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# Stranded Fields in the Netherlands - Opportunities for New Development

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## SUMMARY

Since the start of the hydrocarbon exploration in the Netherlands, some 500 gas and oil accumulations have been discovered, of which around 25% has never been developed for various reasons. Total volumes contained in the around 100 stranded gas fields amount to about 180 BCM (GIIP) and the 20 stranded oil fields add up to 55 million m3 (STOIIP base case only and excluding upside). Analysis shows that effectively 9 factors control the development status of fields. These factors are: Field size, Well Productivity, Compartmentalization, Reservoir Strength, Gas Composition, Distance to Infrastructure, Infrastructure Quality, Taxation situation and Permitting situation. These factors have been quantified and form the basis of a portfolio description and ranking.
The analysis shows that (expected) poor well productivity is often the main cause for a field not (yet) being developed. This implies that improved understanding of tight reservoirs and advancements in the area of reservoir stimulation can make the difference and turn these currently dormant fields into producing assets.

## Introduction

Since the start of the hydrocarbon era in the Netherlands, some 500 oil and gas accumulations have been discovered. Around 120 have not yet been developed for various reasons and are considered "stranded fields". These stranded fields may contribute significantly to maintaining domestic production, mainly gas, at ± 1.2 mil Boe/d.

As Dutch state participant in exploration and production with a production share of around 0.5 mil Boe/d, EBN B.V. has a keen interest in mobilising these stranded resources. In order to understand which measures need to be taken, the principal causes of fields being stranded have been inventorised. This paper presents the main results of the inventorization and illustrates with examples the challenges and opportunities of unlocking gas.

## Size of the portfolio

Total volumes contained in some 100 stranded *gas* fields amount to about 180 BCM (GIIP, base case). Stranded *oil* fields add up to around 55 million $m^3$ (STOIIP, base case). The average size of a stranded gas field is about 1.7 BCM (Focus on Dutch Gas 2012, EBN). The reasons for not being developed have been identified for each field separately. In case the blockers could be removed e.g. by technological advances, significant volumes would qualify for development.

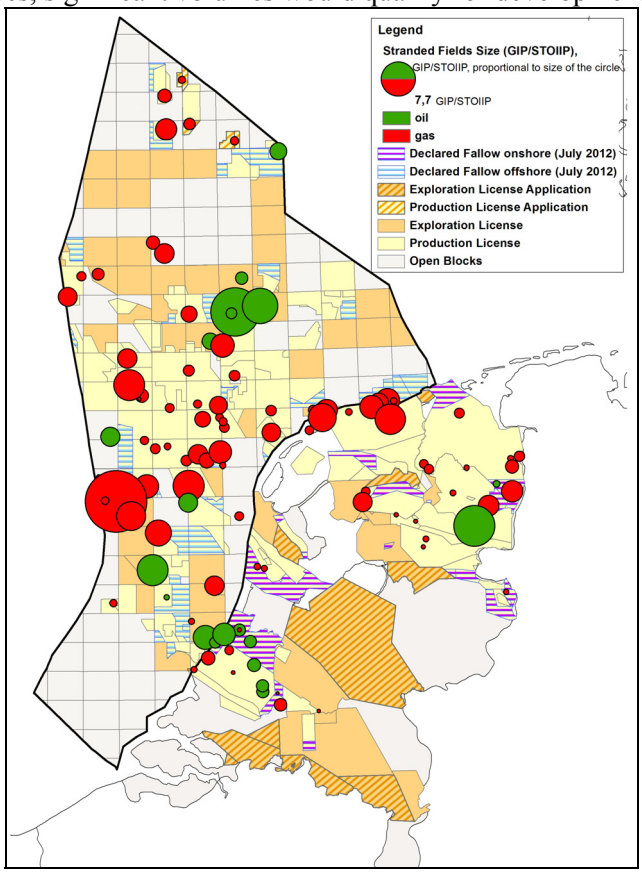



***Figure 1*** *Location and size of the stranded fields in the Netherlands. Fallow acreage is indicated on the map.*

Stranded fields in this study are defined as proven hydrocarbon accumulations that have not been developed and for which no firm development plans do exist. "Proven" here means that mobile hydrocarbons have been produced to surface. The size and location of the ~120 stranded fields are indicated on the map in figure 1. The portfolio consists of about 100 stranded gas fields and 20 oil fields. With an average size of 2.2 BCM the stranded offshore gas fields are larger than the stranded onshore fields with an average of 1 BCM. About 60% of the stranded fields is situated offshore and 40% is situated onshore. Factsheets for most stranded fields can be found using the Dutch Oil and Gas Portal (www.nlog.nl), together with other relevant data including well data and seismic data.

