Afro-Asian Journal of Scientific Research (AAJSR)
المجلة الأفروآسيوية للبحث العلمي
E-ISSN: 2959-6505
Volume 4, Issue 2, 2026
Page No: 33-40
Website: https://aajsr.com/index.php/aajsr/index
SJIFactor 2024: 5.028 ISI 2025: 0.915 معامل التأثير العربي (AIF) 2025: 0.76

Public knowledge Perception of Health and Environmental Impacts of Shale Gas Extraction in Al Kufrah Region

Awatif Ahmed Almaqrahi[1*], Othman Aboubakr Jibreel[2], Wesam Omar Iwaz[3], Ehabeddin Elftisi[4], Abdulhamid Mohamed Alshinqeeti[5]
[1,3,4,5]Department of Environmental, Food and Biotechnological Applications, Libyan Center for Biotechnology Research, Libya
[2]Libyan Center for Biotechnology Research, Libya

تصور قاطني نطاق الكفرة للأثار البيئية والصحية لاستخلاص الغاز الصخري

عواطف أحمد عبدالله المقرحي[1*]، عثمان أبوبكر جبريل[2]، وسام عمر عيواز[3]، إيهاب الدين امحمد الفطيسي[4]، عبد الحميد محمد الشنقيطي[5]
[1،3،4،5]قسم البيئة والأغذية والتطبيقات الحيوية، المركز الليبي لبحوث التقنيات الحيوية، ليبيا
[2] مركز طب المناطق الحارة، الكفرة، ليبيا

*Corresponding author: awatifahmedmg@gmail.com

Received: February 09, 2026	Accepted: March 24, 2026	Published: April 05, 2026

Abstract:
Shale gas has emerged as a significant new energy source in various countries worldwide including Libya. Consequently, evaluating public perceptions of energy sources, especially shale gas, and integrating these perceptions into the development of energy policies and decision-making processes has become increasingly essential. This study showed of a descriptive case study of the local residents of AlKufrah region, in southeastern Libya (N=163), in order to assess their knowledge of shale gas and explore their views on how shale gas extraction can affect the health and environment, as well as if they accept it as a new source of energy. The finding showed that, nearly half of the respondents (48.4%) were familiar with shale gas, and a total of (38.6 %) were aware of the extraction process. An overall assessment indicated that 50.9 % of respondents expressed their support to shale gas extraction in their areas. We found a considerable awareness of potential health and environmental risks. We concluded that increased awareness may guide public attitude positively.

Key words: Hydraulic Fracture, Public Awareness, Risk perceptions, Shale gas.

الملخص:
برز الغاز الصخري كمصدر جديد ومهم للطاقة في العديد من دول العالم، بما في ذلك ليبيا. وبناءً على ذلك، أصبح تقييم تصورات الجمهور حول مصادر الطاقة، ولا سيما الغاز الصخري، ودمج هذه التصورات في تطوير سياسات الطاقة وعمليات اتخاذ القرار، أمرًا ذا أهمية متزايدة. تعتمد هذه الدراسة على منهج دراسة حالة وصفية لسكان منطقة الكفرة في جنوب شرق ليبيا، حيث بلغ حجم العينة (163) مشاركًا، وذلك بهدف تقييم مستوى معرفتهم بالغاز الصخري، واستكشاف آرائهم حول تأثيرات عمليات استخراجه على الصحة والبيئة، بالإضافة إلى مدى تقبلهم له كمصدر جديد للطاقة. أظهرت النتائج أن ما يقارب نصف المشاركين (48.4%) لديهم معرفة بالغاز الصخري، في حين أن (38.6%) فقط كانوا على دراية بعملية استخراجه. كما بيّن التقييم العام أن نسبة (50.9%) من المشاركين أعربوا عن دعمهم لعمليات استخراج الغاز الصخري في مناطقهم. وكشفت الدراسة عن وجود مستوى ملحوظ من الوعي بالمخاطر الصحية والبيئية المحتملة المرتبطة بهذه العمليات. وخلصت الدراسة إلى أن زيادة مستوى الوعي قد تسهم في توجيه مواقف الجمهور بشكل إيجابي.
الكلمات المفتاحية: التكسير الهيدروليكي، الوعي العام، إدراك المخاطر، الغاز الصخري.

