SHALE GAS AND HYDRAULIC FRACTURING

BLESSING OR CURSE?

Shale gas, and its extraction method hydraulic fracturing, is intensely debated in energy and climate circles worldwide. While some argue that it will save us from oil and coal dependency, others point to some disturbing environmental consequences of fracking. SIWI's Mr. Andreas Lindström **dives into the web of uncertainties surrounding this resource, and explains the pros and cons of fracking.**

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For the next few decades, the world will continue to depend heavily on fossil fuels. But while projections show that oil and coal are still likely to form the backbone of global energy supply, it is natural gas that presents the fastest relative growth. Behind the formidable growth lies what some call "a shale gas revolution". New technologies have allowed the extraction of shale gas reserves previously impossible to reach, enabling access to huge quantities of the resource. While some praise the expansion of this cleaner and cheaper fossil fuel, others urge for caution as environmental, social and health related impacts associated with shale gas and hydraulic fracturing are still fairly unknown and unexplored. There are signs, however, of potentially serious environmental implications if extraction processes are managed without attention to possible risks.

At the same time the world is facing growing freshwater scarcity. Water is quickly becoming a limiting resource for many activities, including energy production.

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Unconventional fossil fuels and shale gas

The term "unconventional fossil fuels" usually refers to fossil fuel assets (predominately oil and gas) trapped in different geological formations (on land or under the sea) that cannot be acquired by means of conventional extraction methods. Shale gas is natural gas that is trapped in different types of shale formations. It burns cleaner than other fossil fuels emitting less CO_2 per unit of energy produced, prompting some to call it "a clean energy source". It is not. There are severe uncertainties related to science on climate impacts linked to shale gas use. The International Energy Agency (IEA) predicts that production of natural gas from unconventional sources will increase by more than 40 per cent by the year 2035, doubling its share in global gas production from 12 per cent to 24 per cent. The growth would be spearheaded by shale gas with substantial contributions by other tight gases (collective name for natural gas located in rock material with low permeability) and coal bed methane (natural gas extracted from coal beds) (IEA, 2012). The spatial distribution of unconventional fossil fuels assets worldwide produces tempting scenarios for many nations holding these, not least those that can be considered top energy consumers. The addition of shale gas and other unconventional fuels to the mix could possibly usher in a new era of energy independence and security for many nations. The versatility of unconventional fuel types, particularly shale gas, also provides alternatives for many end use purposes and adds to its attractiveness. Current data suggest that estimated shale oil resources constitute 10 per cent of total crude oil reserves in the world while estimated shale gas reserves constitutes 32 per cent of all known natural gas reserves that can be recovered by using presently available technology (EIA, 2013). The USA, Canada, Russia, large parts of Europe, South America, South Africa and China are areas with considerable documented reserves of shale oil and/or shale gas. Potentially, there is more yet to be discovered in other parts of the world.

Hydraulic fracturing

Hydraulic fracturing or "fracking" is not a new technology; it has been around for half a century. The principle of drilling in rock formations and widening existing cracks by pumping water mixed with proppants and chemicals under high pressure has been an established part of conventional (vertical) drilling for oil and gas for a long time.

Only with the emergence of so called horizontal directional drilling can untapped shale gas and other tight gas reserves be accessed in a cost-efficient way. The technology of horizontal drilling has been refined since its beginnings in the 1970s and with major technological advances being made in the late 1980s on through the 1990s, the landscape of extraction possibilities changed rapidly (Hoffman, 2014).

As the possible distance of drilling along a horizontal layer increased, bore diameters increased and equipment for penetrating even the toughest rock types advanced, new opportunities appeared. Some major advantages brought by horizontal drilling are, for instance, that wells under areas that are unsuitable for drilling can now be reached from afar, the "payment zone" i.e. the area from which gas can leak through a bore hole can be increased if the well is "turned" (refers to how a well is located on a horizontal/vertical axes), and larger areas can be excavated from a single surface drilling position. Additionally, horizontal drilling increases the possibility to hit a maximum number of fracture zones.

