# Can the Dutch Gas Bubble defy King Hubbert's Peak?

**The Peak Oil theory may be on its way to being confirmed by the depletion of Europe's largest natural gas field, which can only be rescued by a new era of gas exploration which would also delay Europe's growing dependency on foreign gas imports. Ruud Weijermars[1*] and Elaine Madsen[2] examine whether past success can be equaled by future exploration initiatives.**

King Hubbert was already a revered Shell research scientist in its Houston research lab when he presented his Peak Oil ideas to the 1956 Spring Meeting of the Southern District, American Petroleum Institute, in San Antonio, Texas. *Science* magazine had published an earlier scholarly account of his theory in 1949. 'The end of the oil age is in sight,' Hubbert stated. He repeated this assertion in a 1974 contribution to the *National Geographic*, claiming that the global production of oil and gas would peak in 1995 (Hubbert, 1949, 1974). His Peak Oil theory was plausible under the assumptions made (Fig. 1a) and provided a provisional deadline for alternative forms of energy that must replace petroleum in the sharp drop-off that would follow.

Fortunately, practical improvements in E&P technologies have shifted the global peaking of oil and gas production a couple of decades into the future. In Holland too, the advent of new technology has delayed the final peaking of domestic gas production several times, as can be seen from the extended production plateau during 50 years of gas production (Fig. 1b). Hubbert's theory – if not deferred by further production innovations - heralds an imminent end for the Dutch gas bubble. The Netherlands still plays a lead role in European gas supply after Norway: in 2009 it was still the world's 6th ranked producer and 7th ranked gas exporter. However, recent inventories of all past gas production and remaining field pressures (EBN/TNO reports) foresee a steep decline in conventional gas production. If correct, Holland's gas production may have peaked for a last time in 2010 and is now entering a final decline phase.

## NAM oil stumbled into giant gas find

The current profit-sharing agreement between Exxon and Shell and the Dutch State (Fig. 2) goes back a long way. Standard Oil (Exxon's parent company) had entered the Dutch petroleum play after World War II to form in 1947 the Nederlandse Aardolie Maatschappij (NAM), a 50/50 joint venture between Shell and Standard's Dutch subsidiary Esso). The NAM partnership was originally formed to develop a giant oilfield at Schoonebeek. Nearly 250 million

