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Innovative management of Poland's shale industry

Introduction

Poland with a population of 38 million uses about 14 billion cubic meters of natural gas a year, of which 60 percent is imported from Russia. Poland and Lithuania are the only two EU countries which are pushing forward with exploration and quick commercial extraction of shale gas reserves using hydraulic fracturing. In addition Poland within diversification framework hopes to import shale gas from the United States, the major global player inn unconventional gas. Shale leasing and development in Poland began in 2007 when the Ministry of Environment implemented highly favorable policies for shale gas development, including a simple tax and royalty fiscal system.

PGI estimated technically recoverable shale gas resources in the onshore Baltic--Podlasie-Lublin region to be 230.5 to 619.4 billion m^3 (8 to 22 Tcf), with an additional 1.569 to 1.956 billion barrels of oil (their "higher probability range" estimate). The corresponding USGS estimate was about 1.345 Tcf and 0.168 billion barrels (mean estimate), or roughly 10% of PGI's estimate (Potential for Technically, 2012:3102). The EIA/ARI shale gas/oil resource estimate for Poland is larger because it includes two additional shale plays (Podlasie and Fore-Sudetic Monocline), incorporates more recent shale industry data, and assumes higher recovery factors more consistent with (but still considerably less than) actual Marcellus Shale well performance. Optimistic estimates showed that Poland could have up to 1.92 trillion cubic meters (67.8 trillion cubic feet) of exploitable shale gas deposits, possibly the third largest reserves in Europe after Norway and the Netherlands. Poland could have between 800 billion and two trillion cubic metres of exploitable shale gas deposits, according to the Polish

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Geological Institute. The PGI and USGS resource estimates both are considerably less than EIA/ARI's current estimate of 146 Tcf and 1.8 billion barrels for Paleozoic shale gas and oil in Poland (see olso Wyciszkiewicz: 2011). Total risked, technically recoverable shale resources in the Poland portion of the Baltic Basin and Warsaw Trough are estimated at 105 Tcf of shale gas and 1.2 billion barrels of shale oil and condensate.

Plentiful natural gas would also potentially allow Poland to reduce its reliance on dirty domestic coal for 90 percent of its electricity production, a situation that has caused tensions with European partners concerned about missing clean air targets. In Poland, shale gas deposits are located in the zone stretching from the north-west to the south-east of the Member State. Due to the specificity of the upstream activities and the complex geology of Polish Basins it is assumed that only 25% of the initial exploration wells will be successful. Poland has four main basins where Paleozoic shales are prospective and exploration activity is taking place, and this include the Baltic Basin and Warsaw Trough in northern Poland, the Podlasie Depression and the Lublin Basin in east Poland, and the Fore-Sudetic Monocline in the southwest.

A fifth region, the Carpathian Foreland belt of southeastern Poland, could be prospective for oil-prone Jurassic shales, but this area is structurally complex and has not yet been targeted for shale leasing. The Baltic Basin in northern Poland remains the most prospective region with a relatively simple structural setting. The Podlasie and Lublin basins also have potential but are structurally complex, with closely spaced faults which may limit horizontal shale drilling. A fourth area, the Fore-Sudetic Monocline in southwest Poland, is less recognized but has non-marine coaly shale potential similar to Australia's Cooper Basin.

Assessment of Poland shale gas resources

Poland's shale industry is still at an early exploratory, pre-commercial phase. About 30 vertical exploration wells and a half-dozen vertical and two horizontal production test wells have been drilled to date.[1] The initial results from some 30 vertical and two horizontal shale wells have been less successful than hoped. Production rates and reservoir quality have been lower than expected, with one operator testing ~4% porosity and ~40% clay content in several wells. Hydraulic fracturing operations to stimulate production from the shale also have been sub-par.

The Polish Geological Institute released a report in June 2012 which suggested shale gas reserves could be up to 1.9 trillion cubic meters and is expected to publish a new report on the country's shale gas reserves in 2014[2]. According to estimates

[1] According to the U. S. Energy Information Administration early results have not met industry's high initial expectations.

