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The economic, social and environmental impact of shale gas exploitation in Romania: A cost-benefit analysis

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ABSTRACT

Romania has recently begun the exploration of shale gas reserves and, it is expected that these unconventional resources to be exploited by hydraulic fracturing. The use of this technology is controversial in high-populated areas, where the economic, social and especially the environmental impact is practically unknown. However, for the public opinion, the shale gas exploitation is presented as an operation triggering no major risks. Therefore, several agreements were concluded between the Romanian authorities and the major players in the exploitation field. Against this background, our paper shows that the shale gas exploitation has no real benefits for the Romanian citizens. More precisely, we conduct an exhaustive cost-benefit analysis, considering the economic, social and environmental consequences of the shale gas exploitation, and we show that in the long run, the costs considerably overlap the benefits. The use of hydraulic fracturing procedure, which implies huge costs with the water consumption and wastewater treatment, influences the outcome of our investigation. These findings are sustained by the sensitivity analysis we have performed.

1. Introduction

The concentration of oil and gas reserves in some countries only, raises concerns for the energetic independence and security of various states. Compared to conventional energy resources (i.e. coal, oil), the shale gas is considered to be a cheaper and a cleaner energy source. Thus, shale gas exploitation transformed the energy market [32,55], at least in the United States (US). During recent years, China has also develop its shale gas industry [56,57]. However, the exploitation techniques, as the hydraulic fracturing or 'fracking', and the economic, social and environmental costs triggered by these techniques, bring forward important questions regarding the opportunity of the shale gas exploitation [13,14,2,6]. The objective of this paper is to perform an ample cost-benefit analysis (CBA), considering a wide range of elements that influence the shale gas exploitation in high-populated areas, with a focus on Romania. According to the Energy Information Administration (EIA) statistics, Romania is one of the largest shale gas reserves owner from the European Union (EU) [18].

The shale gas recorded a noticeable success in the US, reaching more than 40% of the natural gas exploitation and contributing to the reduction of natural gas imports [18]. In the EU, the situation is somewhat different, due to the high level of energy dependence on Russia [23]. The EU member states are trying to identify energy strategies to ensure their energy security [19]. In this context, the exploitation of new energy sources, as shale gas, might represent a solution. However, EU proves no experience, regulation coherency and political agreement in terms of shale gas exploitation. Romania, an Eastern European country, classified as the third EU shale gas reserves owner in the EU, makes no exception.

There is no clear evidence regarding the costs on the one hand, and the benefits on the other hand, of shale gas exploitation. In addition, the environmental impact cannot be precisely assessed [50]. As a consequence, the existing literature advances a series of arguments and contra-arguments, without having in mind a systemic picture on what shale gas exploitation using hydraulic fracturing means (see, for example [22,49,17,54,58,56,1,35]). Several studies (e.g. [30,4]) show that the industry-financed reports might be more influential for public policy decisions compared to academic studies, which fail in presenting a global picture on the implications of shale gas exploitation. Therefore, the authors present an exhaustive list of potential benefits and cost associated with the shale gas exploitation, without reaching a clear conclusion [47].

A particular strand of literature is focused on the Central and Eastern European (CEE) countries. Johnson and Boersma [29] provide a survey of elements characterizing environmental and economic aspects of shale gas exploitation in Poland, starting from the North American

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experience. Kronenberg [31] underlines the cost, benefits and policy implications of shale gas exploitation in Poland. In a more journalistic-oriented analysis, several studies approaching the Romania's case [39,45,52], remain inconclusive regarding the impact of the shale gas exploitation on the economy, environment and society.

However, none of the above-mentioned papers performs a classic cost-benefit analysis of the shale gas exploitation. While most of these papers address the impact of hydraulic fracturing on the environment, other works analyze the elements that may influence the authorities' decisions and the population's perception. In this context, our first contribution to the existing literature is represented by an ample CBA, assessing the economic, social and environmental impact of this new energy source.[1] Compared to other approaches that serves for public decision-making (i.e. surveys, group decision support systems, study of effects or mulita-criterial methods), the CBA is more complex, represents a monetary method, and considers the overall benefits of the community. The hypotheses supporting our long-run analysis conducted over a period of 30 years of exploitation are derived from the existing literature and official reports.

Second, we contribute to the literature assessing the case of Romania, ranked by EIA, as the third EU country regarding the shale gas reserves, after Poland and France [18]. Romania represents an interesting case study, as the authorities have already awarded exploration, or even exploitation licenses to several companies acting in the shale gas sector, without a proper assessment of the economic and environmental impact of this strategy, and especially, without a public consultation.

Our findings state that the shale gas exploitation through hydraulic fracturing has no real benefits in high-populated areas, and the costs considerably overlap the benefits for the Romanian citizens.

