were obtained directly from research subjects through interviews with female students in Cirebon, participatory observation to see female students directly access and utilize digital technology in the field of EBT, FGD with academics, students and practitioners exploring experiences and challenges. Secondary data were obtained from various documents and relevant literature sources such as university policy documents related to women's empowerment, digitalization and renewable energy, previous reports and research related to gender, renewable energy and digital technology as well as journal articles, books and statistical data from related agencies of the Ministry of Education and Culture, ESDM and NGOs working in the field of gender equality and technology.

Respondents were individuals related to the research theme as the main actors or parties who understood the context of digitalization, EBT and gender equality in Cirebon with the categories of female students involved in digitalization and EBT, academics and lecturers in the fields of technology, EBT and gender at universities in Cirebon, practitioners/professionals in the digitalization and EBT industry who had the potential to provide perspectives related to opportunities and challenges for women in this sector, policy makers at universities and organizations that played a role in developing policies for empowering women and EBT.

Table 1: Respondent Characteristics

No.	Characteristics	Category	Total (n)	Percentage (%)
1	Age	< 20 years	5	10
		20–25 years	40	80
		> 25 years	5	10

No.	Characteristics	Category	Total (n)	Percentage (%)
2	Gender	Male	10	20
		Female	40	80
3	Social Status	Students do not work	40	80
		Students work part-time	5	10
		Students work full-time	5	10
4	Education Level	Diploma	0	0
		Bachelor	40	80
		Postgraduate	10	20
5	Access to Digital Technology	No Access	0	0
		Limited Access	10	20
		Full Access	40	80
6	Knowledge related to EBT	Do not know	10	20
		Quite knowledgable	20	40
		Very knowledgeable	20	40
7	Participation in gender equality programs	Never	10	20
		Ever	40	80

Relevant to the research objectives were female students from 5 Cirebon universities with the following criteria: having digitalization and EBT programs or interests; having experiences in digitalization and green energy activities such as organizations, communities or research; aged 18 to 25 years as a representation of the young generation active in academics and technology; having an understanding or interest in gender equality issues in academics and the world of work; willing to participate in research by providing insights, experiences and opinions on digitalization and EBT. Meanwhile, the lecturers involved in this study had the following criteria: academics teaching in the field of digital technology, EBT, or gender at Cirebon universities; having research or project experience according to the research theme and understanding academic policies related to women's empowerment in technology and green energy. Practitioners or professionals should be in the digitalization or EBT sector industry in Cirebon and its surroundings, understand the challenges and opportunities for women, and have experience in programs or projects supporting women's involvement in the green energy and technology sectors. Policy makers and women's empowerment organizations should be involved in formulating policies or

programs to encourage women's digitalization and EBT, represent organizations or communities actively advocating for gender equality, and have insight into regulations and policies influencing women's participation in energy and digitalization.

Data sources, respondents, and characteristics of research respondents were designed to provide a comprehensive and in-depth understanding. Data sources include primary data (observation, interviews and FGD) and secondary data (policy documents, academic literature, and research reports) (Zhang, 2024). The main respondents were female students participating in digitalization and EBT, including academics, policy makers, and practitioners.

Table 2: Data Collection Techniques and Research Instruments

No.	Data Collection Techniques	Research Instruments	Data Collection Objectives
1	Questionnaire	Closed questionnaire and open questionnaire	Measuring students' perceptions and understanding of women's digitalization, EBT and gender equality
2	Interview	Interview guidelines	Obtaining in-depth data on opinions, experiences and challenges faced by students regarding the issue
3	Observation	Observation sheet	Observing student participation in activities related to digitalization and EBT
4	Document Study	Academic documents, journal articles, government policies	Providing secondary data on regulations and practices of women's digitalization in EBT

Source: Results of observations, interviews, and document studies from January 2 to February 20, 2025. Source: Results of observations, interviews, and document studies from January 2 to February 20, 2025.

Qualitative data analysis techniques for case studies were systematic in creating understanding, referring to Miles & Huberman (2021) and Yin (2023). Through data reduction

of observation results, interviews, and document studies, the data were classified based on the main research themes such as the role of digitalization in women's empowerment, the use of EBT by women and gender equality for students related to digitalization and EBT. Data simplification was carried out by filtering relevant information, eliminating data that did not support the focus of the research, and summarizing the core of each finding; the reduction process includes coding and classifying certain categories (Creswell, 2021). Data presentation aims to provide a structured picture of digitalization, gender equality and EBT. The data were presented in a thematic matrix showing the relationship between digitalization, EBT and gender equality among students and a conceptual model describing the role of women in the transformation of EBT through digitalization (Imbulana Arachchi & Bandyopadyay, 2021).

Conclusion drawing and verification were done after the data were presented. After that, the steps were analyzing patterns, relationships, and main findings. Conclusions were verified by data triangulation to ensure consistency. Researchers refer to Yin's (2023) case study analysis technique, namely pattern matching, comparing patterns with previous theories or studies, explanation building, compiling explanations according to research findings to understand the phenomenon more deeply, and time series analysis seeing how digitalization and EBT have developed over time.

Research data was validated to ensure the validity and reliability of the findings of women's digitalization and EBT in improving gender equality of students. The research used source, theory, and method triangulation techniques to achieve data validity. Source triangulation with collecting data from various informants such as lecturers, students, activists, and practitioners in the field of digitalization and EBT to obtain diverse and in-depth perspectives (Casta et al., 2021).