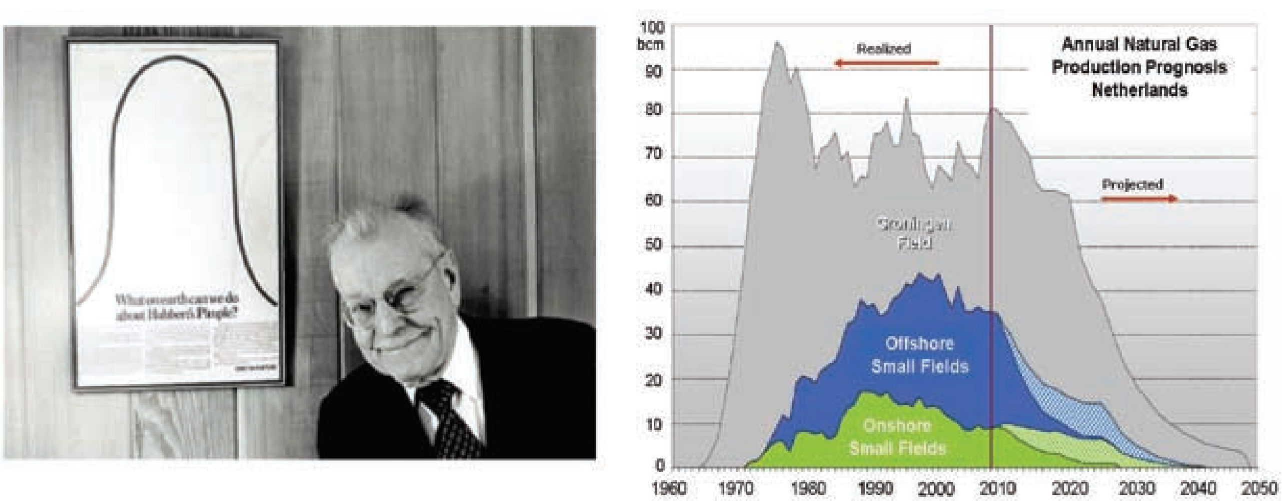


*Figure 1 (a) King Hubbert poses in front of a poster - mockingly headed 'What on Earth can we do about Hubbert's pimple?' Exactly this question is what keeps the Dutch busy. (b) Stacked on top of one another the production profiles of the Groningen Field, offshore small fields, and onshore small fields (after EBN, 2010; Scheffers, 2010) resemble a real life example of Hubbert's pimple peaking.*

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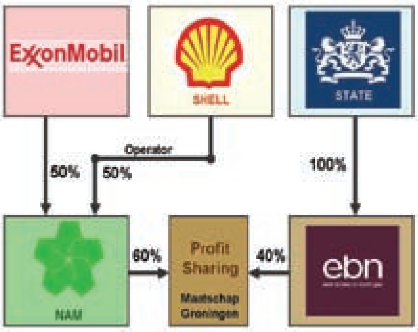


***Figure 2*** *Profits from NAM are shared between Exxon, Shell, and Dutch State at 30-30-40% according to the profit sharing agreement in Maatschap Groningen (adapted from Schenk, 2010).*

barrels of crude have been recovered from that single field between 1947 and 1996. Notably, 750 million barrels of thick viscous oil remained underground at Schoonebeek's abandonment in 1996. Field redevelopment was approved some years ago and was finalized in 2011. Some 100 million barrels of oil will now be lifted above ground by liquefying the residual oil by steam injection over the next decade.

The early development of Dutch gas was much more complicated than Schoonebeek's early oil success. Separate gas finds in wells drilled along the contours of its giant footprint, back in 1959, were at first not recognized as being part of a single reservoir. Reportedly, Royal Dutch Shell was rather disappointed to find gas and no oil in any of these wells. Without a natural gas market in Europe back in the late 1950s, the gas was commonly considered a nuisance as it remained worthless.

## Exxon's gas expertise

The casual announcement by a Belgian politician in 1960 that the Dutch gas discovery could be big enough to serve an entire NW European market revived Exxon's interest in the Netherlands. With so much gas in the ground proven by geological research, the remaining problem could be solved: gas could be produced and sold at a profit if a market was physically tied to the wellhead by a pipeline distribution system. However, no natural gas infrastructure existed in Europe back in 1960. To build the market and the pipelines, Exxon sent a young engineer, Douglass Stewart, to the Netherlands. The story is told in two recent books (Stewart and Madsen, 2007; Madsen and Stewart, 2008) which fill in an important part of the Dutch gas legacy from the perspective of the Exxon stakeholder, something that was completely missing in the Dutch historical records. Stewart's first task was to check the rumour that a major gas field had been found.

His first visit to Shell's headquarters in The Hague in October 1960 led to a remarkable rebuff. Only after overnight transatlantic cable exchanges between the leaders of both companies did Shell accede to the Exxon man access to their geological records. During a surprise visit to NAM's exploration office near the Groningen Field, he quickly realized that a major find was on its hands. Early estimates of the gas field's size were impressive: some 300 bcm, perhaps more. Years later it became apparent that the ultimate recoverable reserves of the Groningen Field were 10 times the original estimated volume, some 3000 bcm.

Exxon, Shell and the Dutch State began an intriguing period of negotiations and inventories to settle numerous questions: Who pays for the start up cost? How do you secure an agreement that benefits all stakeholders? Who has the know-how to develop such a big gas field? The local economy could be severely disrupted by inflation due to the new gas money flowing in – how could one manage the new gas money flow and avoid a negative impact on the economy from the future gas production? How do we manage the (limited) life-cycle of the resource?