[2] Assessment of shale gas and shale oil resources of the lower Paleozoic Baltic-Podlasie-Lublin basin in Poland, Polish; Geological Institute, Warsaw, March 2012, available at www.

by Wood Mackenzie, an oil and gas research group, Poland's unconventional gas reserves could be as high as 48 TCF. Following initial large potential resource estimates, the US Energy Information Administration (EIA) reduced Poland's shale gas resources to 148 trillion cubic feet this year, from its 2011 assessment of 187 trillion, mainly due to a downgrade of the country's Lublin Basin resource[3]. If confirmed, this would significantly increase the EU's proven reserves of natural gas and make Poland, which imports 72 per cent of its gas, selfsufficient for the foreseeable future. Significant shale gas production in Poland could also alter the gas geopolitics for the entire European region, which has historically been dependent on Russian supplies of natural gas. In Poland are present several major energy companies investing in shale gas industry and included among others Chevron, Canadian-based Talisman. and ConocoPhillips.[4]

In 2009 Chevron acquired and currently operates four shale gas exploration blocks totaling 4,433 km^2 in the Lublin Basin of southeast Poland. In October 2011 Chevron completed a 12-month 2-D seismic acquisition program across the four licenses to help plan a multi-well exploration drilling campaign. The company completed its first wells in the Grabowiec and Frampol licenses during Q1 2012but results have not been yet disclosed. On March 31 2014 Polskie Górnictwo Naftowe i Gazownictwo (PGNiG)[5] and Chevron Polska Energy Resources signed a collaboration agreement for shale gas exploration in south-eastern Poland on Monday, surfing the wave of revived optimism about unconventional gas in the country. Under the agreement, the companies will collaborate in appraising shale gas deposits in four exploration license areas in south-eastern Poland – two owned by PGNiG (Tomaszów Lubelski and Wiszniów-Tarnoszyn) and two belonging to Chevron (Zwierzyniec and Grabowiec)[6] The joint effort will include drilling of an exploration well, exchange of geological data from the concessions in question, as well as sharing experience gathered so far as part of PGNiG and Chevron's respective exploration activities.

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pgi.gov.pl/pl/component/docman/doc_download/769-raport-en; *Ekonomiczny potencjał produkcji gazu łupkowego w Polsce w latach 2012–2025. Analiza scenariuszowa*, Centrum Analiz Społeczno-Ekonomicznych Fundacja Naukowa, Warszawa 2012.

3 Decision time for Poland, Regester Larkin Shale Report January 2014.

4 There has been recent success for Lane Energy Poland (a subsidiary of ConocoPhillips) which announced that it is extracting in the region of 8,000 cubic meters of shale gas per day at a test well in the north of the country. This is the highest amount seen in Europe to date and the company is planning to drill two or more wells in 2014.

5 PGNiG is the largest Polish oil and gas exploration and production company. PGNiG owns 51 percent of shares in the Fences concessions. FX Energy owns the remaining 49 percent. The concession covers 1,647 square kilometres in western Poland.

6 The agreement with Chevron is part of PGNiG's new policy of openness towards other companies involved in shale gas exploration projects in Poland. The collaboration will enable the parties to reduce costs, share risks, and increase the pace of the exploration work. http://shalegas.cleantechpoland.com/?page=news&id=127&link=chevron-pgnig-sign-agreement-to-explore-for-shale-gas-in-poland, 15.06.2015.

PGNiG, the national oil and gas company of Poland, holds 15 shale gas exploration licenses. Last year the company reported plans to invest $0.5 billion in shale gas development with several Polish state-owned partners. PGNiG has drilled at least four shale gas exploration wells to date in the Baltic Basin, producing shale gas from the Cambrian in two vertical wells from depths of about 3,000 m, while logging gas shows in the Ordovician and L. Silurian. The company recently drilled its first horizontal well nearby (Lubocino-2H) and targets commercial production in the Baltic Basin starting 2016.

Another U.S. based company ConocoPhilips joined forces with Lane Energy Poland, a subsidiary of UK-based 3Legs Resources, while GDFSuez has forged an alliance with the small explorer Schuepbach Energy. ConocoPhillips has farmed into three of Lane Energy's (subsidiary of 3Legs Resources PLC) shale blocks in the western Baltic Basin. Lane Energy has tested low gas rates (90 and 500 Mcfd) from two stimulated horizontal shale wells. ConocoPhillips recently became the operator of these blocks, shifting focus to the liquids-rich window in the north. The company recently spud its first Poland shale well, the vertical Strzeszewo LE-1, in an area with 3D seismic coverage (see more Gruszczyński: 2014).