3 Results

The author chose the case of students in Cirebon as the object of research, with a sample of 50 students from 5 state and private universities in Cirebon City. Data were collected by interviewing 50 students representing five universities with considerations of data saturation, data completeness, availability of time and resources, snowball sampling techniques, purposive sampling techniques, and theoretical sampling techniques. Participant observation of digitalization activities with renewable energy was carried out for 3 months,

collecting the following documents: student activity reports, news articles, news journal articles, and social media (Creswell, 2021).

Document study and content analysis were conducted to explore written sources that provide in-depth information on the studied phenomena. It aimed at: identifying policies, programs and initiatives for the digitalization of women and EBT; tracing history, trends, developments in digitalization and its implementation in society involving women; and understanding the local context in the Cirebon City environment related to gender equality and women's participation in the EBT and digitalization sectors. Government documents included policy reports, laws, regional regulations and EBT programs, digitalization and women's empowerment, reports from Non-Governmental Organizations that study the field of gender equality and justice, women's empowerment and EBT in Indonesia, especially in Cirebon City, academic articles and journal publications on the theme of gender equality and justice, digitalization and EBT.

Content analysis was used to understand the content of certain texts or media, aiming to identify themes, trends, or patterns related to women's digitalization and EBT and how both affected students' gender equality and justice.

Case study artifacts referred to various types of data and evidence collected and analyzed to understand how digitalization with EBT affected gender equality, becoming concrete evidence used by research to drive findings and analysis. In research on women's digitalization and EBT on improving gender equality and justice, artifacts included various types of data and documents relevant to the topic, with several artifacts used in case studies.

Artifacts served as empirical evidence to drive analysis, supporting researchers in drawing conclusions about digitalization and EBT affecting the gender equality of female students in Cirebon City.

3.1 Digitalization and Renewable Energy Help Women Achieve Gender Equality

Data on digitalization and renewable energy that helps women achieve gender equality were taken using questionnaires, in-depth interviews, participatory observations, and documentation. Regarding the level of digital participation, initial findings showed that 75% of female students were active in digital media. In renewable energy initiatives, 30% have participated in green projects.

Research on digital literacy and renewable energy in the context of equality focuses on understanding how both aspects promote gender equality because: first, access to digital technology. Digital literacy provides greater access to women in education, information and employment opportunities. Through understanding technology, women can use new economic opportunities, participate in e-commerce, and remote work, including access to health services and education. Through digital literacy, women can easily and quickly access training with resources to improve their skills. Third, the transition to renewable energy and the role of women with the transition to renewable energy, such as solar and wind energy, provides opportunities for inclusive energy sectors for women. Fourth is socio-economic empowerment; digital literacy with access to clean energy provides economic autonomy to women, which is important in promoting gender equality. With economic independence, women participate more in decision-making, from the household environment to the community. Fifth, social change supported by digital technology plays a key role in facilitating global discussions on gender equality, women's rights, and empowerment. Sixth, EBT and sustainability in economic transition are oriented towards increasing social justice, supporting carbon emission reduction, and generating opportunities for women in various emerging sectors (Baruah & Biskupski-Mujanovic, 2021).

Looking at the digital participation level indicator, the initial findings showed that 75% of female students were active in digital media. In terms of initiatives regarding renewable energy, 30% had participated in green projects. Campus support resulted in digital and energy start-up incubation programs. The main obstacles are a lack of access to training and stereotypical roles. Opportunities utilized by female students showed a high interest in technology and environmentally-based projects.

3.2 The Right Strategy to Increase Digital Literacy and Women's Participation in the Renewable Energy Sector

In terms of the digital literacy level, temporary findings show that 68% are in the middle category. 52% are interested in EBT although it is not yet widely involved. Effective strategies are implemented through practical project-based training, mentoring successful female alumni of EBT, online communication, and thematic social media. The main obstacles are the lack of special programs for women and inflexible training schedules. The potential for collaboration is in the form of support from lecturers. Student organizations exist but need to be optimized.

There is a need for a strategy to increase digital literacy and women's participation in the field of EBT because the two are interconnected and can support gender equality, sustainable development, and women's empowerment. Some of the backgrounds to increasing digital literacy and EBT include: encouraging gender equality with women's economic empowerment, reducing digital inequality by increasing access to information, strengthening the role of women in sustainable development: with clean energy management and increasing women's participation in decision-making and innovation in the EBT sector (Baruah & Gaudet, 2022).

Table 3: Women's Participation in EBT

No.	Type	Description
1	Continuing Education and Training	Special training for women in digital technology and renewable energy includes basic digital skills, introduction to renewable energy such as solar panels, technical knowledge of installation, maintenance and management of renewable energy projects. Inclusive STEM (Science, Technology, Engineering and Mathematics) curriculum for women from elementary school to college consists of relevant teaching materials and inspires the role of women in innovation and technology.
2	Empowerment through Access to Technology	Expanding the Internet Network and digital infrastructure with wider access to the internet, especially in rural and remote areas, many women have not had the opportunity to utilize digital technology with strong infrastructure, providing opportunities for women to learn and participate in EBT through online platforms and e-learning programs. Distribution of affordable Technology Tools with the availability of technology tools, including smartphones, computers, laptops, iPads and affordable devices, subsidy programs so that women can access opportunities and information.

