PROBLEMY EKOROZWOJU – PROBLEMS OF SUSTAINABLE DEVELOPMENT
2016, vol. 11, no 1, 177-180

Sustainable Development versus Prospecting and Extraction of Shale Gas

Zrównoważony rozwój a poszukiwanie i wydobywanie gazu łupkowego

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Abstract

Energy issues are very important for our civilization. Taking into account the perspective of sustainability a lot of attention is devoted to the sources of primary Energy characterized with low emission. Among them shale gas has gained in importance as the primary energy source.
The paper presents the role of shale gas in the implementation of the main paradigm of sustainable development, i.e. the intergenerational equity. As the reference, the necessity of implementing water intakes monitoring has been pointed out.

Key words: sustainable development, shale gas, water pollution

Streszczenie

Kwestie energetyczne odgrywają kluczową rolę w rozwoju współczesnej cywilizacji. Patrząc z perspektywy zrównoważoności poszukuje się niskoemisyjnych źródeł energii, wśród nich coraz więcej uwagi poświęcając gazowi łupkowemu.
W niniejszym artykule przedstawiono role jaką może odegrać gaz łupkowy w realizacji głównego paradygmatu zrównoważonego rozwoju sprawiedliwości międzygeneracyjnej. Wśród zaleceń zwrócono uwagę na potrzebę monitoringu zanieczyszczeń ujęć wodnych.

Słowa kluczowe: zrównoważony rozwój, gaz łupkowy, zanieczyszczenie wody

Introduction

Energy is of paramount importance in the modern world. It is difficult to imagine how people could function without energy, which is absolutely necessary in four economics sectors: residential, commercial, transportation and industrial. Implementation of the two main paradigms of sustainable development largely depends on the sufficient amount of energy available for everyone (Pawłowski, 2009; Cholewa, Pawłowski, 2009).
Processing primary Energy into various forms of usable energy seriously threatens the paradigm of intergenerational equity by depleting resources on the one hand, and by degrading the environment in the process of fossil fuels combustion on the other.
Therefore, a lot of attention is devoted to the sources of primary Energy characterized with low emission. One of the most extensively developed sources of primary Energy comprises various forms of biomass and wastes (Claassen et al., 1999; McKendry, 2002; Murphy, McKeogh, 2004; Montusiewicz et al., 2008; Pawłowska, Siepak, 2006; Lebiocka et al., 2009).
In the recent years, shale gas has gained in importance as the primary energy source (EIA, 2013; JRC, 2012; Polish Academy of Sciences, 2014). Combustion of the natural gas yields substantially

lower carbon dioxide emissions – i.e. 56.1 kg CO_2/GJ – in comparison to coal, which produces 94.6 kg CO_2/GJ.

Substituting coal with natural gas from shale gas deposits would allow for a significant reduction in emissions of CO_2 (Heath et al. 2014, Newell and Raimi 2014).

However, extracting shale gas from a deposit negatively impacts the aquatic environment (Coulton et al., 2014; Rahm, 2014, Kujawska et al., 2016). Releasing shale gas necessitates employing hydraulic fracturing (Williams, 2013; Vidic, 2013; Vengosh et al., 2013). This method requires large amounts of water, ranging from 3500 to 7200 m^3 for each drilling, which has an impact on the local water economy.

After hydraulic fracturing, the pressure decreases, thus allowing the drilling fluid mixed with water from the deposit to flow back.

At first, flowback water runs quite intensively, with the rate of approximately 1300m^3/day for 2-3 weeks; then, the rate decreases to roughly 50m^3/day and finally stabilizes during the exploitation at the level of 0.5-1.6m^3/day. This stable stage yields so called *produced water*. Depending on how much water there is in a deposit, the amount of flowback water varies from 10% to 80% of volume of the drilling fluid pumped in. For a dry deposit, such as Marcellus Shale in the USA, it amounts to 15-20%. On the other hand, in the case of Barnett Shale in the USA, the volume of flowback water increases up to 75% (Hoffman et al., 2014; Stark et al., 2012; Houston et al., 2009).