Introduction:

The energy industry is constantly faced with challenges concerning the reliability of resources, expenses, and the impact on human health and the environment. The decrease in conventional resources and the necessity of addressing numerous scientific and technological challenges in order to achieve high production with minimal health and environmental impact are the reasons why unconventional hydrocarbons are attracting attention. Shale gas, as a new source of energy, has the potential to increase the world's energy supplies. Where shale gas is defined as natural gas confined within shale layers as illustrated in Figure 1. Shale gas is contained in the pores of this sedimentary rock [1], it primarily consists of methane and is found within mudstone and shale formations [2,3]. Shale gas is chemically similar to other types of natural gas, but the extraction process is quite different. Where the extraction and production of shale gas became technically feasible, according to two forms of technology: horizontal drilling and hydraulic fracturing [4,5].

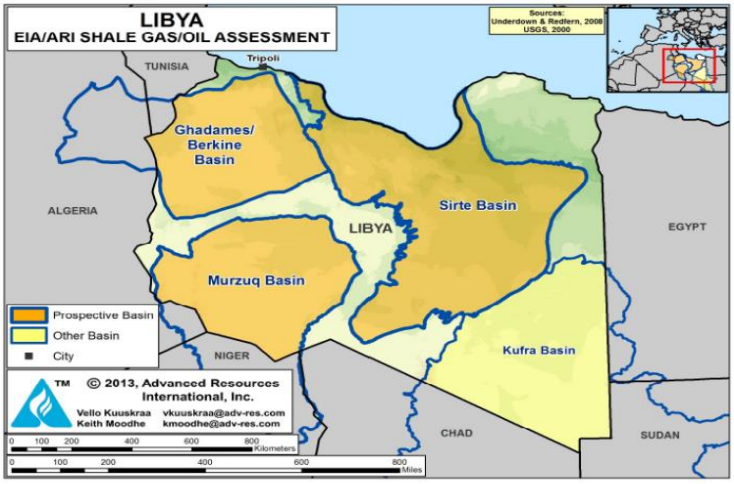

Figure (1): Source: ARI,2013

Unlike conventional wells, horizontal drilling (which is more complex than vertical drilling) is required for fracking in shale, as well as a large number of wells, and massive amounts of water and synthetic chemicals. [6,7]. Globally, combined technologies (vertical and horizontal fracturing) have led to increased gas development in shale formations across the US, Europe, Asia, Australia, and other regions [8]. Where the majority of hydraulic fracturing has taken place in the United States [9], the finding of shale gas resources in Central and Eastern Europe raised hopes for increased energy self-sufficiency in the region [10]. In Libya, where a proven quantities of shale gas were discovered, as seen in Fig. (1), Libya's sedimentary basins are categorized as: (1) continental basins (Ghadames, Murzuq, Sirte, Kufra, and Cyrenaica) and (2) offshore basins (Sabratah, Misratah, and Benghazi basins [11,12]. With respect to the Ghadames basin, Algeria, Tunisia, and Libya are exploring adjacent areas of the same basin [13]. The Kufrah Basin is discussed but not quantitatively assessed [14,15].

Despite its economic importance globally and in Libya, shale gas extraction may pose environmental and public health risks, fracking is often criticized due to its potential effects on both the human health and environment. The major concern about hydraulic fracturing is the significant influence is on water availability and quality. Furthermore, many argue that the toxic or hazardous chemical additives used are carcinogenic on the long term [5]. As Hydraulic fracturing requires (2.57-37.85 million m3) of water per well and fracture [16]. This situation raises alarms regarding the exhaustion of both surface and groundwater resources. Additionally, there is a risk of contamination of both underground and surface water due to insufficiently treated drilling wastewater containing potentially hazardous substances, chemical spills on the surface, and the migration of methane from gas wells into aquifers [17].