No.	Type	Description
3	Collaboration with the Private Sector and Non-Governmental Organizations	Partnership with EBT Companies to produce internship and job training programs, prioritizing women with industry leaders. Encouragement of women-oriented non-governmental organizations (NGOs) to support the spread of digital literacy and EBT community programs, campaigns, and other initiatives designed to disseminate women's participation in the energy sector.
4	Scholarship and Incentive Programs	Scholarships for renewable energy and digital technology increase the number of scholarships for women studying renewable energy, engineering, and digital technology. Scholarships are financially supported by research and innovative projects related to green energy. Incentives for companies to employ women by the government in the renewable energy sector, with employment opportunities for women, especially in technical and managerial positions, encouraging gender-responsive companies to support women's inclusion.
5	Public awareness campaigns	Social media campaigns and digital platforms, including public campaigns, spread awareness of the importance of women's roles in the renewable energy sector. Socialization includes the success of women involved in renewable energy projects and inspires others. Community digital literacy programs are attended by women sharing knowledge, discussing technology, and inspiring each other to explore renewable energy sector opportunities.

No.	Type	Description
6	Policies and regulations Promoting Gender Equality and Justice	To advance women's participation, the government is required to design policies to encourage women's participation in the renewable energy sector, including regulations to support companies to involve many women in renewable energy projects, including gender quotas, flexible work rules, with anti-discrimination policies. Regulations support the use of renewable energy by women through the development of renewable energy subsidy programs targeting women in rural areas to access and utilize clean energy to improve their standard of living.
7	Development of Women's Networks in Renewable Energy	Women's Community and Forum builds professional networks and forums for women interested in or working in the field of renewable energy as a forum for sharing knowledge, experiences, and collaboration opportunities for career development. Conferences, panel discussions, and seminars oriented towards women with innovation in the renewable energy sector create a space for women to learn and develop skills, including networking.

3.3 The Role of Female Students in Promoting Digitalization and Renewable Energy

The problem formulation data was taken from data based on questionnaire instruments, in-depth interviews, FGDs, documentation and literature studies. Regarding digitalization, 78% of female students actively utilize digital platforms for academic and organizational activities, 55% participate in digital training and many feel that digitalization opens up opportunities for MSMEs and self-development. Regarding EBT, 65% of respondents know the basic concept of EBT but only 23% have been involved in environmental project activities. Students who are members of campus organizations actively campaign for green energy. In terms of gender equality, 80% of respondents agree that women's participation

in digitalization and EBT can increase the strategic role of women in the future.

The results of the study showed that female students in Cirebon were actively involved in digitalization programs and EBT projects through academic and community activities. Research shows that EBT projects in higher education environments can be inclusive learning spaces for women in developing ideas and implementing projects. Challenges and obstacles include gender stereotypes, lack of access to technology training, and minimal support from the social environment. The impact of gender equality in digital collaboration with EBT can be a catalyst for achieving gender equality. Female students feel empowered and have equal opportunities to develop.

The role of female students in the digital era: first, in the field of technology and innovation, women are increasingly participating, leading innovation, and solving complex problems in the technology industry. Second, in business and entrepreneurship, women run start-ups or are involved in big technology. Third, digital literacy is important for women because the ability to utilize information technology effectively helps women access information, communicate, and participate in public discussions. Fourth, advocacy for gender equality, pioneers of inclusion, the vanguard of gender equality advocacy in the industrial and technological fields, supporting an inclusive and fair higher education environment, ensuring that women have equal access and opportunities in the digital field (Tregnago, G., 2024).

Regarding digitalization, 78% of female students actively utilize digital platforms for academic and organizational activities. 55% participate in digital training, and many digitalizations open opportunities for MSMEs and self-development. Regarding EBT, 65% of respondents know the basic concept of EBT, but only 23% are involved in environmental projects. Students, who are members of campus organizations, actively campaign for green energy, gender equality. 80% of respondents agree that women's participation in digitalization and EBT can increase the strategic role of women in the future. Still, the challenge is minimal support from higher education institutions for gender-based programs and green technology.

Inequality of digital access and women's literacy in Indonesia is confirmed by the Digital Divide Theory, which states that the gap in access and use of technology for community groups is based on gender. The analysis, the INFID and Kominfo studies show that women face obstacles in accessing digital technology, including limited time due to double workloads and gender stereotypes that assume men dominate technology. The discussion summary states that although 78% of female students actively utilize digi-

tal platforms, inequality of access and digital literacy is still a challenge for those from low socio-economic backgrounds. Data analysis shows that 65% of respondents know the basic concept of renewable energy, and 23% have been involved in environmental projects. The role of student organizations in the green energy campaign is confirmed by the Social Movement Theory, explaining that social groups can mobilize resources for collective goals.

Student organizations can become agents of change to promote renewable energy, requiring institutional support to strengthen their impact. Gender equality in digitalization and renewable energy is confirmed by the Empowerment Theory, prioritizing the importance of women's empowerment through access to resources and participation in decision-making. The analysis shows that 80% of respondents agree that women's participation in digitalization and renewable energy can increase strategic roles in the future. The discussion summary states that awareness of the importance of gender equality in the technology and energy sector has increased.

The process of female students supporting digitalization and EBT, including improving gender welfare, is a combination of education, advocacy, active participation in technology projects, influence in decision-making and community empowerment (Cannon & Chu, 2021). Participation at various stages supports the creation of more inclusive and sustainable changes in the social or environmental context.