As long as the pipeline and the market did not exist, there was no reference price for the Dutch gas. In essence, the Dutch gas remained worthless unless many practical above-ground issues could be solved. A large field required a major field development plan and enormous investments to build the pipelines to the customers. This required the setting of an acceptable gas price with the help of the several governments involved in an emergent NW European gas market. It took an agonizing four years of negotiations between the three principal partners (Exxon, Shell, and the Dutch State) before the gas from the Groningen Field came into production in 1963. What no one considered then was what happens when the gas is depleted. Now in 2011 the question has suddenly become very relevant and answers are sought as to how to deal with the impending gas deficit.

## Gas income for the State

Substantial income from the national gas endowment has been part of the Dutch government's operational budget since 1963. The discoveries of oil at Schoonebeek (1943) and gas at Groningen (1959) have had a tremendous

***Figure 3*** *Gas money has been important for the Dutch economy and provides innovation incentives. Gert-Jan Lankhorst, director of the Dutch gas-trading company GasTerra (right) awards the annual sustainable energy prize. In 2010, €50,000 went to Coos Wallinga (centre) and four more students of the Hanzehogeschool in Groningen received €10,000 each for their carbon neutral village concept. (Photo: GasTerra)*

impact on the postwar economic recovery of the Netherlands. In addition to the 40% profit sharing in NAM (Fig. 2), the State receives 50% of the gas trading profits from GasTerra; the remainder is shared equally between Exxon and Shell. GasTerra trades the NAM gas and buys additional supplies from abroad for re-export through the gas pipelines and roundabout of Gasunie. GasTerra's annual turnover averaged some €20 billion in recent years (Fig. 3).

The Dutch golden age of conventional oil and gas production has brought the State a windfall income of hundreds of billions of Euros. Handsome net earnings of €230 billion accumulated between 1963 and 2010, mainly from taxes and participations in indigenous gas production. A year with high natural gas prices like 2008 brought the State over €14 billion net income in that year alone.

Unlike Norway, which created a Sovereign Wealth Fund (SWF) from excess oil and gas earnings to protect its national economy against inflation, the Netherlands chose not to institute such a fund. Instead, gas income has been spent by the government over five decades, mostly as sunk cost into durable infrastructure, with the argument that such spending would cushion inflation, and future wealth would be generated by the improved infrastructure.

While the debate to install a belated Netherlands SWF continues until today, much of that easy, past gas income will evaporate for the Dutch State (Weijermars and Luthi, 2011). The drop in gas production income implies the Dutch GDP will decline by as much as 3% over the next few decades. But can the accumulation of lost gas income perhaps be avoided? For example, could shale gas bring a halt to the steep gas production decline in Holland, the country which launched Europe's conventional gas markets?

## Can unconventional gas defeat the King's prophecy?

The US has averted an imminent decline of its domestically produced natural gas by developing new technologies to unlock gas trapped in tight sand, shale, and coal seams. The development of these so-called unconventional gas resources requires horizontal drilling and high pressure hydraulic fracturing of the rock, as well as a pioneering spirit to turn these risky geological plays into an economic business (Holditch and HusamAdDeen, 2010). As a result of early successes, production of US domestic gas from unconventional reserves has now surpassed domestic output of conventional gas. Is there a formula for success here for the Netherlands?

The Dutch have begun to assess their unconventional gas resource potential in earnest in attempts to replace the falling gas production from conventional fields. Some small successes can be reported from the application of unconventional and new technologies. Recovery has already been demonstrated from a tight sand formation near Ameland, northwest of the Groningen Field, using multi-stage fracking and horizontal drilling technology (Crouch et al., 1996). But much more is needed to replace the deflation of its huge conventional gas production.