Accordingly, the American Environmental Protection Agency (2011) investigated the connection between drinking water quality and hydraulic fracturing from a public health and environmental standpoint. Regulations pertaining to the disclosure of the chemical components of hydraulic fracturing fluid have also been enacted by federal and state agencies [18]. Equally important, one of the considerable environmental issue related to shale gas extracting is air pollution. Primarily by releasing methane gas, and the various air contaminants linked to extracting activities, which affect the respiratory and neurological health [19] It is also noticed that a significant increase in seismic activity have also been linked to the discharge of wastewater from fracking [20]. As well, the development of shale gas resources demands a dense spacing of well pads, which increases land consumption [21],

Subsequently, the establishment of fracking sites may result in the destruction of wildlife habitats, a species reduction, and habitat loss for animals [22]. Research regarding perceptions of renewable energy indicates that a significant issue is the preservation of cherished landscapes [23].

Furthermore, there are also a serious concern about the effect of hydraulic fracturing activities on soil contamination [24]. In addition, the infrastructure for exporting natural gas is matter of controversy, as concerns about climate change have gotten greater. [25]. Another essential point, that studies, especially from the United States, which has had a lengthier adoption of hydraulic fracturing "fracking " technology, indicate risks such as changes in 'quality of life' [26] and loss of identity [27] when local communities become industrialized as shale gas activities expand. Moreover, as additional workers and industry move into a region, demand may grow, placing pressure on public services like schools, leisure centers, water and sewage, healthcare, and infrastructure like roads [28].

On the other hand, Shale gas is having a beneficial impact on supplies and consumer prices for natural gas, including economic benefit as improve energy security, reduce CO2 emissions, and promote economic development, including wage increase, job creation, financial stability for future generations [29], market expansion, and improved public services [30]. Since public understanding of shale gas extraction can either facilitate or handicap its development. Studies on shale gas production perceptions show Conflicting views and widespread doubt among laypeople [31]. Accordingly, some European governments have opted to ban the shale gas extraction, or to restrict the primary extraction method, hydraulic fracturing [32]. With concerns about human health, environmental costs and community effect [33]. In United States, Research has indicated that, to a certain degree, public opinion influences energy policy decisions [34].

In light of these conflicts, planners must have a thorough understanding of public support and opposition [35]. Building on the above. This understanding could either help or handicap government policies, business growth, and consumer preferences. In our study, we wanted to explore public understanding and acceptability of shale gas development in kuffrah region. Furthermore, to examine whether the public knowledge of the extraction consequences of shale gas may affect the acceptance of shale gas as an alternative source of energy.

Methodology:

Study area:

The survey were undertaken in the region of Al Kuffra in the southeast of Libya, figure (1), where shale gas extraction has not taken place and has not received a lot of attention from the media. The study area was chosen to provide a range of demographic and geological factors, covering areas that are within the shale gas reserves. To some extent of importance, the sample was intentionally chosen to mirror the composition of the local regions based on age, gender, socioeconomic status, and home ownership. All ethical guideline was properly followed, including obtaining the respondents' agreement, and confidentiality guarantees.

Design and measures:

The survey was carried out by engaging a total of 163 local participants, using both paper and online formats. The study was conducted between March 2023and August 2024. In order to establish a survey design that is both effective and carefully planned, the questions were categorized into sections based on the subject matter. The first section of the survey focused on collecting socio-demographic information about the respondents. The second set of scales included questions about (regarding) knowledge of shale gas and hydraulic fracture. The third set of scales comprised questions regarding potential health and environmental risks due to the extraction process, where the risk factors included long and short-term health issues, air pollution, noise pollution, groundwater contamination, animal habitat destruction, vegetation degradation, and geologic risks. Participants were asked to judge the risks on the scale from 0 to 10 as well. Furthermore, the benefits of shale gas were also included within the measurement, such as the economic growth, energy security, and offering new jobs. Our fourth measure to get a sense of the acceptance of shale gas extraction, an "overall" question, in the context of the survey, was set to capture a respondent's general or comprehensive opinion, participants were asked to decide whether they supported or opposed future shale gas extraction projects. The data was extracted and analyzes through the Statistical Package for Social Sciences (SPSS).

Results and discussion:

Social and Demographic Characteristics:

Social and demographic variables are essential for comprehending the composition of the study sample and for guaranteeing accurate interpretation of the research findings, as they offer critical context concerning population diversity and representativeness [36]. The characteristics of the achieved sample show that the respondents were rather young, well educated, and the gender distribution was almost balanced, male (42.4 %) and female (57.6 %), as shown in Figure (2). With about 55.6% of respondents falling between the ages of 18 and 34. These variables are considered among the factors

that contribute to the interpretation of the results. Table (1) displays the educational level and social status of the Sample.