Table 4: Effectiveness of Gender Equality of Students in Cirebon City

No.	Results	Description
1	The Role of Digitalization in Women's Empowerment	The results of the study show that digitalization has a positive impact on women's empowerment in the student environment. Many female students feel that access to digital technology, such as the internet and social media, supports them in getting more information. Digitalization provides opportunities for female students to develop new skills, in the field of technology with digital businesses that were previously dominated by men.

No.	Results	Description
2	EBT and Gender Equality	In the field of EBT, research explains that although there are great opportunities for women to participate, gender stereotypes and minimal awareness require women's participation. Most students do not yet understand EBT as a gender-exclusive field. On the other hand, students affected by education related to EBT are optimistic about the great opportunities for women in environmental care work.
3	Raising Gender Awareness	The study found that digitalization indirectly increases awareness of gender equality. Through easier and more open access to information, students are increasingly aware of the need for gender equality in various aspects of life, such as education and work, adopting more inclusive values for women in the field of technology or EBT.
4	Structural Barriers	The research identified several structural barriers, such as unequal access to digital technology among women from marginal economic backgrounds, and the stereotype that the renewable energy sector is more suitable for men, limiting women's interest and participation.

The study shows that digitalization and renewable energy have great potential to promote gender equality for students in Cirebon, although more efforts are needed to anticipate obstacles.

Specifically, the study found answers to questions such as how digital literacy levels of Cirebon women compare to men, what are the obstacles faced by women in accessing technology and utilizing renewable energy, what programs have been implemented to improve gender equality through digitalization and renewable energy, and the impact of these programs on women's lives. This study recommends improving welfare and gender equity in Cirebon by utilizing technology and sustainable energy.

4 Discussion

4.1 Digitalization and Renewable Energy Empower Women in Achieving Gender Equality

In the digital participation level, 75% of female students are active in digital media. Regarding initiatives regarding renewable energy, 30% have participated in green projects. Campus support resulted in digital and energy start-up incubation programs. The main obstacles are a lack of access to training and stereotypical roles. Female students show high interest in technology and environmentally based projects.

The issue has been discussed in five other studies. First, Ini Wayan Dian Irmayani, Ini Luh Putu Surya Astitiani, and Ida Ayu Ria Paramita from the Community Development Journal discussed digital literacy for millennial women facing technological developments. Digital literacy as the key to women's empowerment provides opportunities to adapt and use technology in everyday life (Irmayani et al., 2023). Then, Silitonga & Zatira (2023) addressed challenges in forming female leaders with digital literacy in Indonesia. Dinamica Governance emphasizes that culture and digital infrastructure support influence women's ability to become digitally literate leaders. Digital literacy and women have been addressed by Veranita (2023) in the Dialektika Journal, emphasizing the importance of women's roles in digital interactions in promoting family and community welfare.

Women's empowerment and the realization of women with digital literacy through the Perempuan Bercerita Digital Platform have been written by Aisyah Anggreni, Friska Indria Nora Harahap, Jihan Sunita, and Nurhasanah. It explores the women's story digital platform empowering women by sharing knowledge, learning and inspiring stories with a mentoring and economic empowerment platform, showing that technology can encourage women in various fields of life (Anggreni et al., 2022). Then, "change the stereotype: women are capable of technology" has been written by Amanda Simandjuntak from DW Indonesia. It discusses the women's innovation initiative aimed at overcoming gender stereotypes in the technological aspect with a digital skills training program for women, especially the underprivileged, to increase self-confidence and skills in the field of technology (Lolindu, 2024).

According to Confirmed Theory: Theory of Empowerment (Kabber, 1999), empowering women with access to digital technology can strengthen women's bargaining position in

social and economic spaces. Participation in the EBT project (30%) is confirmed by the Gender and Sustainable Development Theory (UN Women, 2024) that women's involvement in environmental initiatives has a dual impact on sustainable development and social justice. The discussion summary shows that 30% have participated in green projects, showing great potential for development. Lack of socialization and role space are the causes of low active participation, not lack of interest.

"Institutional Role: Digital and Energy Start-Up Incubation Program" confirmed the Supportive Institutional Theory (North, 1990): educational institutions are structural implementers that drive social transformation with systemic support. The analysis is from the data collected through open questionnaires and interviews with campus program managers and tested for content analysis with thematic matching. The discussion summary shows that universities in Cirebon have provided open start-up incubation programs for female students, including in the energy and digital fields. High Interest Opportunities for Technology and Environmental Projects confirmed the Opportunity Structure Theory (Cloward & Ohlin, 1960): Individual potential emerges when the opportunity structure supports. The discussion summary shows a strong indication that female students are highly interested in participating in green technology projects. If systematically facilitated, it can become a field for the regeneration of female leaders in the technology and environmental sectors (Majid & Jaaffar, 2023).

Confirmed Theory of Empowerment (Kabber, 1999): empowering women with access to digital technology can strengthen women's bargaining position in the social and economic space, The analysis uses descriptive statistics (frequency, percentage), supported by qualitative data from student narratives actively creating educational content, online stores, and digital freelancers. Participation in the EBT project (30%) is confirmed by the Gender and Sustainable Development Theory (UN Women, 2024). This study uses descriptive analysis of the Likert scale related to clean energy knowledge and qualitative narratives of students who are members of the nature lover community and the green campus campaign. The summary of the discussion shows that even though 30% participated in the green project, great potential has been developed. Lack of socialization and role space are factors in low active participation, not lack of interest.

Institutional Role: Digital and Energy Start-Up Incubation Program confirmed the Supportive Institutional Theory (North, 1990): educational institutions, as structural implementers, can drive social transformation with systemic support. The discussion summary shows that several Cirebon universities offer start-up incubation programs for female students.