The rest of the paper is structured as follows. Section 2 presents the controversies on the exploitation of shale gas in Romania and the Romanian energy market. Section 3 describes in details the cost-benefit analysis. Section 4 discusses the findings while the final section concludes.

2. Shale gas exploitation in Romania: some stylized facts

The Romanian Regulatory Authority for Energy [43] shows that the electricity production in Romania is based on hydropower (31.71%), coal mining (26.38%) and nuclear power (18.23%). At the same time, the conventional natural gas resources used for electricity production represent only 11.64% from the electricity production (Fig. 1). Therefore, although there is some progress in using cleaner energy sources, the development of renewable energy sector in Romania is still incipient.

Romania's energy strategy shows that Romania is placed after Poland, and has the second-largest reserves of natural gas from the Central and Eastern European (CEE) countries. The existing reserves are approximated at 150 billion cubic meters, while the geological reservoirs at 615 billion cubic meters [41]. The annual natural gas production is about 11.5 billion cubic meters in average, which, under a reserve replacement rate of 80%, would mean a depletion of these resources in about 14 years. Romania's annual average consumption is about 14 billion cubic meters of natural gas. The internal production covers 82% of the consumption, while the imports exceed 2.5 billion cubic meters and are covered in a proportion of 98% by Russia.

Although Romania has significant reserves of natural gas in the next period, these reserves will diminish. The Energy Strategy of Romania for the period 2015–2035 states that the hydrocarbon reserves in Romania will decline by 10% per annum, which will lead to increased

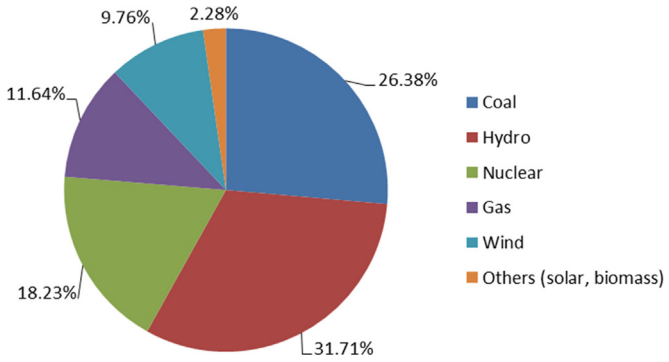

Fig. 1. Electricity production by energy source.
Source: RRAE [41]

Table 1
Estimated reserves of shale gas.
Source: [18]

Current issue	Country	Estimated reserves of shale gas (bil. m^3)
1	Poland	4190
2	France	3879
3	Romania	1440
4	Denmark	906
5	United Kingdom	736
6	Germany	481
7	Spain	226

imports in the coming years [41]. Given that Romania is ranked third in the EU in terms of shale gas reserves (Table 1), this energy source attracted the attention of several exploitation companies in the field. Therefore, the Romanian authorities started very quickly to award exploration, and even exploitation licenses. Along with Romania, other EU member states such as Denmark, Poland, Germany, Sweden and the United Kingdom (UK) have granted concessions or authorizations for the prospection/exploitation, which were launched in the recent years. Other states (i.e. France, through the Jacob Law) refused to make shale gas prospections.

However, the shale gas requires the consideration of all the aspects of sustainable development: economic, environmental and social [44]. Thus, the shale gas exploitation should not be done without a proper analysis of its long-run impact. Similarly to the US, shale gas deposits are planned to be exploited in Romania using hydraulic fracturing. This technology requires huge quantities of water and implies no adequate or costly strategy of wastewater treatment.

Unlike the US, Romania is a densely populated country. Therefore, it is necessary to carefully consider whether this technology can be used and especially to demonstrate that there is no danger for people and for the environment. In addition, Romania has not in place an Integrated Water Resources Management (IWRM) system, which can be useful to manage the wastewater resulted from the shale gas exploitation. Furthermore, the economic benefits of shale gas exploitation must be proved. Even in the US, who has a large experience in shale gas extraction, there are no clear official data about the environmental impact of hydraulic fracturing. This leads to a permanent confrontation between environmentalists and representatives of exploitation companies [39].

From a technical standpoint, studies show that the hydraulic fracturing can cause environmental risks. The problems are not related to the process itself, but rather to the quality and integrity of casing drilling fluids used in drilling and fracturing activities, accompanying the process [25]. The shale gas drilling by the hydraulic fracturing method means that the probe is stretched vertically, then horizontally at a depth of 3–6 km, under very high pressure (about 1000 atm.). An average of ten billion gallons of water are injected with each shot in the

[1] As far as we know, no previous works perform an exhaustive CBA for shale gas exploitation using hydraulic fracturing. Nevertheless, there are several attempts to realize a technical-economic evaluation of shale gas exploitation for China [57]r to apply a synthetic control method for several areas in the US [36].