ENERGY: A ROLE FOR PROSUMERS?

Frans van den Heuvel
Chief Executive Officer, Solarcentury

The energy debate is often full of doom and gloom. With bills going up dramatically, it is easy to feel powerless. Now the time is here for consumers to take control of their energy production.

Let us remind ourselves that energy powers our society and modernising energy modernises us. How else do we get to the digital lives that we are promised in sci-fi? We leap forward with the next generation of energy, our catalyst for modernity. While there may be anger about bills and fear about climate change, these are the pains of growth in a new direction. We are the fortunate ones to be involved in the third industrial revolution.

The next generation of energy is bringing about a paradigm shift. It is no longer just about financial and social capital but also natural capital. By that, I mean nature is an asset. How dependent are we on its resources? How much do you consume? Whether one runs a country, a company or a family, we must manage our relationships with energy, fuel, water and waste. Our success, our wealth and competitiveness depend upon it. Sustainability is not news, nor is energy getting expensive but it seems to be hitting home only now.

The paradigm shift does not stop with our attitude. In fact, this is where it begins. What greatly alters is our role as energy consumers. We become both energy producers and consumers, or Prosumers. This is truly modern. Traditionally, our energy producers were utility companies. Traditionally, our energy retailers were utilities too. But now the man on the street is producing and retailing energy as he feeds into the grid. It is happening in the UK; there are solar panels on roofs, both residential and commercial. Energy has begun the process of decentralisation. Next is the transition to smart grids and energy storage in the home and car. We will all be producers, retailers as well as a storage unit for electricity.

This requires local optimisation of production, consumption and storage behind the electricity meters, at customer level. A Distribution Network Operator (DNO) manages the mid- and low-voltage grid, avoiding congestion. Once we produce 15-20% of our electricity locally, the grid in regions like Europe and the US will become unstable due to congestion. IT technology, creating a smarter grid, can prevent this, saving billions in grid extension investments for DNO's. In addition, it will enable the Transmission System Operators (TSO) to balance the grid more effectively as consumers will automatically use or store electricity that would otherwise be surplus and sold at a loss. Of course, for this to happen, the right regulatory framework needs to be put in place.

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This we know already. But what I see for the future is an energy internet, a synergy amongst prosumers. One business has a big roof so installs a large solar system to be the local producer, the neighbouring factory has high-energy use from all its equipment and so has additional consumption requirements. Local electric cars act as a storage unit, a battery for the community.

. . . creating over 100,000 jobs . . .

We are bombarded with the idea that the shift to renewables will cripple our economy. So far this has not happened in the UK. The UK has increased its share of renewables in electricity from 5.0% to 9.4% since 2007. According to OFGEM, the Feed-in-Tariff (FiTs) subsidies have added less than £1 per annum per home. The Renewable

Obligations (ROC) has added £21 per annum per home. These figures are for all renewable technologies. Whereas we have seen an average increase of £100 per home in energy bills just this year, mainly due to exposure to volatile energy markets. The price of fossil fuels is moving in only one direction – up.

If we look at the experience in Germany, they have 20% renewable electricity at a cost of £34.50 per annum per home. The impact of local generation of energy through solar PV (photovoltaic) has been overwhelmingly positive. The Germans have installed over 32GW of solar PV. This contributes energy during daylight hours when there is greatest demand for electricity (known as the peak-load). Normally, this is when electricity is most expensive. However, the peak-load price of electricity has fallen from 58€/MWh to 44€/MWh, a fall of nearly 25% since 2008 because of the impact of decentralised PV and wind, benefiting consumers and businesses. The solar power industry is also credited with creating over 100,000 jobs in Germany.

I envisage a new network of prosumers. How will we, our appliances and our cars interact with each other and the grid? Much has been promised and much confusion surrounds smart grids and what they can deliver and how they change our lives. But really what is being rolled out now is only a fraction of what is needed. It is the difference between an old-fashioned landline telephone and an iphone. The latter is attached to the home and offers no insight into the user. What happens behind the landline, nobody knows? On the other hand, the mobile has become a vital channel for collecting data on users. With those data, companies can offer solutions; offer new products and services, making lives better.