The analysis is from data collected from open questions in questionnaires and focus group discussion forums (FGD), classified based on the theme of structural and cultural barriers. High Interest Opportunities for Technology and Environmental Projects confirmed the Opportunity Structure Theory (Cloward & Ohlin, 1960): individual potential arises if the opportunity structure supports it. The discussion summary shows a strong indication that female students are highly interested in participating in green technology projects.

Thus, digitalization and EBT provide opportunities, access and tools for women to improve their skills, economic involvement and social influence, encourage overcoming social and structural social barriers that hinder gender equality, encourage women to achieve more equal and empowered roles in various aspects of life (Mahajan & Bandyopadhyay, 2021).

4.2 Strategy for Increasing Digital Literacy and Women's Participation in the Renewable Energy Sector

The data summary shows the digital literacy level indicator with temporary findings of 68% in the middle category. Regarding EBT, 52% are interested even though not much is involved, effective project-based practical training strategies, mentoring successful female EBT alumni, online communication and thematic social media. A study on student digital literacy in the digital transformation era by Widyastuti and Rahmawati (2021) confirmed the Digital Literacy Theory (Paul Gilster), which states that digital literacy includes understanding and utilizing learning and life technology. Women and EBT Participation Study in Green Projects by Arumsari et al. (2020) confirmed the Gender and Sustainable Development Theory (UNDP, 2016), women play an important role in sustainable development, including the energy transition. The analysis, surveys and interviews with women involved in clean energy projects found that 40% of students had been directly involved. The summary of the discussion states that women show high interest in environmental and energy issues but low involvement. The effectiveness of mentoring women in STEM and EBT by Safitri and Handayani (2022) is confirmed by the Social Cognitive Career Theory (Lent et al., 1994), which states that social support and role models increase self-efficacy and participation of women in STEM fields.

Through a qualitative study of in-depth interviews, thematic analysis was carried out to map the impact of mentoring. The discussion summary shows that mentoring successful female alumni in the EBT field supports participants' confidence and has a career picture that strengthens networks and involvement in energy projects. Gender-Sensitive

Digital Training Strategy: A case study of a Local NGO studied by Nurul Aini (2021), confirmed the Empowerment Theory (Kabeer, 1999) that training considers the needs of women, especially increasing participation and empowerment. In the analysis, field observations and FGDs of NGO training programs and program evaluations are carried out using the outcome mapping approach. Collaboration between Campus and Student Organizations in Technology Literacy was studied by Mulyani et al. (2023), confirmed the Theory of Collaborative Learning (Vygotsky) social interaction in collaborative learning supports understanding and motivation to learn. Analysis was done using qualitative methods, surveys and interviews of lecturers and BEM heads, whereas evaluation was done using the SWOT method. The discussion summarizes that collaboration between students, lecturers and organizations produces a learning space and innovation, although not optimal.

4.3 The Role of Female Students in Encouraging Digitalization and EBT

The data summary consists of digitalization: 78% of female students actively utilize digital platforms for academic and organizational activities, and 55% participate in digital training. Many feel that digitalization opens up opportunities for MSMEs and self-development. In terms of EBT, 65% of respondents know the basic concept of EBT but only 23% are involved in environmental project activities. Students who are members of campus organizations actively campaign for green energy. Regarding gender equality, 80% of respondents agree that women's participation in digitalization and EBT increases the strategic role of women in the future.

Inequality of Digital Access and Women's Literacy in Indonesia is confirmed by the Digital Divide Theory, which states that there is a gap in access and use of technology for community groups based on gender. The analysis, the INFID and Kominfo studies show that women face obstacles in accessing digital technology, including limited time due to double workloads and gender stereotypes that technology is dominated by men. The discussion summary states that although 78% of female students actively utilize digital platforms, inequality of access and digital literacy is a challenge, especially from low socio-economic backgrounds. Data analysis shows that 65% of respondents know the basic concept of EBT, and only 23% are involved in environmental projects. This reflects the low involvement of women in the EBT sector. The summary of the discussion shows that women's

involvement in EBT is still lacking, due to the lack of special programs that encourage participation and the stereotype of the energy sector being dominated by masculine.

In the analysis, from the interview method, students who are members of campus organizations actively campaigning for green energy show great potential to encourage awareness and participation in environmental issues. In summary of the discussion, student organizations can become agents of change promoting EBT, but need institutional support to strengthen their impact. The analysis shows that 80% of respondents agree that women's participation in digitalization and EBT can increase their strategic role in the future. The discussion summary mentions the importance of increasing awareness of gender equality in the technology and energy sector, although the lack of support from higher education institutions for gender equality and green technology programs hampers its implementation. The analysis shows that the main challenge faced is the limited support from higher education institutions for gender equality and green technology programs.

Research findings related to women's digitalization and the use of renewable energy in improving gender equality are considered important. First, in the context of Cirebon, the research provides an in-depth understanding of Cirebon's specific conditions related to gender disparities, access to technology using renewable energy in the local context, and interventions are designed appropriately. Second, building appropriate policies that are the basis for decision-making: research findings can be the basis for local governments, educational institutions, and stakeholders to formulate more effective policies and programs to improve gender equality. Third, developing women's empowerment programs in the form of a holistic approach: the research can encourage women's empowerment oriented towards increasing digital literacy and using renewable energy as a sustainable energy source. Fourth, it contributes to global research, including the development of science that contributes to the development of digital science, renewable energy and gender equality, especially in developing countries. Fifth, increasing public awareness: the socialization of research issues can increase public awareness of the importance of gender equality and the role of technology in empowering women with the potential and utilization of renewable energy and community mobilization; through better understanding, the community can actively contribute to realizing gender equality (Lazoroska, Palm, & Bergek, 2021).