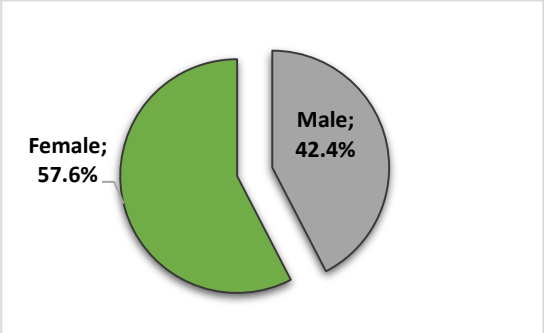

Figure (2): Participants by Gender

Table (1): Educational Level and Social Status of the Sample

Gender	Percentage
Single	58.8%
Married	41.2%
Education	
Basic Education	5.7%
secondary education or equivalent	22.3%
Higher Education	66.2%
Illiterate	5.8%

Familiarity:

Participants were initially asked to indicate their knowledge of shale gas, 48.4% of them indicated prior aware of the topic. Subsequently, participants were asked about their knowledge of the extraction process (hydraulic fraction), only 38.6% admitted to being familiar with it, and 46.8% indicated that they were unaware of it. Whereas 14.6% were unsure. As shown in Figure (3), the findings indicate a moderate level of general awareness of shale gas, with significantly lower familiarity regarding the extraction process, as illustrated in Figure (4). This gap highlights the need for targeted educational efforts to enhance public understanding of shale gas development [37].

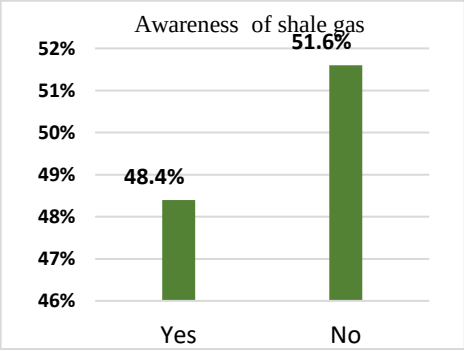

Figure (3): Awareness of shale gas

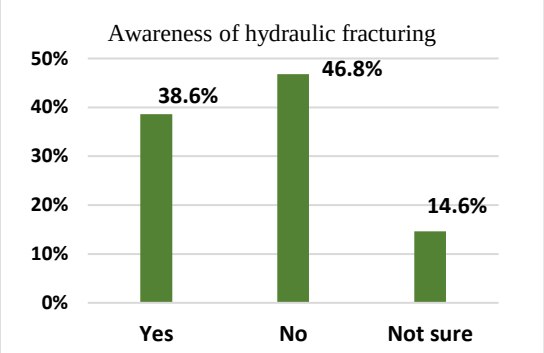

Figure (4): Awareness of hydraulic fracturing

Risks of fracking:

In an attempt to understand the participants' perception of the process of extracting rock gas and their judgment on the term (hydraulic fracturing) whether it is positive or negative. 47.8% of participants considered that the term reflects a positive connotation, 9.6% held a negative perception. Meanwhile 42.7% reported uncertainty figure (5). To gain insight into risk assessment as perceived by participants, they were asked to gauge the level of risk due to shale gas on the scale from 0 to 10. a question was posed using a numerical scale from (0 to 10), where (0) indicated “no risk”, and” (10) “extreme risk”. The findings indicated that (5) was the biggest risk scored by 24.8% of respondents as outlined in Figure (6). Where the majority of participants rated the risk of drilling waste as 5 out of 10, indicating a moderate or neutral perception of the issue. This suggests a possible lack of awareness or limited exposure to its environmental impacts. The finding underscores the need for increased community awareness to promote a more accurate understanding of such risks [37].

