French Republic

PARLIAMENTARY OFFICE FOR SCIENTIFIC AND TECHNOLOGICAL ASSESSMENT

Alternative techniques to hydraulic fracturing in the exploration and exploitation of non-conventional hydrocarbons deposits

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In response to a referral from the Senate Committee of Economic Affairs, the Parliamentary Office for Scientific and Technological Assessment (French – OPECST) adopted on 26th November 2013, the report prepared by Mr. Christian BATAILLE, Member of Parliament and Mr. Jean-Claude LENOIR, Senator, on alternative techniques to hydraulic fracturing in the exploration and exploitation of non-conventional hydrocarbons deposits. This report focuses on alternative techniques that are already operational or being researched. It also highlights the continuing improvements in hydraulic fracturing techniques and the hopes raised by the mining of coal gas (coal bed methane).

I. Alternative techniques to hydraulic fracturing

A. The characteristics of non-conventional hydrocarbon deposits

All techniques for mining non-conventional hydrocarbons aim at freeing the resource that is trapped in the impermeable rock (shale).

- Horizontal drilling increases the productive area of each well and limits the number of wells
- Stimulation improves the permeability of the rock. Fracturing is one way of doing this. It creates microscopic cracks and reactivates the network of natural fissures in the rock, thus facilitating the oil flow.

Hydraulic fracturing is the main method employed, although others are possible. Different parameters must be considered in choosing the most appropriate technique.

- The availability of water close to the drilling site.
- Protecting the integrity of the well from damages that can be caused by water.
- Protecting the environment by reducing the amount of chemical additives required, and using additives that are chemically compatible with the resource being mined.

B. The different processes

1. Processes which reduce the large amounts of fluids used

- **Fracturing using an electric arc**: this technique has been studied at Pau University in France. An electric wave is generated, thus creating a very dense, but not widespread, network of cracks. This method uses little water and does not require additives, but for the moment is not considered as a viable alternative to hydraulic fracturing since it only stimulates the rock in the immediate vicinity of the well.
- **Thermal fracturing**: here, the rock is heated, with two consequences. First, the rock is dehydrated and thus cracks. Second, heavy hydrocarbons are more easily transformed into light hydrocarbons.
- **Pneumatic fracturing**: compressed air is injected into the shale which disintegrates under the pressure of shock-waves. Compressed air guns may be used. A variation on this technique is to use helium – the rock fractures when the gas expands as it heats up underground.

These methods are far from operational. Their energy efficiency and environmental consequences remain to be studied.

2. Energized fluids

These are liquid gases that may be used alone or with additives, to make foams.

- These alternative fluids have been used in the United States of America and Canada for the past forty years now, particularly **nitrogen and CO_2 based foams**, as well as liquid nitrogen and CO_2. They are still being researched. The use of liquid gas makes it possible to do without any water or additives at all. Foams reduce the amount of water that is necessary by 80 %. They are gelled using by-products of guar gum (food gum). These are long-standing and totally operational techniques.
- Research is underway, particularly in Poland, where techniques to improve the productivity of wells are being studied, especially a method of sequestering underground CO_2 associated with recovering shale gas. No additives are used. So far however, this technology has only been experimented in the laboratory.

3. Propane stimulation

Propane has been used for many years now but is now being updated.

- **Propane stimulation** has been used by the industry for fifty years. Propane was mainly used in the past to re-stimulate under-pressured conventional wells. For non-conventional extraction, gelled propane stimulation techniques have been developed by the Canadian company GasFrac. Between 2008 and 2013, GasFrac carried out nearly 1 900 well stimulation operations in North America (mainly Canada). The gel used requires fewer additives than hydraulic fracturing, and in particular, no biocides.
- The ecorpStim company developed and successfully tested a **pure propane stimulation** method without additives in 2012. The fluid is 95% re-usable, thus reducing transportation requirements. However, this technique requires handling large quantities of flammable propane. It is not suitable for use in densely populated zones.
- Propane stimulation techniques are rapidly improving, with the use of **non flammable propane** (NFP) developed by ecorpStim. Here, the propane is fluorinated, with no water or additives, thereby totally eliminating all the industrial risks linked to using traditional propane. Non flammable propane is used in medicine and for extinguishing fires. It has been developed for use in aerosols since it does not damage the ozone layer. It could be produced in France (Solvay).