. . . and the more money the solar panel generates . . .

This is what is needed with the grid, not just the dumb 'smart' meter that is being offered now. These reveal nothing about the behaviour of the house, the appliances consuming the energy or the people in charge. We need to know what happens behind the meter so we can offer advice on how to act, how to save energy, how to be efficient. Then, we can buy energy off the grid when it is cheapest not just when we use it. We may have lost some of the old ways of doing things with the digital revolution but it has created much growth and many jobs. We must open up the untapped market behind the meter and let business and innovation flourish there.

The mood is now set for change. The next frontier is grid parity, which is already hitting parts of Europe. For solar PV, what is important is the intensity of light (irradiation) as opposed to the temperature. It does not need to be hot, it just needs to be light to generate PV power. Different parts of Europe and the UK have different levels of light intensity. The more intense the light, the more energy is produced and the more money the solar panel generates.

At present the cost of generating solar PV energy is more expensive than gas in the UK, which it competes with for the peak–load market. However the price of a PV installation has plummeted in the last two years, and as the price of the panel drops, it reaches grid parity, starting with areas with highest irradiation and the most expensive conventional energy. According to the McKinsey report, Darkest Before Dawn, solar PV will reach grid parity for the UK around 2014. PV has already reached parity in some developed markets, including parts of California, Spain, Italy, Australia and The Netherlands.

In 2011, global power investments totalled 203 GW of electricity, almost 50% of which is renewable. This percentage is substantially higher if we consider only European investments. This staggering trend confirms that an energy transition is taking place.

A beautiful sunrise after a long dark night.

ENERGY – THE NEXT GENERATION

ENERGY – A ROLE FOR SHALE GAS?

Francis Egan
Chief Executive Officer, Cuadrilla Resources Limited

The prospects for shale gas in the UK and in parts of continental Europe are very promising, based on assessments of a number of geological formations that are not dissimilar in scale to US and Canadian sites where major deposits of natural gas have been discovered.

There are upsides to development of an indigenous shale gas industry:

- Reducing our import dependency of liquid natural gas and pipeline gas (we currently import 50% of our gas)
- A decreased carbon footprint as indigenous natural gas displaces coal and gas imports
- An opportunity to make the UK a leading centre of shale expertise for Europe and the developing world
- Substantial tax revenues for the Treasury and significant employment opportunities.

However, the journey to realising this opportunity is not purely technical or geological. It is socio-political. And here, all comparisons with the US are essentially irrelevant, because developing shale gas in the UK is a story of two journeys, not one.

WHO IS CUADRILLA?

Cuadrilla is a UK company, formed in 2008, whose mission is to unlock onshore oil and gas in the UK and Europe.

Cuadrilla's team consists of highly experienced shale gas explorers and engineers. We integrate the technical side with a risk management team who work with regulators and communities to manage health, safety and environmental issues. We are committed to ensuring that all stakeholders across Government and Parliament, along with the general public, are fully informed about the practice of shale exploration, development and production in the UK.

> . . . fully informed about the practice of shale exploration . . .

We understand the need for transparency and openness and adopt this ethic at every stage.

We are on two journeys. One is the geological and technical. The other is the socio-political. We strive for excellence on both journeys.

THE ISSUE IS NOT GAS IN PLACE, BUT ITS RECOVERABILITY

The geological journey has produced some eye-popping opportunity. The economic benefits of shale gas have not yet been fully ascertained. Based on our surveys, core samples and analysis, we believe there are at least 200 trillion cubic feet (TCF) of original gas in place (OGIP) in the Bowland basin alone. We are analysing a 3D seismic survey completed over the licence area, and analysis of data from the next well, which we are drilling at the Anna's Road site near Blackpool. Based on this we may raise our estimates of OGIP.

However, what of this is recoverable?

The recoverable reserve is a function of shale geology and a function of the number of horizontal wells that can be drilled and fractured. Estimates range from 10% to 40%. Only experience will reveal what we can recover from the Bowland shale.