Flowback water contains the components of drilling fluid, as well as dissolved salts and suspended loam. The most problematic factor is salinity, which mainly consists of sodium and calcium salts. During the initial flowback stage, salinity increases rapidly throughout the first 14 days. Afterwards, this increase slows down. After 90 days, salinity usually reaches 200 000mg/L.

These ions mainly come from the salts washed off from a deposit. As it was mentioned earlier, the composition of flowback water varies, depending on how much water and soluble substances a deposit contains.

When exploitation begins, a certain amount of produced water flows out along with the extracted gas. Produced water mainly comes from the dewatering of a deposit and contains dissolved salts with a small addition of the remains of drilling fluid. Therefore, its composition varies and depends on the geological structure of a deposit. In general, produced water contains following groups of chemical compounds:

- soluble salts,
- oils and fats,
- natural inorganic and organic compounds,
- natural radioactive compounds.

Prospecting and extraction of shale gas meets with the protests of local communities which blame the pollution of drinking water intakes on the process. Adequate monitoring, which would allow for an early detection of potential sources of pollutants, is necessary.

Identification of characteristic pollutants in the flawback and produced water

In order to determine to what extent prospecting and extraction of shale gas may influence polluting of water intakes, it is necessary to identify characteristic pollutants found in the flowback and produced water. These substances may infiltrate to deep water intakes and to rivers and streams.

In the case of deep waters, the infiltration of pollutants may result from the percolation of drilling fluids. In the case of surface waters – rivers and streams – the possibilities are more numerous. On the one hand, it is possible that the pollutants may infiltrate from the drilling fluids, as well as flowback and produced water, spilled on the ground.

The intensity of this problem depends on the carefulness of performing surface operations.

On the other hand, large amounts of flowback and produced water must be disposed of. Therefore, it needs to be checked whether the employed methods enable disposal of pollutants to a sufficient degree, so as not to contaminate the surface waters.

Answering these questions requires identifying the characteristic pollutants found in the flowback and produced water.

Identification of pollutants from prospecting and extraction of shale gas in the environment

In order to track the movement of pollutants from prospecting and extraction of shale gas in the environment, it is necessary to identify the compounds which are typical for these processes.

Usually, wastewater produced during the above-mentioned operations is characterized by high salinity, reaching up to 400 g/L (Gleason, Tangen, 2014). It also contains such compounds – found in drilling and fracturing fluids – as heavy metal ions, compounds washed off from geological deposits, and radioactive elements (Haluszczak et al., 2013; Kharaka, Hanor, 2014; Vengosh, 2013). Generally, both flowback and produced water contain characteristic radioactive isotopes and elevated concentration of Ba^{+2}, Sr^{+2}, I^-, Br^-.

These pollutants are characteristic, and their presence in examined water intakes may mean that they had been polluted during prospecting and extraction of shale gas.

Pollution of deep water intakes is rather unlikely to occur if the drilling operations are carried out with due carefulness. Nevertheless, monitoring is of huge importance, as it alleviates social unrest. In the case of surface waters, the situation is more complex. Usually, it is difficult to avoid spilling some amount of the polluting fluids. Moreover, flowback and produced water is treated both in the existing treatment plants, and special plants built specifically for the purpose of treating this kind of fluids. In this case, proper disposal of fluids containing radioactive elements is problematic. Moreover, J^- and Br^- ions are not removed in these processes. Although they do not negatively impact the biocoenosis of surface waters, they hinder the intake of drinking water. This is because these ions oxidize to bromates and iodates during disinfection, acquiring mutagenic properties. Therefore, monitoring of pathways (spreading) of these compounds in the environment should be considered necessary.

Summary

Exploitation of shale gas can be seen as a solution which aids in the implementation of the intergenerational equity paradigm of sustainable development, as its large deposits will also be available for the future generations. However, extraction should be carried out in such a way, so as to avoid the degradation of water resources, the protection of which is as important as the supply of energy.

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