Concessions overview and developments

It is interesting that the firm Lane Energy Poland – controlled by US energy giant ConocoPhillips – was the first to extract shale gas in July 2013, and has been extracting about 8,000 cubic meters of gas per day since July 21 2013. Although the yield was lower than at sites in Canada and the United States, it was the best such result in Europe to date but such amount is not big enough to qualify as commercial production, however. Gas is being extracted at a depth of 3,000 meters (9,800 feet) without present threat to the environment. Another American company BNK Petroleum Inc. (the „Company" or „BNK") in 2013 has successfully drilled, cased and cemented its Gapowo B-1, which is the longest horizontally drilled well in Poland, horizontal well with excellent gas readings regularly recorded throughout the lateral (Levi, 2012: 90–92).

The well successfully drilled the targeted over-pressured, gas-charged, organic-rich Lower Silurian and Ordovician shales that were originally encountered in the vertical Gapowo B-1 well. The well has approximately 5,900 feet of lateral available to fracture stimulate.[7] BNK Petroleum has all together drilled five vertical shale wells in the Baltic Basin ($12 million/well). Porosity (3–4%) was lower than expected in over-pressured L. Paleozoic shale; clay content was fairly high (30–40%). The company estimated total GIP concentration of up to 135 Bcf/mi2, including 86 Bcf/mi2 in the target Ordovician and L. Silurian shale zones (total 110 m thick). The Lebork

[7] The Company believes that it controls about 285,000 net acres that have good potential to produce natural gas and another approximately 285,000 net acres that are also prospective but have higher associated risk.

S-1 well flared gas from several intervals, but a fracture stimulation was unsuccessful due to high stress and inadequate pump capacity (Casselman, Russell, 2012: 20–25).

But in July 2013 the Polish Oil and Gas Company (PGNiG) and FX Energy informed that they achieved "disappointing" results after the testing of the three fracked Rotliegend intervals in the Plawce-2 well on the Fences concession, western Poland cited that The top interval, where log interpretation indicated more than 60 meters of gas saturated sandstone at the top of the Rotliegend, flowed only non-commercial levels of gas along with formation water.[8]

It is worth to mention that US energy giant Chevron announced in 2013 that it had joined forces with Poland's PGNiG on shale gas exploration in the country's south. Chevron Corp. has commenced in May 2014 drilling its first shale gas exploration well in Romania.[9] Earlier plans to proceed with exploration for the unconventional gas saw protests and the occupation and blockage of a drilling site that saw Chevron twice suspends its plans in Eastern Romania. Exploratory drilling at the well site near the village of Silistea, Pungesti commune in Vaslui County, is targeting a depth of approximately 4,000 meters. Chevron also holds three shale-gas exploration blocks in the south-eastern region of Dobrogea, near the Black Sea (Begos, 2012: 12–18).

Global trends and prospects

The same company along with Shell corporation won in 2012 a tender to explore two major deposits in Ukraine Yuzivska (Kharkiv and Donetsk Oblasts) and Oleska (Lviv and Ivano-Frankivsk Oblasts) which the government estimates could hold 2.98 trillion cubic meters of gas,[10] Gas extraction on an industrial scale is expected to commence in late 2018/early 2019 at the earliest. According to estimates presented in the draft Energy Strategy of Ukraine 2030, annual gas production levels may range between 30 billion m3 and 47 billion m3 towards the end of the next decade. According to initial estimates provided in the still unapproved Energy Strategy of Ukraine 2030, gas from non-porous sandstone formations is the most promising form of unconventional gas. Estimated reserves of tight gas range between 2 and 8 trillion m^3 and are found at depths of between 4 and 5 km. Estimated shale gas reserves range between 5 and 8 trillion m^3. In turn, the volume of potential coal bed methane deposits is expected to range between 12 and 25 trillion m^3. According to optimistic

[8] See more at http://shalegas.cleantechpoland.com/?page=news&id=95&link=pgnig-and-fx-energy-achieve-disappointing-results-on-plawce-2-well.pdf.