Our exploration has shown that the Bowland shale in Lancashire is significantly thicker than any comparable US shale. This opens the possibility of developing a very productive horizontal drilling approach, with a much lower-density surface "footprint" than US shale plays.

The most important factors for determining whether shale gas is present and the scale of the resource is dependent on

> . . . reality under the ground is much more complex . . .

(1) *Thickness* of the shale

(2) Natural *fracture intensity* (high fracture intensity allows for increased production rates and recoverable reserves)

(3) *"Frac-ability"* meaning how brittle and easily the rock will crack

(4) *Structural setting* (extensional, compressional or strike-slip)

(5) *Total gas volume*

(6) *Carbon* remaining in the rock or total organic content (TOC)

(7) *Temperature and depths* of the shale reserve

(8) *Reservoir pressure* and its stress regime.

Artists usually render shale as a series of coherent horizontal layers. Overall this is a fair picture, but the reality under the ground is much more complex as the layers themselves have been disturbed by sedimentation and the displacements of fault lines in the subsurface. In the UK, Cuadrilla's 3D seismic survey in the Fylde shows there is remarkable subsurface complexity. The Bowland regime shows sequences that reflect disturbance from faults we can see – and faults we cannot see.

What does this do to the chances of successfully fracturing the rock? The analysis is helpful, but no substitute for actual appraisal. We need to fracture some shale, and learn more.

We are hoping the regulators will allow us to fracture and test two wells to start. We are confident that the industry can learn how to work with these formations. Recovery of shale is the product of continuous operating experience coming from both appraisal and production drilling. The process of finding and "surfing" the best layers takes experience.

> . . . "surfing" the best layers takes experience. . . .

WHAT ABOUT THE RISKS?

There are issues about seismicity, migration of hydrocarbons to the aquifer, water use and management. It is important that regulators and operators develop, implement, monitor and improve practices that identify and mitigate these risks.

The UK has a strict regulatory framework governing both offshore and onshore oil and gas exploration and production. Risks with shale exploration are heavily regulated and closely scrutinised by the relevant independent bodies.

Our principal regulator, DECC, and Cuadrilla are guided by best practice. The Royal Society together with the Royal Academy of Engineering have put together a guiding framework for developing shale gas safely.

This is a collaborative process. An example of this is seismicity. Even the best 3D survey cannot see all the faults, and importantly, the pressures. For our first two wells, we developed a plan with DECC to install a micro-seismic array, so that we can see the effects of hydro-fracturing in real time. We can therefore be aware of a perturbation before it is discernible to humans, and reduce our pressures, or move on to another section of the well-bore. It will also help us save water, because a shale can leak away pressure. We will know when we have optimised any given fracture.

Our seismic array is very expensive and is installed in many locations. It cannot be

. . . framework for developing shale gas safely . . .

scaled for every well without considerable cost and inconvenience. If experience shows our "traffic-light" system can function with less sensitivity, then we will be able to optimize fracturing at a lower cost and inconvenience.

The water risk is more about our well integrity than fracturing, per se. Above the Bowland shale formation in Lancashire lies the Manchester Marl, a thick impermeable rock forming the 'regional seal', a barrier between the hydrocarbons trapped in the Shale rock below and the aquifer several thousand feet above. We consider it exceedingly unlikely that hydrocarbons or fracturing fluid could leak into shallow aquifer water as a result of the fracturing process. This is very different from coal bed methane. The fracturing risks from the two are often confused.

THINK AHEAD TO DEVELOPMENT

If the shale proves out, what will development itself look like? We are treated to pictures of Pennsylvania or Texas – a veritable "pincushion" of locations. Will that be the same here?

We believe development here will be very different and much lower density for several reasons. The thickness of the shale is one of them.

Horizontal wells can radiate from the same well bore like the tines of a fork, and radially in several directions. We have learned that the Bowland shale is unusually thick, this can be repeated at different vertical levels, so called "vertically stacked" horizontal wells. One pad can manage around 36 such horizontal wells, using current technology, and probably more in the future. Each horizontal well is equivalent to a piece of keyhole surgery.