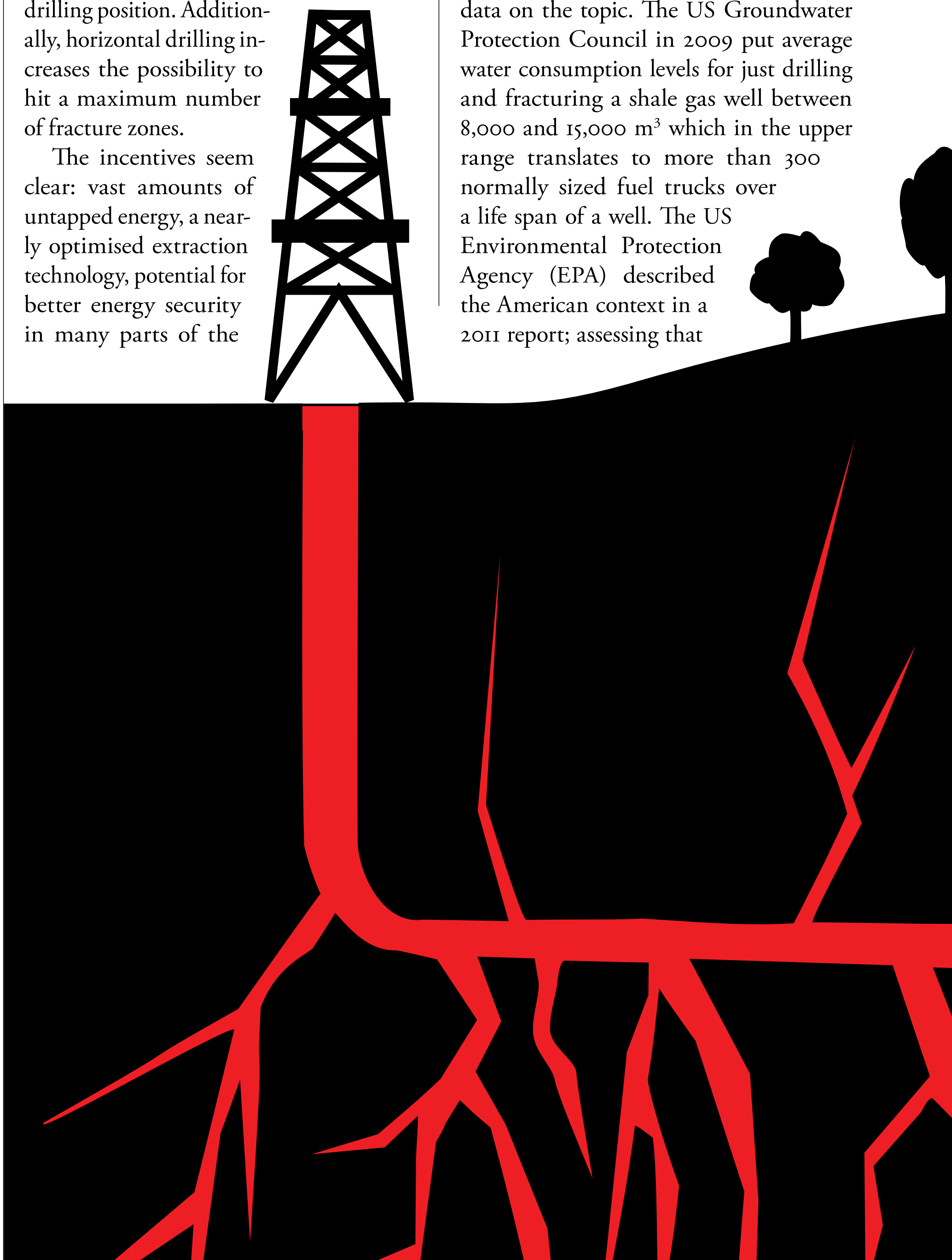
The incentives seem clear: vast amounts of untapped energy, a nearly optimised extraction technology, potential for better energy security in many parts of the world, possibilities for advancements and paradigm shifts in different end use sectors including the transport sector, and a possible reduction of fuel imports and shipments around the world. Should it be "Drill baby, drill!" as the term coined during the 2008 American presidential election campaign went?