4.4 Limitations

The study has several limitations. First, Cirebon has geographical limitations with certain social, economic, and cultural characteristics. Thus, the results of the study cannot necessarily be generalized to other areas with different social contexts or digital infrastructure, including large cities and rural areas. Second, participants are limited to students, generally in the 17-25 year age group, and have better access to technology than other community groups, thus limiting the understanding of the influence of digitalization and EBT on female gender groups outside the academic environment or students. Third, there is a limited access to detailed gender data on women's participation in the EBT sector, specific data on the use of digital technology by female students in Cirebon, resulting in less in-depth analysis, relying on limited secondary data, fourth, limited time and resources. The research was carried out over a certain period of time so that it only reflects current conditions, not long-term trends. It does not allow for longitudinal studies or observations of changes over time. There are also limited resources (funds, experts) that have the potential to limit the use of more comprehensive methods, including cross-university FGDs or surveys through a larger number of respondents. Fifth, there are qualitative methodological limitations; the results have the potential not be statistically generalized. Sixth, there are limited interdisciplinary perspectives. The topic involves several scientific fields (gender studies, energy, education, and technology). However, the researcher's limited scientific knowledge resulted in a less comprehensive analysis that was only oriented towards one area, such as the gender aspect, so that they did not master the analysis of technology and renewable energy in depth. Seventh, there are limitations of the socio-cultural context where cultural norms and perceptions related to gender can influence respondent participation and study results, including conservative views on the role of women in the technological and energy aspects. It is causing bias in respondents' answers and respondents' unwillingness to be open because gender issues are considered sensitive.

4.5 Implications

The research has implications for several parties, including university policies and human resources that function as catalysts to encourage gender equality and justice, so that higher education policies need to include gender equality components as part of the strategy for implementing technology and renewable energy programs. Universities

in Cirebon and others can use the findings to develop more inclusive policies, including providing special scholarships or training programs to increase women's participation in technology and renewable energy.

The research has important implications for the development of higher education curricula, especially considering the integration of digital technology and renewable energy in study programs related to engineering, energy and Science Technology Engineering and Mathematics which are designed to encourage women's participation, such as special training or collaborative renewable energy projects to increase the participation of female students and support them in choosing careers.

The inclusive use of digital technology can increase women's access to educational resources with opportunities for skill development that can accelerate empowerment in universities for the provision of easily accessible e-learning platforms, digital-based mentoring programs and special study groups for women.

The transition to renewable energy is supported by women's participation so that it positively impacts the development of the Cirebon renewable energy sector with the involvement of more female students in renewable energy programs. Universities are involved in strengthening local human resources that support the renewable energy transition to improve the competence of the renewable energy workforce and provide many job opportunities.

Support is needed from industry, government, and non-governmental organizations to anticipate funding challenges, joint training programs, and socialization of public awareness of the need for renewable energy and gender equality. Collaboration between various parties encourages the adoption of best practices in the use of digital technology and renewable energy to support gender equality and justice for students.

5 Conclusions

Digitalization and utilization of renewable energy contribute significantly to promoting gender equality for female students because digitalization opens wider access to information, education, digital entrepreneurship opportunities that directly increase aspects of women's independence, participation and competitiveness in social and academic environments. Meanwhile, women's involvement in renewable energy issues and projects en-

courages environmental awareness, strengthening roles in sectors previously dominated by men. The emergence of affordable and inclusive green technology reduces the gap in access to energy and technology between genders. The combination of both aspects shows that women are not only beneficiaries but agents of change in creating a just and sustainable society in terms of gender

An effective strategy to increase digital literacy and women's participation must be integrated, contextual, and based on gender inclusion. An approach that includes the integration of environmentally friendly technology-based curriculum, practical digital training, and the provision of creative community-based learning spaces can increase women's understanding and involvement. The strategy must be supported by collaboration between educational institutions, local governments and the private sector to create adaptive digital literacy programs, expand access to renewable energy resources and create an environment supporting women's active participation as innovators and drivers of change. Through targeted and sustainable strategies, women have a greater opportunity to play an equal role in digital transformation and the green energy transition.

Female students play a strategic role in promoting digitalization and renewable energy development as part of efforts to realize gender equality. With active participation in academic activities, campus organizations, and digital communities, female students can become agents of change that strengthen technological literacy and spread awareness of the importance of sustainable energy. Their role is evident in their contribution to environmentally based digital projects, educational campaigns for renewable energy, and the use of social media as an advocacy tool. Meanwhile, the participation of female students encourages inclusivity in fields that are still dominated by men, thus strengthening women's position as future leaders of sustainable development.

The study shows that digital technology plays an important role in facilitating more equal access for female students to obtain information, education and training related to the development of knowledge and skills. The use of digital technology in universities in Cirebon provides greater opportunities for female students to participate in academic and non-academic programs, increasing self-confidence and independence. The transition to renewable energy supports changes in the perspective of society and educational institutions towards the role of women in areas previously dominated by men, such as energy and technology. Awareness of the importance of sustainable energy sources supports the focus on the need for gender equality in anticipating the challenges of globalization in the realm of higher education where female students in Cirebon City show an increased

interest in the renewable energy field through university initiatives that socialize renewable energy programs or projects.