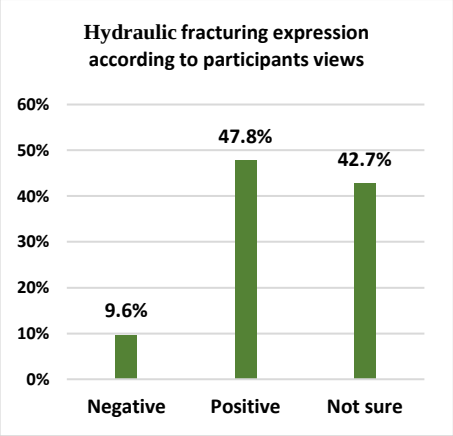

Figure (5): Hydraulic fracturing expression according to participants views

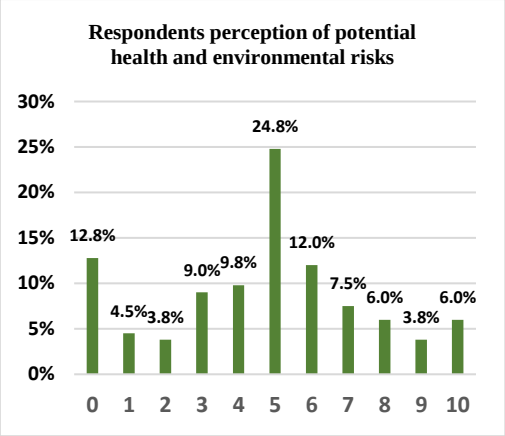

Figure (6): Respondents perception of potential health and environmental risks

Perceptions of Health and Environmental Impacts:

Perceived risks and benefits are significant indicators of resistance or support for energy development, both individually and in communities [38]. In this study, a set of potential environmental consequences was presented to assess their likelihood of occurrence. The results show that, among a range of proposed potential consequences, water (29.4 %), and health (23.3 %) effects were rated the highest. The findings reflect a significant concern, likely tied to fears over chemical exposure, contaminated drinking water, and respiratory problems from air pollutants. This consistent with global debates on fracking's consequences on public health and water resources. Water and health issues dominate, land and wildlife concerns [37], highlight ecological priorities, while earthquakes and air pollution [39], though scientifically significant were perceived as less probable as shown in Figure (7).

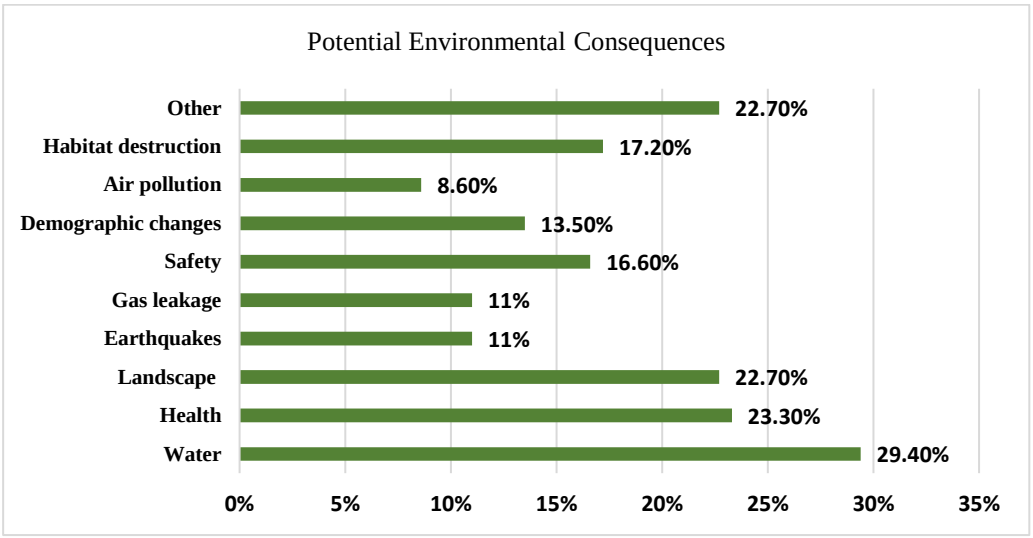

Figure (7): Potential Environmental Consequences

Economic Growth and Demand for Energy perception:

Regarding the potential significance of future shale gas development for the economic situation in Libya, Figure 8 illustrates that more than half of the respondents (53.8%) anticipate that shale gas extraction would be economically important. This perspective is consistent with prior studies highlighting public recognition of the economic benefits of unconventional gas development [37,40]. While 9% expressed skepticism, 37.2% remained uncertain, reflecting a need for targeted information dissemination to clarify the potential impacts of this industry before its commencement. On a positive note, the majority of participants expressed optimism regarding the long-term benefits; 86% acknowledged that shale gas development could play a crucial role in future job creation, and 61.1% confirmed their expectation that it would provide a cheap energy supply once production begins.