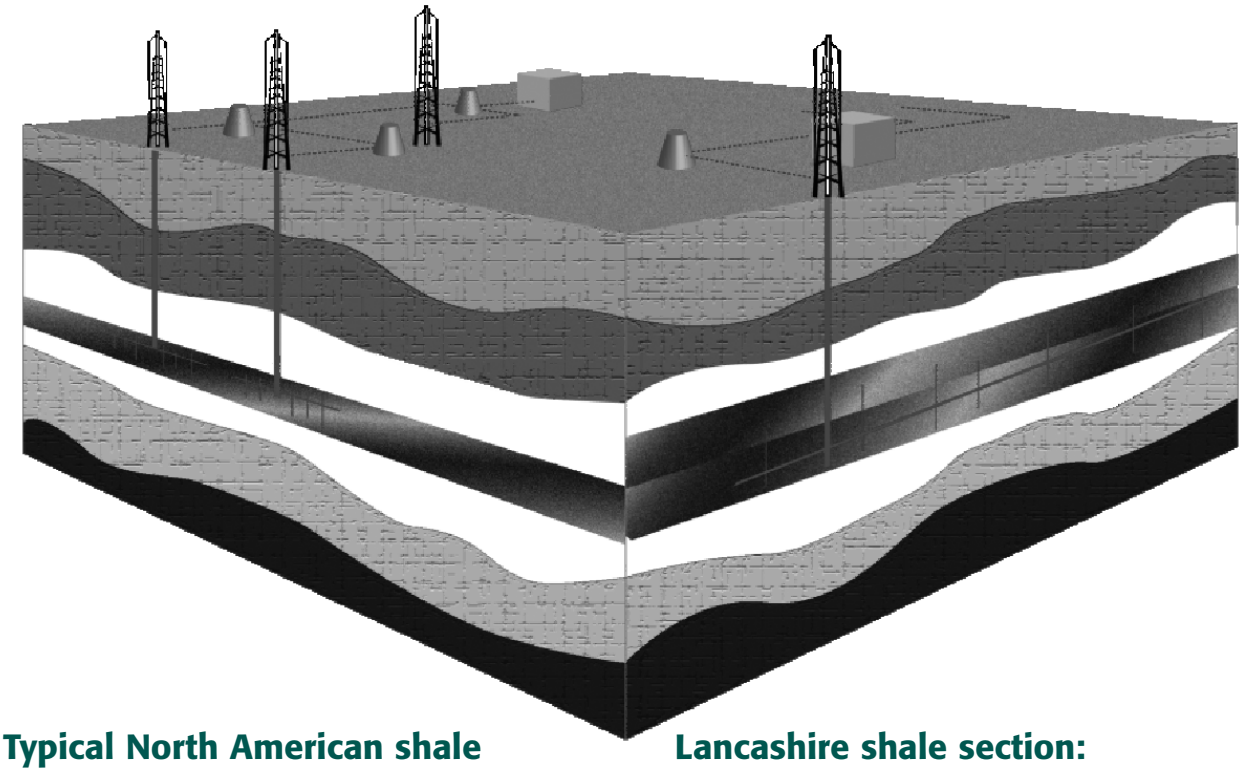
A lot of development can thus take place from a small number of pads – hence our view that the UK offers a low-density development opportunity. Moreover, those pads can also be sites that generate electricity to back up intermittent renewable sources, or provide district heating. In other words, the very concept of "pad" can be re-thought.

THE SOCIO-POLITICAL CONTEXT

The limitations of UK shale are highly dependent upon the level of public and political acceptance. In the US, exploration firms have traditionally excelled at the technical side of shale development, but less so at understanding and effectively managing the socio-political context. In the UK, we need to tell a different story. Onshore shale development is a relatively new phenomenon across Europe, and because the sector attracted its share of controversy from the outset, Cuadrilla has quickly come to grips with the challenges of the 'social licence to operate'.