The challenges of achieving sustainable gender equality and justice include the inequality of access to digital infrastructure in several universities, the lack of policies to encourage gender equality in the fields of technology, energy and very strong social stereotypes related to gender roles in the university environment. Coordination is needed between the government, educational institutions, industry, and civil society organizations to create an ecosystem that encourages women's participation in digital technology and renewable energy. Ensuring that the programs developed anticipate real challenges and needs in the field is important.

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Educational institutions need to ensure that facilities and comprehensive digital technology access in higher education encourage active participation of female students in technology-based activities. Higher education institutions and local governments need to organize counseling and education on renewable energy with career potential for female students to encourage women's participation in the renewable energy sector.

The development of a gender equality-based curriculum attempts to integrate the field of gender equality with educational curriculum technology to produce a responsive and inclusive learning environment for the needs of all students. Strengthening inclusive policies, FGDs on equality and justice, by participating in scholarships or special training for female students.

Higher education institutions need to develop policies that encourage gender equality, provide student scholarships or organizational internship programs, collaborate with industry or non-profit organizations in the renewable energy sector, and empower women in the technology and renewable energy sectors to produce training programs, internships, or joint projects that improve students' skills and experience. Meanwhile, the implementation of ongoing policies and programs needs to be monitored and evaluated continuously and periodically to identify successes or obstacles faced and adjustments to suit student needs and developments.

Declarations

Ethical Approval

This study was conducted in accordance with the ethical principles for research involving human subjects. All procedures were performed in compliance with the Declaration of Helsinki. The research protocol was reviewed and approved by the Institutional Review Board of Universitas Islam Negeri Syekh Nurjati Cirebon (Approval Number: UIN.SN/IRB/2025/011).

Consent to Participate

Informed consent was obtained from all individual participants included in the study. Each participant was fully informed about the purpose, procedures, and potential impacts of the research, and their participation was voluntary.

Consent to Publish

Not applicable. This manuscript does not contain any individual person's data in any form (e.g., individual details, images or videos).

Data Availability

The datasets generated and/or analyzed during the current study are not publicly available due to privacy and ethical restrictions but are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare that they have no financial or non-financial competing interests in relation to this work.

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Author Contributions

R.P. conceptualized the study, conducted the fieldwork, and drafted the original manuscript. B.B. supervised the theoretical framework and substantially revised the

manuscript for critical intellectual content. A.K. performed data analysis, validation of results, and final approval of the version to be published. All authors reviewed and agreed to the published version of the manuscript.

References

Abd Majid, N., & Jaaffar, A. H. (2023). The effect of women's leadership on carbon disclosure by the top 100 global energy leaders. Sustainability, 15(11), 8491. https://doi.org/10.3390/su15118491

Anggreni, A. A., Harahap, F. I. N., Sunita, J., & Nurhasanah, N. (2022). Pemberdayaan perempuan dan perwujudan perempuan berliterasi digital melalui platform digital "Perempuan Berkisah". Learning Community: Jurnal Pendidikan Luar Sekolah, 6(2). https://doi.org/10.19184/jlc.v6i2.34387

Arias, K., et al. (2022). Green transition and gender bias: An analysis of renewable energy generation companies in Latin America. Inter-American Development Bank.

Aryanto, A. D., & Rahmawati, E. (2022). Digitalisasi dan pemberdayaan perempuan di Indonesia: Sebuah tinjauan literatur. Jurnal Ilmiah Administrasi Publik, 8(2), 145–158.

Bansal, M., & D'Agosti, N. (2024). Women in power: The role of gender in renewable energy policymaking. Environmental Research: Climate, 3, 025009.

Bappenas. (2021). Rencana pembangunan jangka menengah nasional (RPJMN) 2020–2024. Bappenas.

Baruah, B., & Gaudet, C. (2022). Creating and optimizing employment opportunities for women in the clean energy sector in Canada. Journal of Canadian Studies, 56(2), 240–270.

BPS. (2022). Statistik gender 2022. Badan Pusat Statistik.

BPS. (2023). Statistik gender 2023. Badan Pusat Statistik.

Casta, C., Rohidi, T. R., Triyanto, T., & Karim, A. (2021). Production of aesthetic tastes and creativity education of Indonesian glass painting artists. Harmonia: Journal of Arts Research and Education, 21(2), 266–277. https://doi.org/10.15294/harmonia.

v21i2.30348

Cannon, C. E. B., & Chu, E. K. (2021). Gender, sexuality, and feminist critiques in energy research: A review and call for transversal thinking. Energy Research & Social Science, 75, 102005.

Chan, et al. (2022). Tinjauan status dan tren masa depan tenaga surya fotovoltaik.

Hammond, G. P. (2021). Penilaian siklus hidup energi terbarukan: Sebuah tinjauan metodologis.

Haraway, D. (1991). A cyborg manifesto: Simians, cyborgs, and women: The reinvention of nature. Routledge.

Imbulana Arachchi, J., & Managi, S. (2021). Preferences for energy sustainability: Different effects of gender on knowledge and importance. Renewable and Sustainable Energy Reviews, 141, 110767.