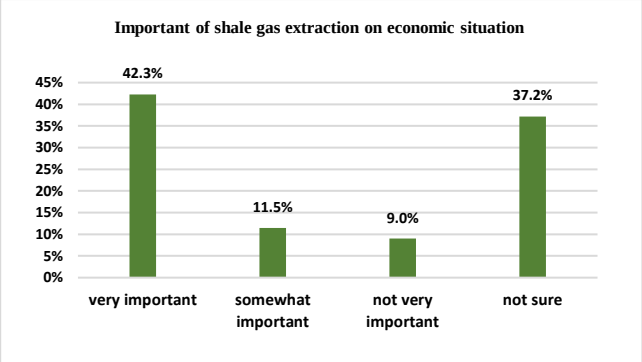

Figure (8): Important of shale gas extraction on economic situation

Regulations:

Shale gas poses environmental risks that necessitate the existence of regulations and laws to minimize its impact on the environment and public health. This viewpoint was supported by the majority of participants, with 94.7% expressing agreement. Such findings correspond with literature stressing the importance of effective regulations and oversight to ensure environmentally sustainable and safe fracking practices [41,42]

Overall Governance:

With respect to embracing shale gas exploitation in the future. A total of 50.9% are in favor of shale gas extraction, and just 16.6% of all respondents opposed shale gas production in their areas, while 32.5% were unsure, as illustrated in Figure (9). The finding showed a general tendency towards acceptance, with a significant level of hesitation or lack of sufficient information among the public. Similar patterns have been observed in global studies, where public perceptions of shale gas often reflect cautious acceptance, influenced by perceived environmental and health risks, as well as limited knowledge of extraction processes [37,39] These results underscore the importance of targeted public engagement and risk communication to enhance awareness and inform decision-making regarding shale gas development.

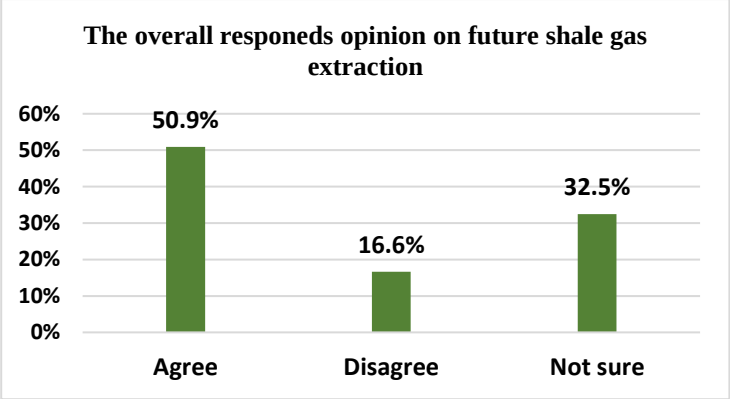

Figure (9): The overall responds opinion on future shale gas extraction

Conclusion:

The study revealed that 52% of participants expressed support for shale gas extraction, while 30% remained uncertain, reflecting a combination of public interest and hesitation. Environmental concerns were widely recognized, with 97% of respondents emphasizing the necessity of implementing strict regulations and safety measures. Among the potential environmental impacts, participants identified water depletion and contamination, adverse health effects, and land or landscape disturbances as the most significant concerns. These findings are consistent with previous studies, which have indicated that shale gas exploitation may contribute to energy security and economic growth, while simultaneously posing substantial environmental and public health risks. Given that shale gas development has not yet commenced in Libya, media coverage and public awareness of hydraulic fracturing techniques remain limited. Consequently, this study provides a valuable framework for future research involving larger and more representative populations, enabling a more comprehensive understanding of public attitudes toward shale gas development. It is important to note that public perceptions are not static; rather, they evolve over time in response to specific events and emerging

information. This underscores the importance of continuous communication, transparency, and public education to maintain trust and informed decision-making. The majority of respondents anticipated that the establishment of a shale gas industry could represent a strategic opportunity to strengthen the national economy, particularly through job creation and the provision of a cost-effective domestic energy supply. However, the considerable level of uncertainty observed among some participants highlights the urgent need for clear communication strategies and targeted educational initiatives prior to the initiation of any extraction activities. Overall, the study concludes that achieving a balance between energy development and environmental protection is essential. Future research should therefore focus on optimizing extraction technologies, minimizing ecological and health impacts, and enhancing public engagement to support a sustainable acceptable energy transition.