Stimulation using non flammable propane is an interesting way forward, as is **using carbon dioxide, which would make it possible to mine shale oil and gas cleanly and, at the same time, contribute to trapping this greenhouse gas**.

II. Non-fracturing methods: coal gas

A. Specific features of producing coal gas

Coal gas is a non-conventional gas whose host rock is composed of coal. For many years, it was considered as dangerous for the mining industry because of firedamp explosions. Today, it is seen as potentially a major source of energy throughout the world. Coal gas includes coal-mine methane and coal-bed methane. Coal -mine methane has been mined in the Nord Pas-de-Calais since 1975. Coal-bed methane comes from the un -mined coal seams. It has been produced since the 1980s in the United States, and since the 1990s, in Australia.

Techniques employed for extracting coal-bed methane are different from those more generally used in producing non-conventional hydrocarbons:

- Producing coal-bed methane usually produces **large quantities of water**;
- Its extraction **does not always require horizontal drilling**. The thinness of the seam may be an obstacle;
- Finally, **extracting coal gas does not always require hydraulic fracturing** either. The coal seam may be sufficiently permeable depending on the network of fissures it extends through. While hydraulic fracturing for coal gas is widespread in the USA, it is rarer in Australia. In the australian state of Queensland, which is the main producing area of coal-bed methane, hydraulic fracturing has only been used in 8 % of the wells drilled into the seams of coal;
- When no fracturing techniques are used, **industrial management uses traditional methods, without water** ; on the contrary, the mining operation produces water. According to a recent report by the Bureau de recherches géologiques et minières (BRGM – The French Geological Survey), and the Institut national de l'environnement industriel et des risques (INERIS – French Industrial Risks Assessment Institute), the main risk is of contamination of the water extracted during the mining process, which requires special monitoring.

B. Encouraging estimates to be confirmed

In France, the two most promising fields are in Lorraine and Nord Pas-de-Calais. The EGL company which is currently exploring there, believes that coal gas could be produced without using hydraulic fracturing techniques if the initial results from Lorraine are confirmed by current work, due to finish in 2014.

- In **Lorraine**, production tests have already been carried out on a well with multilateral horizontal drains. The coal seams appear to be thick, which would make it possible to install horizontal drains. The coal itself appears to be permeable enough to allow for drilling without fracturing. Nevertheless, more results are needed to draw conclusions. Four other pilot sites are planned. The political consensus in the region is in favour of more exploratory work.
- The situation is not so far advanced in the **Nord Pas-de-Calais.** The resource is potentially vast since it is estimated that only 10 % of the local coal has been mined so far. Four authorizations for drilling have been requested. These would be vertical wells going down about 1 500m deep, aiming to assess the amount of gas and the permeability of the coal.

In these regions, long-standing local mining and industrial traditions create a favourable environment for these activities.

III. Hydraulic fracturing: a constantly improving technique

A. Different regional risks

Three points must be emphasized about the (already well known) risks of hydraulic fracturing:

- The film **Gasland** showed misleading pictures: it is clear today that the tap water catches fire in this film because of biogenic gas, i.e. gas produced close to the earth's surface by decomposing and fermenting organic matter, and has nothing to do with gas that is a by-product of hydrocarbon exploitation.
- The question of **methane leaks** is examined. While different studies estimate them at between 3% and 8% which could totally offset the advantages of reducing coal consumption in the United States, a more recent study at Austin University has concluded that leaks during the production of non-conventional gases stand at 0.42%. Techniques and regulations covering methane emissions into the atmosphere have improved and can still lead to better performance levels in the future.
- Finally, the **risks vary from one region to the other**. In France, the complex geological structure in the south-east creates specific risks. The networks of cracks and groundwater channels are not well identified. In addition, the water for human consumption does not come from the water table just below the ground surface, but from deeper lying aquifers. Far more research into the underwater system is therefore required.