Accelerating the unlocking of unconventional resources is now in the hands of Cuadrilla Resources Holdings, a junior company with a market capitalization of some $100 million. The company is 41% owned by AJ Lucas Group, an Australian diversified mining services group. Riverstone/Carlyle Global Energy and Power Funds, for which former BP chief executive Lord Browne is UK managing director, invested $58 million in Cuadrilla in February 2010. The company drilled the Bowland shale formation near Blackpool (UK) in 2010, and will frac the well in 2011.

Cuadrilla is not into shale gas for long-term development. Chris Cornelius, director and co-founder, stated in a UK Channel 4 interview last year: 'If those (Bowland shale) explorations prove successful, then Cuadrilla will look to sell the entire operation to a large exploration company, like Shell, to carry out the expensive and time-consuming production process'. This assumption may be optimistic as US shale gas drilling has slowed considerably for economic reasons (Weijermars, 2011), and majors like Shell and Exxon have their own exploration going on elsewhere in Europe (Shell in Sweden's Alum shales; Exxon in German shales).

Cuadrilla is entrepreneurial enough to have acquired an exploration licence to drill a 4 km deep vertical well into Jurassic Posidonia shales at Boxtel in 2011. The operation is run by Cuadrilla subsidiary Brabant Resources, with a negative cash flow in the 2009 annual report. Nonetheless, EBN has taken a 40% share in the company's Dutch operations as stated in a 2010 presentation by Brabant Resources in Boxtel.

Meanwhile, the Netherlands has pragmatically secured future gas supplies – a new LNG landing terminal is already under construction on a remote stretch of Rotterdam's reclaimed seafloor board (Fig. 4a). Giant storage tanks can hold landed LNG from Nigeria, Qatar, Trinidad, and other overseas LNG providers. Additionally, giant ships equipped with stingers for laying submarine gas pipelines are now preparing to build the 1224 km Nordstream pipeline. Gas supplies may come in via the Nordstream pipeline, a joint venture of Gazprom and Dutch Gasunie, from the Urengoy Field in the Russian tundra (Fig. 4b). Russian gas fields connect via Nordstream with northwest European consumers and can be dispatched to the Dutch gas grid. The new LNG terminal and the Nordstream gas pipeline will both be operational in 2012.

As more foreign gas will be landed in the Netherlands to close the emerging gas supply gap, all seems fine and solved. But some worries remain. There are geopolitical concerns: What happens if the Russians block the gas flow in Nordstream as has happened on a number of occasions with the Ukraine?

## Europe's dash for gas

The question remains whether the Netherlands will be a play opener or a follower in European unconventional gas development. Following the US example is particularly attractive

**Figure 4a** *LNG Gate terminal construction in Rotterdam port started in 2009 with three huge storage tanks. They will be ready to land LNG imports from 2012 onward. The LNG terminal will have an initial through-put capacity of 12 bcm per year, which requires about 150 shipments a year (Photo: GATE).*

**Figure 4b** *The Urengoy Field is Russia's largest gas field and also one of the largest onshore deposits in the world. By completing a pipeline link from the world's biggest gas reserves in Russia to the European gas network, Nord Stream will meet about 25 percent of the additional gas import needs of the European Union. (Photo: Nord Stream).*