References:

[1] The Shale gas 'revolution' in the United States: Global implications, options for the EU, the European parliament, Directorate-General for External Policies,2013.

[2] Wang. H et al, A feasibility analysis on shale gas exploitation with supercritical carbon dioxide. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, 2012.

[3] Speight, James, Handbook of natural gas analysis, John Wiley and Sons, New Jersey, USA,2018.

[4] Aguilera, F. Roberto et al, Link between endowments, economics and environment in conventional and unconventional gas reservoirs, Fuel, 2014a.

[5] Sovacool, Benjamin. K, Cornucopia or curse? reviewing the cost and benefits of shale gas hydraulic fracturing (fracking), renewable and sustainable energy review, 2014.

[6] Colorado Department of Public Health and Environment, Public Health Implications of Ambient Air Exposures as Measured in Rural and Urban Oil & Gas Development Areas: An Analysis of 2008 Air Sampling Data, Garfield County, Colorado 2010.

[7] Osborn, S.G., Vengosh, A., Warner, N.R., Jackson, R.B. Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing. Proc. Natl. Acad. Sci.., 2011.

[8] Hilary B., Christopher C., Dylan B., Edward M., Connie R., Anthony L., “Fracking” controversy and communication: Using national survey data to understand public perceptions of hydraulic fracturing, Energy Policy, 2013.

[9] Public engagement with shale gas and oil, A report on findings from public dialogue workshops, Prepared by TNS BMRB, 2014.

[10] Gospodarka paliwowo-energetycznaw latach 2012-2013 [Fuel and Energy Economy in 2012-2013. Warsaw: Głowny Urząd Statystyczny [Central Statistical Office], GUS. 2014.

[11] Galal, S., Oil and natural gas industry in Libya - statistics and facts, oil-and-natural-gas-industry-in Libya, 2023

[12] Osama R., Abobakar A., Unconventional hydrocarbons in Libya - A review, International Scientific Conference on Natural Resources in Libya, 2024.

[13] Hilary Boudet, Christopher Clarke, Dylan Bugden, Edward Maibach, Connie Roser-Renouf, Anthony Leiserowitz, “Fracking” controversy and communication: Using national survey
data to understand public perceptions of hydraulic fracturing, energy Policy,2013.

[14] EIA (U.S. Energy Information Administration, technically recoverable shale oil and shale gas resources: Libya. Technical Report; 2015b.

[15] Osama R. Shaltami1, Abobakar E. Algomati, Unconvential Hydrocarbons in Libya, International Scientific Conference on Natural Resources in Libya, 2024.

[16] Soeder, D.J., Kappel, W.M., Water Resources and Natural Gas Production from the Marcellus Shale (No. Fact Sheet 2009–3032). US Department of the Interior, US Geological Survey, Reston, Virginia, 2009.

[17] Kargbo, D.M., Wilhelm, R.G., Campbell, D.J., Natural gas plays in the Marcellus shale: challenges and potential opportunities. Environ. Sci. Technol, 2010.

[18] Groeger, L., Federal Rules to Disclose Fracking Chemicals Could Come with Exceptions. ProPublica, 2012.

[19] Esswein, E.J.; King, B.; Ndonga, M.; Andronov, E. Respirable Crystalline Silica Is a Confirmed Occupational Exposure Risk during Hydraulic Fracturing: What Do We Know about Controls? Proceedings from the Silica in the Oilfield Conference. J. Occup. Environ. Hyg. 2019

[20] Sovacool BK. Cornucopia or curse? Reviewing the costs and benefits of shale gas hydraulic fracturing (fracking). Renew Sust Energy Rev., 2014.

[21] Sumi L. (2008). Shale gas: focus on Marcellus shale. Report for the Oil & Gas Accountability Project/ Earthworks. 2008.