Or is there a need for caution?

Yes. There is. Despite the many benefits, shale gas and fracking might not be the magic bullet that will solve our short- to medium-term energy needs. The potential environmental costs of fracking come in many layers, not least in connection to water resources.

Water quantity concerns

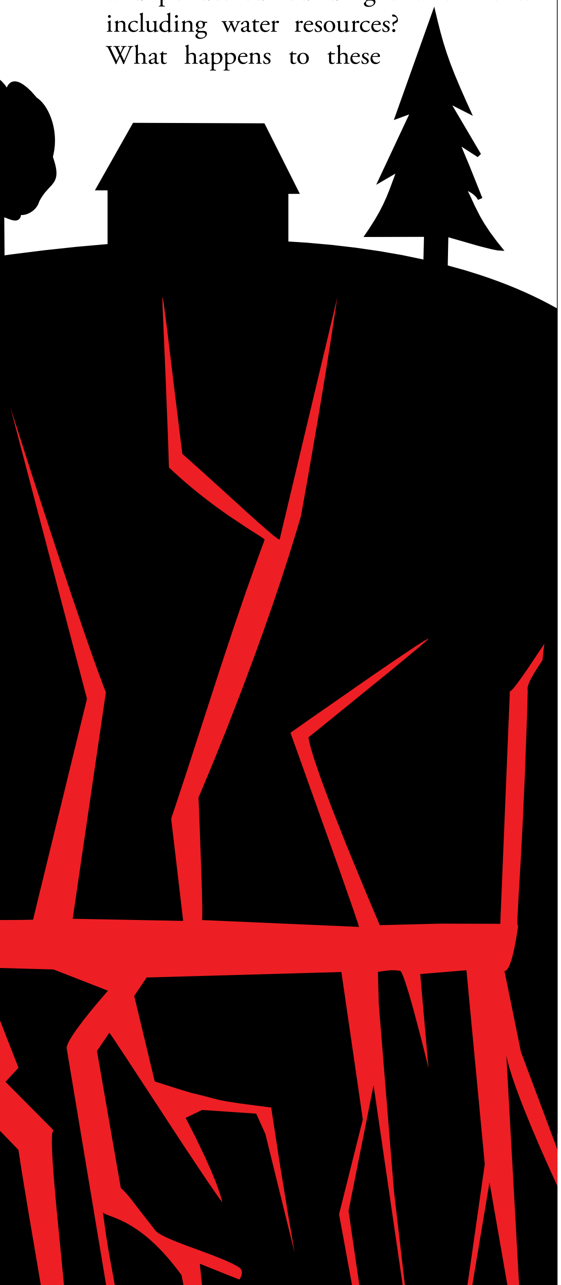
Fracking can be a water-intense activity. Water is the main component, 80 per cent, in the fluid used in the fracking process. The lack of common definitions when assessing water use in the fracking process is an obstacle to producing undisputable data on the topic. The US Groundwater Protection Council in 2009 put average water consumption levels for just drilling and fracturing a shale gas well between 8,000 and 15,000 m^3 which in the upper range translates to more than 300 normally sized fuel trucks over a life span of a well. The US Environmental Protection Agency (EPA) described the American context in a 2011 report; assessing that



water consumed annually by fracking processes in the nation could be as much as 530 million m^3, or about a fifth of the total annual water consumption of Sweden in 2010 (EPA, 2011) (Statistics Sweden, 2012). It is difficult to foresee how water quantity aspects will play out in a future where shale gas excavation through fracking increases exponentially as nations start capitalising on this resource. It should however not surprise anyone if the result is intensified competition for water, especially in areas that already suffer water scarcity.