[9] See more at http://www.naturalgaseurope.com/chevron-commences-shale-gas-drilling-in-romania

[10] In January 2013, Ukraine and the Anglo-Dutch group Shell signed a $10-billion production-sharing agreement to explore shale gas at the Yuzovska deposit in the eastern Donetsk region.

forecasts from IHS CERA, total gas production (from both conventional and unconventional reserves) could reach as much as 73 billion m^3.[11]

In the aftermath of global financial crisis and global energy ExxonMobil in 2012,[12] Marathon[13] and Talisman dropped shale gas exploration in Poland, after disappointing drilling results – finding deposits too deep to extract using the conventional method of hydraulic fracturing, or fracking along with the environmental concerns. In 2009 ExxonMobil leased six licenses in the Lublin and Podlasie basins of eastern Poland. The company drilled two vertical shale gas test wells (Krupe 1 and Siennica 1), locating one well in each basin. In late 2012 ExxonMobil sold two of the licenses (Wodynie-Lukow and Wolomin in the Podlasie Basin) to PKN Orlen. PKN Orlen holds 10 shale gas licenses totaling nearly 9,000 km^2 (including the two former ExxonMobil blocks). In late October 2012, PKN reported drilling the first horizontal well in the Lublin Basin, which it plans to hydraulically stimulate. Exxon already cautioned that commercial production of Polish shale was at least five years away, said it would not go forward with exploration That was until March 2013, when a government report revealed the country's likely reserves were about one-tenth the size of previous estimates.[14] Exxon realised that commercial extraction was not possible with currently available technology (Carey, 2012: 30–38).

In addition Eni, the Italian oil company in Janaury 2014 announced that is giving up on producing natural gas from shale rock in Poland, Italian oil giant Eni withdraw totally from its shale gas project in Poland, allowing two of its three exploration licenses expire, with a third one likely to follow Eni has let its licenses expire due to unclear regulations and difficult geology. As of 1 September 2011 26 shale gas prospection/exploration licenses were granted, many of them also covering other hydrocarbons than shale gas.[15] Talisman Energy Polska Limited Corporation reported it has three concessions in the Northern part of the Baltic Basin. Most of the projects

[11] But Ukrainians were concerned about the ecological consequences of shale gas exploration in the mountainous forest region, which is also a prominent tourist resort.

[12] In December 2009, ExxonMobil (Exxon) announced plans to buy XTO Energy (XTO) in an all-stock transaction worth about $41 billion (including debt of $10 billion), Exxon's interest in XTO was driven primarily by XTO' strong unconventional gas resource base and its technical expertise in extracting shale gas through hydraulic fracturing technology.

[13] Marathon and partner Nexen have acquired new seismic and drilled at least one shale well in the Baltic Basin. Marathon in May 2012 noted disappointment with the reservoir quality.

[14] Poland had high hopes for shale after a study by the U.S. Energy Information Association in 2011 estimated Polish reserves at 5.3 trillion cubic metres, enough to cover domestic demand for some 300 years. The government's study in March slashed estimates for recoverable shale gas reserves at 346 to 768 billion cubic metres.

[15] ExxonMobil has submitted applications to the Ministry of Environment regarding the relinquishment of two exploration concessions in the Podlasie Basin (Legionowo and Mińsk Mazowiecki) and one, together with its partner (French operator Total E&P Poland), in the Lublin Basin (Werbkowice). Both companies eventually has had pulled out of shale gas extraction. Canadian International Oil Corp. (CIOC) has filed for three concessions in south-central Poland, Pro Energis for two and Mazovia Energy Resources for nine.

currently are at the phase of seismic surveys. Talisman and San Leon Energy have drilled three vertical shale wells in the Baltic Basin, logging gas and some liquids shows throughout the Cambrian, Ordovician, and Silurian section.[16]

San Leon had not finished removing fracking fluid from the well when it achieved the flow rate, according to the statement. It estimated a potential flow rate of 200,000 to 400,000 standard cubic feet per day if the clean-up of fracturing fluid from the well was completed. That's equivalent to as much as 4 million cubic meters per year, or 0.03 percent of Poland's fuel use. San Leon will drill and hydraulically stimulate a horizontal well in the Lewino area to test the entire vertical extent of the Ordovician interval with each frack and prove commercial flow rates, according to the statement. In the U.S., horizontal wells typically yield between seven and 30 times the production rate and recovery of vertical wells in the same formation. The company reported that it may drill its first horizontal shale well during 2Q-2013, with a planned 1,000+ m lateral completed with a multi-stage frac. San Leon became the sole owner of three permits in northern Poland after Talisman's exit, including the Gdansk West license where the Lewino well is located. Lewino produced gas almost immediately after clean-up and has done so continuously when the well is open.[17]