[22] Caldwell, J. A., Williams, C. K., Brittingham, M. C., & Maier, T. J. A consideration of wildlife in the benefit-costs of hydraulic fracturing: Expanding to an E3 analysis. Sustainability, 2022.

[23] Pidgeon, N., Demski, C, From nuclear to renewable: Energy system transformation and public attitudes. Bulletin of the Atomic Scientists, 2012
[24] Welch, S.A.; Sheets, J.M.; Daly, R.A.; Hanson, A.; Sharma, S.; Darrah, T.; Olesik, J.; Lutton, A.; Mouser, P.J.; Wrighton, K.C.; et al. Comparative Geochemistry of Flowback Chemistry from the Utica/Point Pleasant and Marcellus Formations. Chem. Geol. 2021.
[25] Gravelle, T. B., & Lachapelle, E., Politics, proximity, and the pipeline: Mapping public attitudes toward Keystone XL. Energy Policy, 2015.
[26] Evensen, D., Stedman, R., O'Hara, S., Humphrey, M., Andersson-Hudson, J., Variation in belief about 'fracking' between the UK and US. Environ. Res. Lett. 2017.
[27] Schafft, K.A., McHenry-Sorber, E., Hall, D., Burfoot-Rochford, I., Busted amidst the boom: The Creation of New Insecurities and Inequalities Within Pennsylvania's Shale Gas Boomtowns, 2017.
[28] Jacquet, J.B., Energy Boomtowns & Natural Gas: Implications for Marcellus Shale Local Governments & Rural Communities. Northeast Regional Center for Rural Development, The Pennsylvania State University, University Park, PA. 2009.
[29] Kijewska, B. Problematyka energetycznaw ujęciu politycznym: Kwestie energetycznew programach politycznych [The political aspect of energy: Energy issue in political party programmes]. Przegląd Naukowo-Metodyczny. Edukacja dla Bezpieczeństwa, 2014.
[30] Kay, D., The Economic Impact of Marcellus Shale Gas Drilling: What Have We Learned? What are the Limitations? Working Paper Series: A Comprehensive Economic Analysis of Natural Gas Extraction in the Marcellus Shale. Cornell University, Ithaca, 2011.
[31] Boudet H, Clarke C, Bugden D, et al. "Fracking" controversy and communication: using national survey data to understand public perceptions of hydraulic fracturing. Energy Policy, 2014
[32] COMMODITIES AT A GLANCE, Special issue on shale gas, special issue on shale gas, United Nations conference on trade and development, 2018.
[33] Davis, J. B., & Robinson, G. R. A geographic model to assess and limit cumulative ecological degradation from Marcellus Shale exploitation in New York, USA. Ecology and Society, 2012.
[34] Edwards, M. L. Public perceptions of energy policies: Predicting support, opposition, and nonsubstantive responses. Energy Policy, 2018.
[35] Boudet, H.S., Ortolano, L., A tale of two sitings: contentious politics in liquefied natural gas facility siting in California. J. Plan. Educ.,2010.
[36] Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approach (4th ed.). Sage Publications.
[37] Sovacool, B. K. Cornucopia or curse? Reviewing the costs and benefits of shale gas hydraulic fracturing (fracking). Renewable and Sustainable Energy Reviews, 2014.
[38] de Groot, J. I. M., Schweiger, E., & Schubert, I. Social influence, risk and benefit perceptions, and the acceptability of risky energy technologies: An explanatory model of nuclear power versus shale gas. Risk Analysis, 2020.
[39] Boudet, H., Clarke, C., Bugden, D., Maibach, E., Roser-Renouf, C., & Leiserowitz, A. "Fracking" controversy and communication: Using national survey data to understand public perceptions of hydraulic fracturing. Energy Policy, 2013.
[40] European Parliament. The shale gas 'revolution' in the United States: Global implications, options for the EU. Directorate-General for External Policies, DG EXPO/B/PolDep/Note/2013.
[41] European Commission. Fracking: Minimum principles for the exploration and production of hydrocarbons using high-volume hydraulic fracturing. Retrieved from, 2014.
[42] Clancy, S. A., Worrall, F., Davies, R. J., & Gluyas, J. G. The potential for spills and leaks of contaminated liquids from shale gas developments. Science of the Total Environment, 2018.