Water quality concerns

The fracking process involves the usage of fluid which is predominately water, mixed with sand and chemicals to facilitate the fracturing and increase the permeability of the shale. There are several overlaying issues that need to be examined carefully in order to assess potential risks from chemicals used and possible impacts on the environment and humans: Are the chemicals used dangerous to health and the environment? Is there a risk that chemicals might leak and pollute surrounding environments including water resources? What happens to these chemicals when fracking water is returned to the surface? What happens to the minerals and radioactivity flushed at depth by the fracking water and returned to the surface as well?



Although the debate on potential system impacts from fracking in many regards is in its infancy, and science is still playing catch-up assessing impacts associated with the rapidly evolving energy landscape, some interesting results are emerging relating to the above questions.

A recent study issued by the University of Missouri found that among the 700-800 chemicals known to be used in the fracking extraction process, many can be labeled as hormone disrupting or Endocrine Disrupting Chemicals (EDC:s), affecting the endocrine system which regulates several bodily processes and functions such as growth, reproductive functions and metabolism, with possible further links to birth defects and forms of cancer (Kassotis *et. al.*, 2013).

The concern that methane and fracking chemicals can leak to surrounding water sources is backed up in recent science and reporting. A 2011 study issued by Proceedings of the National Academy of Sciences (PNAS) concluded that there is systematic evidence of contamination of drinking water sources in connection to shale gas extraction sites in northeastern Pennsylvania and upstate New York, registering methane concentrations in 85 per cent of examined drinking water wells (Osborn *et. al.*, 2011). Polluted water as a consequence of fracking has also been confirmed and reported in several other US states (Associated Press, 2014).

The way forward

Technological shifts with profound impacts on the course of human development are rare. Looking back into history, we can conclude that mankind would have made some different choices if present information and knowledge had only been available at the time. The potential "shale gas revolution" presently at our doorstep could be one of these. This time, however, we possess the needed information and knowhow in order not to add burden on coming generations with the choices we make today. Careful regulation and transparent information and monitoring will be essential.

The benefits of natural gas in general and shale gas in particular are possibly too great to make us want to deviate from the path of exploiting the resource on a massive scale, although other choices, such as continued investment and deployment of renewable energy, might be much better. If shale gas is the path that will be chosen for the short- and medium-term, then we must set a stage where this can happen in the least harmful way possible. It requires having the wisdom and courage to make the right priorities. We must treat warnings of severe negative impacts with utmost seriousness and address the issue through many channels such as: agree upon common process definitions and descriptions, introduce standards to promote soundest possible drilling practices, allow for and enforce restrictions on drilling in areas where it is deemed as less safe, implement standards for best possible mitigation measures and techniques to protect water, land and air from negative impacts, and invest in waste water treatment and reuse. Furthermore, we must create inclusive processes that can factor in and sufficiently deal with the concerns of local populations at risk of negative impacts, and introduce proactive regulatory and legal frameworks that extensively protect the environment and human wellbeing. An opportunity also lies in using this cleaner natural gas to replace even more carbon-emissive fossil fuels while pushing harder for faster expansions and growth in the deployment of renewable energy types.

A lot has to be done and considered, and now is the time. ■

REFERENCES

Associated Press. (2014). Retrieved from www.dailymail.co.uk/news/article-2534508/Water-three-U-S-states-Penn-sylvania-Ohio-West-Virginia-polluted-FRACKING.html. January 6, 2014.

Energy Information Administration (EIA). (2013). Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States. EIA: Washington.

Environmental Protection Agency (EPA). (2011). EPA Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources. EPA: Washington.

Hoffman, A. (2014). Retrieved from www.lapsedphysicist.org/2013/08/12/fracking. January, 31 2014.

Kassotis, C., Tillitt, D., Davis, W., Hormann, A. and Nagel, S. (2013). Estrogen and Androgen Receptor Activities of Hydraulic Fracturing Chemicals and Surface and Ground Water in a Drilling-Dense Region. University of Missouri: Columbia, USA.

Osborn, S., Vengosh, A., Warner, N. and Jackson, R. (2011). Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing. PNAS: Boston. World Energy Outlook. (2012). Golden Age of Gas. International Energy Agency (IEA): Paris.