Law of exploration and extraction of hydrocarbons

The Polish government has granted over 100 concessions for the exploration of non-conventional hydrocarbons as companies have flocked to the country, but and the biggest holders of shale gas concessions are state-owned companies, most notably Polish Oil and Gas Company (PGNiG). Despite over 110 exploratory shale concessions having been awarded, no company has made a "Declaration of Commerciality" and, as a result, no license has moved into the Production Concession stage. Licenses covering primarily the most promising shale belt area, reaching from Pomorze to Lubelskie have been granted to Polish private as well as state-controlled companies and foreign registered companies. Out of nineteen companies involved only three are partly State-owned (Witter, 2012: 56–67).

As a reminder of legal obstacles facing issuance of licenses serves the case Commission v. Poland decided by the Court of Justice (before Treaty of Lisbon called European Court of Justice) on 23 June 2013.[18] The Judges ruled that polish government failed to fulfil obligations arising out of the Directive 94/22/EC – Conditions for granting and using authorizations for the prospection, – Non-discriminatory access, by allowing licenses to be issued for the exploration and extraction of hydrocarbons,

[16] In Poland gas companies drilled about 50 shale wells as of the last year, is needed at least 200 of them to test the fuel's potential,with about 30 reservoirs will be drilled this year, up from 14 in 2013, he said in an interview earlier this month.

[17] http://www.bloomberg.com/news/2014-01-23/europe-nears-first-commercial-shale-gas-production-in-poland-1-.html

[18] Judgment of the Court (Fourth Chamber) 23 June 2013 In Case C-569/10.

without fully open tenders. The European Commission alleged that priority to obtain the production concession, given by the Geological and Mining Act of 1994 to holders of exploration licenses, contradicts the requirements of the Directive because tendering procedures were not fully open and effective as the Directive clearly states that exploratory and mining authorizations should be granted by separate, transparent tenders. Poland had not met obligations under the directive to ensure a non-discriminatory granting of such rights to economic operators.[19]

The polish government plans to invest 12.5 billion euros ($17.3 billion) in exploration and development of its shale gas sector by 2020, with total investment in exploration and development of the shale gas sector in Poland by both domestic and foreign companies could reach 12.5 billion euros. The country plans to invest 12.5 billion euros ($17.0 billion) Politically Poland remains supportive of shale gas development with the Deputy Environment Minister announcing Poland would commence commercial shale gas production in 2014. However, the terms of and delays in the enactment of new legislation to regulate the licensing and tax system have led to industry criticisms. The Polish government has shown continuing strong support for the shale gas industry in the past six months. On 12 June 2013, two draft bills were published, one entitled 'Bill on Hydrocarbon Taxation', the other 'Bill to Amend the Geological and Mining Act'. These bills are intended to address gaps in the existing legislation, to better provide for shale gas, and eventually to increase government revenues (Pearson, 2012: 23–25).

Oil and gas exploration activities, like other geological and mining activities, are subject to general Polish mining regulations, particularly the act of June 9 2011 Geological and Mining Law.[20] Exploration and exploitation of shale gas deposits is not different from conventional hydrocarbons or any othe underground natural resources. As a general rule, deposits of hydrocarbons, hard coal methane (as an accompanying mineral), brown coal, meta ores (with the exception of bog meadow iron ores and native metals), ores of radioactive elements, native sulphur, rock salt, potassium salt, magnesium-potassium salt, gypsum, and anhydrite and precious stones, irrespective of the place where they can be found, are covered by mining ownership. The right of mining ownership is vested in the State Treasury. The State Treasury may use the object of mining ownership and dispose of its right only through the establishment of amining usufruct (Jusińska, Kotowicz, Swoczyna, 2013: 189–192).

The government of Poland introduced new, competitive and attractive fiscal legislation for shale gas in order to attract sufficient foreign investments to develop shale gas reservoirs in Poland. On March 11, 2014 the Polish government on Tuesday decided to make it tax-free to extract shale gas at home through 2020, after 2020, taxes shouldn't exceed 40 percent of extraction income. In April 2013, the Polish

[19] Poland might face claims for damages from plaintiffs who will establish a connection between a decision not to grant a license and material damages and that a license would have been granted to the company, if the EU's directive had been correctly implemented.