This is why we are listening to a wide number of

. . . effectively managing the socio-political context . . .



Typical North American shale section: Relatively thin shale target (<60m thickness)

Lancashire shale section: Much thicker (up to 1'200m thickness) and more structurally complex

stakeholders at every stage. This gives us a unique understanding of the issues.

"Energy" is not a living room topic in the UK, apart from complaints about energy bills. We have learned that all stakeholders have a great deal to learn about natural gas, much less onshore gas. Easy comparisons with US shale gas experience are often misleading. Mis-information is particularly sticky. The image of the flaming tap water has been discredited because hydrocarbons in that part of the US are very close to the surface. But that doesn't matter, because it speaks to a deep fear of the unknown.

A consequence of what we have learned from our stakeholders is the need for a form of 'industrial education' so that Government, opposition, industry bodies, academia, and our supply chain have the opportunity to learn from each other, and can work together to enlist the engagement and understanding of the local and national population.

This education is not pedagogic – it is a "conversation" with different independent voices, including those who are sceptical about shale. This is what we are hoping to catalyse, so that people can make up their own minds.

IN SUMMARY…

As a socially responsible company, Cuadrilla has made it a goal to demonstrate that shale gas from the UK Bowland licence can be developed safely in an environmentally responsible fashion that is acceptable to all affected communities. As outlined there are two aspects to this mission, technical and the socio-political.

We await operational clearance to resume our fracturing operations so that we can prove that this gas can be hydro-fractured and will flow successfully. Achieving one or two proven flowing shale gas wells will be a major milestone for Cuadrilla and for the UK.

Maximising the benefit of shale gas for the UK will require a process of long-term investment and technological innovation and improvement by Cuadrilla and others. Shale gas specific expertise can be imported from the US, but the UK has significant oil and gas knowledge and can and must further develop its own shale gas capabilities. These can then be employed not just in the UK but also in European and Global shale markets.

The UK currently has a first-mover advantage in Europe, while being able to rely and improve upon expertise developed in the United States. However, Cuadrilla recognises that shale gas is a sovereign resource, and ultimately the decision over whether or not to develop it, and at what speed, is a socio-political one. The balancing of local concerns with national priorities is a difficult act.

In this, we err on the side of the communities that we are in the process of becoming part of. Their interests and our interests are closely intertwined. At the same time, clear directives from the centre regarding the national interest, alongside stable and pragmatic policies, will give us the confidence to invest in those communities for the long term.

ENERGY – THE NEXT GENERATION

ENERGY – A ROLE FOR WIND POWER

The third speaker on 16th October was Dr Gordon Edge, Director of Policy, RenewableUK

He made the following points

RenewableUK is the trade body representing wind power generation.

The UK currently has 5,000MW (5GW) of onshore wind power capacity installed. Together with 2,700 MW (2.7GW) of offshore, this generated 5% of the country's electricity in 2011. This increased by 30% during 2012, and it is anticipated to have 7GW and 4GW respectively available by 2014.

There is also a significant backlog of approved onshore installations waiting to be built at a cost of around £1bn per GW.

This is all financed by the private sector.

The Department for Energy and Climate Change (DECC) has recently published its targets for 2020. These are 13GW of onshore capacity, and at least 18GW offshore. The industry is totally confident that these are achievable.

Onshore wind generated electricity is the cheapest low carbon source. Offshore wind's present cost is £140 per MWh, but the target is to reduce this to £100 per MWh.

Wind power is often described as "intermittent". This is misleading. It suggests that the power is switched on and off at a whim.

The correct description is "variable". The important point is that too little (and also too much – in excess of 25m/sec) is predictable many hours in advance, and therefore contingency alternatives can be made available. Building a "spare" gas fired plant is not expensive.

However in the longer term, interconnection needs to be increased. The UK already imports power from France and the Netherlands, and future connections to countries such as Norway will allow us to share surpluses and shortfalls to the mutual benefit of all.

Further information is available at http://www.renewableuk.com/

Alan Malcolm
Editor, Science in Parliament