B. An evolving technique requiring regulation

Hydraulic fracturing is therefore a technique that must be strictly regulated. France has all the necessary competences for introducing and controlling the implementation of specific regulations, which must cover the following points:

- Transparency and consultation;
- The choice of the drilling sites, after appropriate geological studies;
- The monitoring and prevention of leaks;
- The use of additives, with a list of authorized products and the compulsory publication of the composition of the fracturing fluids;
- Protection of land, by grouping wells together, protecting the ground-soil and re-planting pads after drilling.

These regulations will have a cost for industry, but do not present any major problems of principle.
In France, the DREAL network (directions régionales de l'environnement, de l'aménagement et du logement) is well capable of managing the implementation of regulations.

IV. Assessing French Resources: the essential first step

Before deciding whether or not to exploit our resources, it is necessary to first establish France's hydrocarbon assets.

A. Little information about France's resources

Estimates of resources are based on calculations by the American Energy Information Agency (EIA). These estimates are rather theoretical and are based on data on the hydrocarbon content of sample wells extrapolated to a whole region, without taking account of geological variations. For France, the figure of 3 900 billion m3 of technically recoverable resources of gas has been advanced.

The main oil-producing regions that have been identified are the Paris region, for oils, and the south-east, for gas. To confirm this however, it will be necessary to:

- Pool existing knowledge;
- Carry out non-invasive experiments and work, such as seismic reflection, which is currently forbidden in non-conventional hydrocarbon research;
- To carry out, *in fine*, within a legal framework yet to be defined, test drilling, which is essential for assessing the level of recovery of hydrocarbons.

To protect public finances and given that private companies are willing to invest if given enough visibility, private financing with government control of operations would be the best approach to work towards.

B. High potential economic impact

Knowing the level of resources is the first, key step towards assessing the economic impact of possibly developing non-conventional hydrocarbons. This impact is clear in the United States – on its trade balance and economic growth, employment and public finances. However, these consequences are difficult to transpose to Europe, given the lack of clear knowledge about reserves.

In France, there would probably be an appreciable impact on at least jobs in the relevant regions, and on France's trade balance.

Finally, if there is one abroad economic impact of the American energy revolution that is clear, it is its consequences for the **European petrochemical industry**. The American petrochemical industry is booming today. Relocations of European companies to the other side of the Atlantic are to be feared, with knock-on effects in all branches of manufacturing industry which use petrochemical products.

PROPOSALS

1. **Fully enforce the 13th of July 2011 Act**: re-start long-term dialogue between the State and industry, that is by:
   - Setting up the National Commission for Policy, Monitoring and Assessment of Exploration and Exploitation Techniques of oil and gas;
   - Presenting Parliament with the annual report as fixed by law;
   - Implementing the scientific experiment programme under governement control, as planned for in law.
2. **Move rapidly going towards exploring and exploiting coal gas**, if producing it without hydraulic fracturing turns out to be viable.
3. **Repeal the government directive of 21st September 2012** which prevents any research into this field.
4. **Encourage the creation of a European framework** for exploring and developing non-conventional hydrocarbons deposits (regulations and research).
5. **Make mapping the ground and subsoil a priority.**
6. **Create a research programme into techniques for extracting shale oil and gas** and related risks, with a specific sub-programme devoted to alternatives to hydraulic fracturing .
7. **Carry out experiments on sites, overseen by the competent authorities.**
8. Keep existing competencies in France, **by sending young researchers abroad** and encouraging inter-university cooperation.
9. Introduce a **social contract with local populations**, which would be effective from the initial experimentation stages, with a mechanism for public participation and by creating local monetary interest in developing the underground resources.
10. Conceive of mechanisms whereby **non-conventional hydrocarbons resources can be used to facilitate the transition towards renewable energies.**

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