[20] The Journal of Laws from 2011 No 163 item 981 as amended.

finance ministry announced that it is preparing a new tax regime for the oil and gas industry. The proposed tax rates will have a massive impact on the industry, because the new rate caps out taxes at nearly 60%, as opposed to an earlier promise of 40%. PKN Orlen, one of the country's statecontrolled refiner's, has stated that the taxes on exploration and extraction of unconventional oil and gas reserves could reach as high as 130%. These new rates are important when discussing the country's shale gas potential, because Poland has high hopes of finding significant amounts of shale gas over the next few years.

The polish authorities are exploring all possible avenues to succeed, for example the Polish Ministry of Foreign Affairs had a contract with one of the biggest European lobbying company Burson-Marsteller for around 0.5 million Euro, making it the firm's third largest client in 2011.[21] According to latest rough estimates 5000 to 15 000 wells would be required to produce shale gas in Poland, leading to capital requirement of approximately $25 to $125 billion. Just over 50 exploratory wells have been drilled in Poland, about 40 of which were drilled in 2012. Experts estimate that up to 300 wells will have to be drilled at up to $15 million a pop before we have a sound estimate of Poland's commercially viable reserves. But energy firms operating in Poland have only drilled 33 wells over the past three years and have hydraulically fractured only. That is not nearly enough to launch this industry and none of the drilled wells have produced encouraging results. There are only 11 drilling rigs in Poland as compared to 2000 in the United States and this too is impeding development. It costs roughly $15 million to drill and fracture a well in Poland as compared to $4 million in the Barnett Shale region of Texas. Local and global companies have thus far sunk around 50 exploratory wells in Poland. This country has granted exploration rights to local and global firms which have sunk 48 exploratory wells (Haluszczak, 2013: 22–23).

Environmental challenges and concerns

Nevertheless we must take into account the report criticizing the progress on shale gas exploration by Poland' supreme Audit Office (NIK (senior auditing institution) which warned that at the current rate it will take 12 years before the country's shale gas potential can be properly assessed and pointed out that while 113 licenses have been issued, only a small proportion of the territory in question has actually been explored. The report explained that work on the legal framework for shale gas exploration and extraction was started with a considerable delay in 2011. License issuing processes were unreliable and did not promote equality, they also took more time than was necessary, the report went on to say. All this irregularities could lead to potential corruption, NIK concluded (Krauss, 2013: 12–21).

[21] Entry on Burson-Marsteller in the EU's Transparency Register: See more at http://ec.europa.eu/transparencyregister/public/consultation/displaylobbyist.do?id=9155503593-86

The office was also skeptical of the progress in estimating the size of Poland's shale gas reserves. If the current rate of test drilling is maintained, it may take about 12 years to complete the process, the report said. NIK also criticized companies that were granted exploration licenses. According to the report, they did not conduct necessary geological studies, or conducted them with significant delay. They also delayed the payment of licensing fees.[22]

The Polish Exploration and Production Industry Organization (OPPPW) argues that lack of regulatory clarity is to blame for the radical slowdown in shale exploration this year. At the current rate of just over ten wells a year, the country will take about 25 years to reach a reliable assessment of the country's shale gas resources. Poland has some regulatory provision addressing the concerns addressed by the environmental groups, which in both the US and Europe have raised the alarm that the chemical-laced waste could be contaminating fresh water resources. The risk of environmental contamination is present at all stages of extraction (Fowler, 2013: 55–56).

These include surface spills and leakages, emissions from gas-processing equipment, and pollution from the large numbers of heavy transport vehicles involved. There is therefore ample opportunity for pollutants to contaminate the air, and ground and surface water. The fracking drilling sites have larger surface footprints, and may be like in Poland much closer to where people live. The need to transport and store large volumes of toxic chemicals and contaminated water are likely to pose negative consequences for health. In addition to local threats to health and environment, another key consideration is the contribution of shale gas to climate change. There is conflicting evidence about whether fracking produces more or less greenhouse gas emissions than coal. In any case, the evidence from the US is that shale gas has developed alongside the use of coal, rather than replacing it, leading to an overall increase in greenhouse gas emissions. In Poland, the Act of 25 February 2011 on Chemical Substances provides for penalties with the purpose of enforcing compliance with REACH.