Irmayani, N. W. D., Astitiani, N. L. P. S., & Handayani, I. A. R. P. (2023). Pemberdayaan perempuan millennial melalui literasi digital. Community Development Journal: Jurnal Pengabdian Masyarakat, 4(4), 7129–7133. https://doi.org/10.31004/cdj.v4i3.17932

Jin, H. (2024). Re-calibrating methodologies in social media research: Challenge the visual, work with speech. arXiv.

Karim, A., Agus, A., Nurnilasari, N., et al. (2023). A study on managerial leadership in education: A systematic literature review. Heliyon, 9(6), 1–20. https://doi.org/10.1016/j.heliyon.2023.e16834

Karim, A., Bakhtiar, A., Sahrodi, J., & Chang, P. H. (2022). Spiritual leadership behaviors in religious workplace: The case of pesantren. International Journal of Leadership in Education, 1–29. https://doi.org/10.1080/13603124.2022.2076285

Karim, A., Faiz, A., Parhan, M., et al. (2020). Managerial leadership in green living pharmacy activities for the development of students' environmental care in elementary schools. Journal of Critical Reviews, 7(13), 714–719. https://doi.org/10.31838/jcr.07.13.125

Karim, A., Fathurrohman, O., Saripudin, W., et al. (2023). Altruistic works, religion, and corruption: Kiais' leadership to shape anti-corruption values in pesantren. Cogent Social Sciences, 9(1), 1–25. https://doi.org/10.1080/23311886.2023.2238968

Karim, A., Purnomo, H., Fikriyah, F., & Kardiyati, E. N. (2020). A charismatic relationship: How a kyai's charismatic leadership and society's compliance are constructed? Journal of Indonesian Economy and Business, 35(2), 129–143.

Karim, A., Fathurrohman, O., Sulaiman, S., et al. (2025). How do principals act as leaders and managers in boarding and public school in Indonesia? Cogent Education, 12(1), 1–26. https://doi.org/10.1080/2331186X.2024.2445354

Kurniawati, R. (2021). Akses perempuan terhadap energi bersih dan berkelanjutan di Indonesia. Jurnal Perempuan, 28(2), 23–40.

Lazoroska, D., Palm, J., & Bergek, A. (2021). Perceptions of participation and the role of gender for engagement in solar energy communities in Sweden. Energy, Sustainability and Society, 11, 1–12.

Lazoroska, D., Palm, J., & Kojonsaari, A.-R. (2024). Gender-based opportunity structure in the energy sector: A literature review on women's networking and mentoring. Energy, Sustainability and Society, 14, Article 67.

Lolindu, M. E. (2024, October 22). Ubah stereotip: Perempuan juga mumpuni dalam teknologi. DW Indonesia. https://www.dw.com/id/ubah-stereotip-perempuan-juga-mumpuni-dalam-teknologi/a-70506324

Mahajan, R., & Bandyopadhyay, K. R. (2021). Women entrepreneurship and sustainable development: Select case studies from the sustainable energy sector. Journal of Enterprising Communities, 15(1), 42–75.

Michelen, M., Phan, M., & Zimmer, A. (2024). Practical qualitative data analysis for public health research: A guide to a team-based approach with flexible coding. International Journal of Qualitative Methods.

Mira Veranita. (2023). Literasi digital dan perempuan. Jurnal Dialektika: Jurnal Ilmu Sosial, 21(2), 27–33. https://doi.org/10.63309/dialektika.v21i2.147

Muhajir, M., Kultsum, U., Choiri, M. M., et al. (2025). Integrating multicultural values to foster tolerance and inclusivity in Islamic religious education. Jurnal Pendidikan Islam, 11(1), 17–32. https://doi.org/10.15575/jpi.v11i1.44607

Peraturan Presiden Republik Indonesia Nomor 112 Tahun 2022 tentang percepatan pengembangan energi baru terbarukan untuk penyediaan tenaga listrik.

Plumwood, V. (2023). Feminism and the mastery of nature. Routledge.

Putri, A. A., & Wardana, I. G. B. (2021). Perancangan sistem pembangkit listrik tenaga surya atap (PLTS atap) untuk rumah tinggal di Bali. Jurnal Ilmiah Teknik Elektro Universitas Udayana, 10(1), 75–82.

Santoso, & Budiman. (2023). Potensi energi surya di Indonesia. Renewable Energy, 175, 111–120.

Sahrodi, J., & Karim, A. (2024). Leader power of Islamic higher education institutions in improving the performance of human resources management. Cogent Arts & Humanities, 12(1), 1–17. https://doi.org/10.1080/23311983.2024.2442818

Sari, D. P., & Rahardjo, W. (2022). Analisis kinerja sistem pembangkit listrik tenaga surya terpusat di Indonesia. Jurnal Teknik Elektro, 14(2), 123–132.

Sumarno, T. B., Yasgiantoro, I. B., Fitriyanti, V., & Khusna, V. A. (2024). Challenges in increasing women's participation in the energy transition in ASEAN and G7 countries: A qualitative approach based on the three tenets of justice. Energy Policy, 191, 114163.

Sustainable Energy for All. (2017). Gender and energy in South Asia: Lessons from the field.

Tregnago, G. (2024). Increasing women's representation in the energy sector. Nature Energy, 9, 1177–1178.

Wulandari, D. (2022). Peran perempuan dalam transisi energi di Indonesia. Jurnal Energi dan Kelistrikan, 20(2), 101–110.

Zhang, H., Wu, C., Xie, J., et al. (2024). When qualitative research meets large language models: Exploring the potential of QualiGPT as a tool for qualitative coding. arXiv.