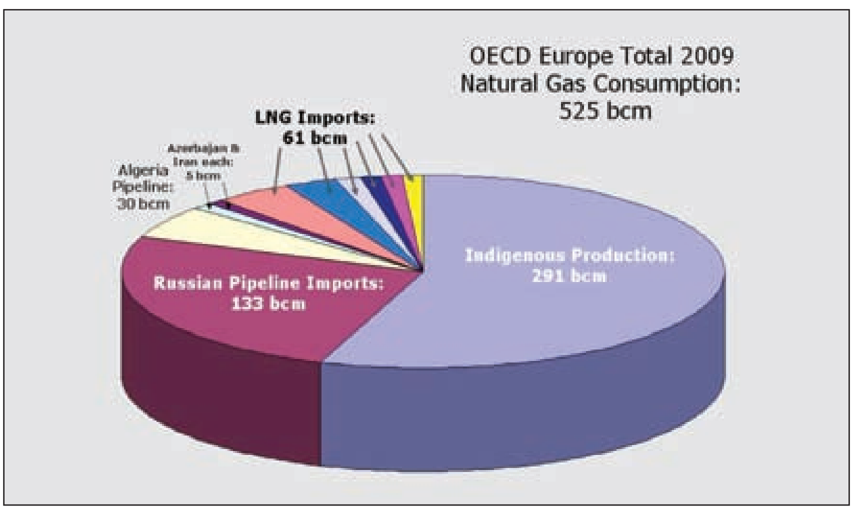


**Figure 5** *Gas supply origin for OECD Europe. LNG imports account for 12% of total consumption and come from Algeria (21 bcm), Qatar (15 bcm), Nigeria (8 bcm), Trinidad (6 bcm), Egypt (5 bcm), and other sources (6 bcm). (Plotted from data in OECD/IEA, 2010).*

**Figure 6** *Students from the Department of Geotechnology, TU Delft, have fanned out to study oil and gas formations in all corners of the world, as well as participated in domestic oil and gas operations. This readies them for the world's energy realities after completion of their degree studies. (Photo: TU Delft).*

for many European nations. Europe's indigenous gas production is declining rapidly since 2005. The statistics of the International Energy Agency show that of the 16 countries in the OECD Europe, only Norway and the Netherlands harness sufficiently large gas reserves to cover domestic demand. All other European countries are now net importers of natural gas.

A hefty 45% of Europe's total gas supply comes from imports outside the European Zone (Fig. 5): 33% of Europe's gas is brought in via pipeline imports from Russia, Algeria, and Azerbaijan. LNG landing terminals account for a staggering 12% of Europe's gas consumption. These LNG imports come into European ports via overseas LNG carriers from Algeria, Qatar, Nigeria, Trinidad, and Egypt.

Europe could break out of its dependent position by vigorous exploration for unconventional gas resources. Shale gas has become somewhat of a global hype, and is still in an early stage as production of unconventional gas outside the US remains insignificant. Most EU countries are now inventorying their unconventional gas resources, with Poland in the lead, partly aided by experts from the USGS Survey and workshops organized by the US State Department in 2010. Shale gas strategy drivers vary somewhat across Europe.

For example, Poland is 50% dependent on Russian gas imports and wants to reduce its dependency on these imports while also replacing a portion of power supply from polluting coal generators by gas generators to meet EU GHG emission reduction targets. Germany too is keen on unlocking its own gas potential as domestic gas consumption is now for 80% dependent on pipeline imports from Russia (31%), Norway (29%) and Netherlands (20%). On August 8th, 2010, the German Research Center

*The Solitaire in Rotterdam harbour can lay pipes for oil and gas and oceans to depths over 2700 m using the S-lay method over its stinger. This floating factory ship with a length of 300 m (excluding stinger) accommodates 420 men. (Photo: DirkJan).*

for Geosciences (GFZ) started a scientific drilling project in the Danish Alum shale, a dense Cambrian deposit of some 500 million years old – a prospective resource for shale gas in both Germany and Denmark. Clearly, hopes are high in Europe to improve its security of energy supply by upgrading prospective unconventional gas resources into securely proved reserves.

## New gas research focus

To help unlock Europe's unconventional gas potential, Delft University of Technology has launched a new unconventional gas research initiative (UGRI). Delft University's confidence is growing about future solutions for closing the emergent Dutch gas gap. Hopes are high that a next generation of geoscience and petroleum engineering students from Delft (Fig. 6) will help to unlock unconventional gas reservoirs large enough to delay the unfolding of a Peak scenario for Dutch gas. Whether King Hubbert can really be defeated in the small Dutch nation remains to be seen. Nonetheless, by putting academic ingenuity into practice, TU Delft wants to contribute to the postponement of King's Peak for another generation or more.

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