Conclusion

Unfortunately shale gas resource in Poland estimates are potentially overoptimistic and it is uncertain to which extent they can be produced economically. Poland should adopt measures that should encourage not only shale gas exploration but what is most important find new means of national energy policy. It is very likely that investments in shale gas projects in Poland might have a short-living impact on gas supply which could be counterproductive, as it would provide the impression of an ensured gas supply at a time when the signal to consumers should be to reduce this dependency by savings and efficiency measures. water sourcing and local infrastructure in Poland might also present difficulties given the fact that the fracking process

[22] See more at http://wbj.pl/article-64745-nik-lambasts-polands-shale-gas-exploration.html?type=lim.

requires large amounts of water that The biggest problem in Poland is to simplify the existing bureaucracy.

It is very important for local and national agencies to identify ways to speed up the process, so that more exploration and production can take place in order to learn more about the country's geology. The foreign companies complained that administration procedures are inefficient, there is not enough expertise of unconventionals in the administration, and while the government has pledged to be more efficient, similar commitments at the local level are required. It is clear Poland cannot go it alone on shale gas. But the extent to which foreign majors will be willing to keep the money flowing into the country will depend largely on how much legislative progress the government makes in what could be a make-or-break year for shale in Poland.

The industry specialist predict that it may take 1–16 years before shale gas can be added to Poland's energy supplies: from five years to eight years to assess whether shale gas exists in commercial quantities, maybe another seven years before production starts and then a few more years before enough shale gas is produced on the commercial scale.

Exploitation of Poland's shale gas reserves – potentially Europe's biggest – needs to be handled carefully to avoid local pollution, especially from water contamination and methane leakages. Improving water quality and waste management are other important environmental challenges: fertiliser and pesticide use has risen, and Poland still uses mainly landfill-based solid waste management, while wastewater treatment should be further developed. Despite considerable progress, a third of the population was still not connected to a sewage network in 2013. In addition in order to minimize disruption of the local population during shale gas development, the existing legal provision should be amended to protect both landowners and those that do not have cleartitle to lands.

The further amendments should not only give landowners a choice in selling or leasing their land and allow for some gas development operations under negotiated surface use agreements, but also in private lands are sold to the state, compensation should be based on a market assessment. Neither buyout nor condemnation should be allowed without clear title; the state or developers should be required to pay for the title work to settle ownership. In order to properly protect water resources a model framework for drilling and completing wells that involve hydraulic fracturing should be implementing along with revising existing law on withdrawal and disposal of water used and produced during development; the law regarding use of process water basins and retention ponds may require clarifications and needless to say the government agencies should ensurethat drainage waters from oil and gas construction and operations is treated to reduce the level of pollutants before discharging into water bodies.

To protect biodiversity, Poland should develop a comprehensive law on non--native species and provide the resources to collect adequate baseline information

and to monitor populations and enforce existing biodiversity protection laws. Plans for shale gas development should require and insurance or bonding to guarantee successful interim and final reclamation that supports a restoration of native communities where appropriate.

Streszczenie

Innowacyjne zarządzanie przemysłem łupkowym w Polsce

Krajowe zasoby gazu łupkowego otwierają przed polską gospodarką znaczące możliwości. Gaz łupkowy może być dla Polski szansą, ale również poważnym wyzwaniem. Dzięki przeprowadzonej analizie możliwości pozyskania gazu łupkowego w Polsce poprzedzonej jego charakterystyką, oceną wielkości jego zasobów w kraju, wpływu wydobycia gazu łupkowego na rozwój polskiej gospodarki, roli gazu łupkowego w kształtowaniu bezpieczeństwa energetycznego kraju, w artykule wykazano, że zarówno surowiec energetyczny, jak i technologia jego wydobycia w sposób istotny są związane z innowacyjnymi sposobami pozyskiwania energii. Publikacja analizuje innowacyjne metody zarządzania perspektywicznym przemysłem łupkowym w Polsce w świetle ustawodawstwa Unii Europejskiej.

Słowa kluczowe: innowacyjne zarządzanie, bezpieczeństwo energetyczne, przemysł wydobywczy gazu łupkowego, geopolityka, prawo UE

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