The reasons for not being developed are often economical, however, technical reasons which impact the economics, generally play a role as well. With technical improvements and changes in economic climate, a stranded field might become commercially interesting to develop. In order to assess the options in the future, it is useful to understand in detail what is holding back developing this class of assets.

**Portfolio analysis - Radar plots**

In order to understand which measures need to be taken in order to mobilise these assets (e.g. targeted research, bundling of activities between 2 or more operators, new seismic acquisition, adjustments to investment climate etc) EBN has assessed what reason or combination of reasons prevents each specific field from being taken to development. The analysis shows that effectively 9 factors control the development status of fields.

These factors are:

1. Fieldsize: base case volumetrics
2. Productivity: measure of expected productivity e.g. as per well test (without stimulation treatment).
3. Compartmentalisation: Measure of intra-reservoir flow baffles and boundaries
4. Unconsolidated: measure of reservoir rock stability and ease of completion
5. Gas composition: measure of gas quality (presence of $N_2$, $CO_2$, $H_2S$)
6. Distance: distance to infrastructure required for evacuation
7. Infrastructure: measure of the quality/ capacity of available infrastructure relevant for evacuation
8. Taxation: applicable taxation regime
9. Permitting: measure of complexity permitting (e.g. nature park status)

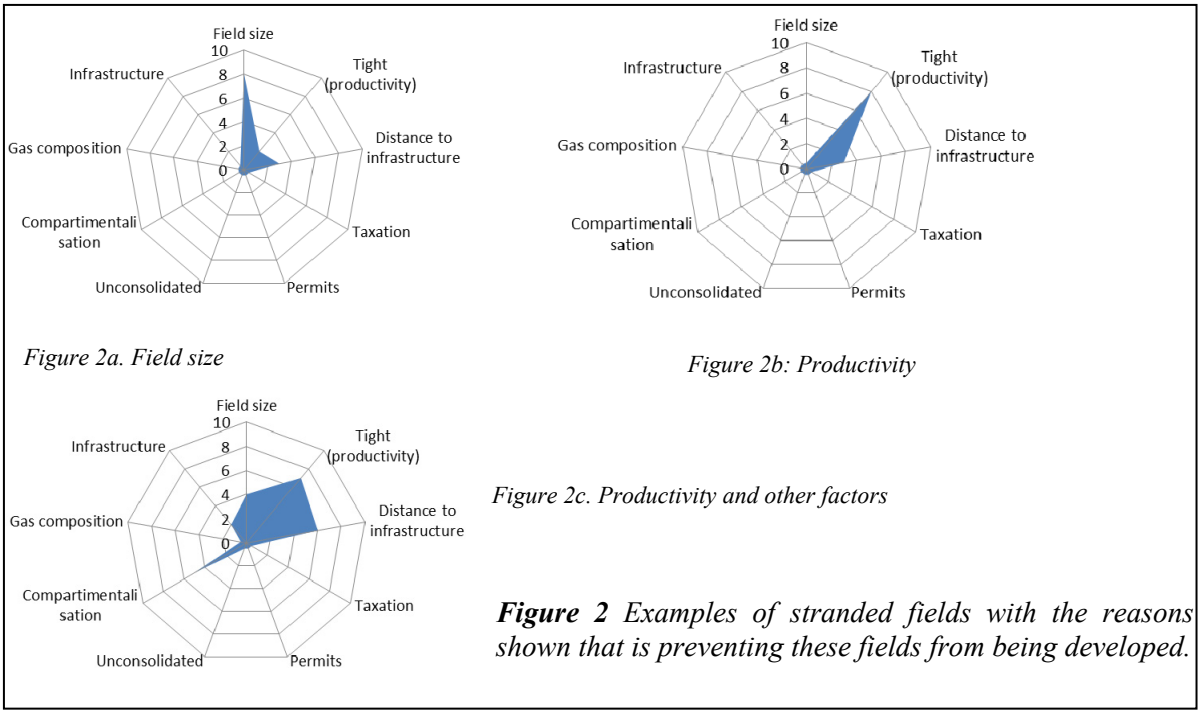



*Figure 2a. Field size*

*Figure 2b: Productivity*

*Figure 2c. Productivity and other factors*

***Figure 2*** *Examples of stranded fields with the reasons shown that is preventing these fields from being developed.*

Above factors have been quantified using a scoring scheme running from 1 (very favourable or not an issue for this project) to 10 (very unfavourable: absolute showstopper for development). Each stranded field can subsequently be characterized using this scheme and the result can be graphically represented using radar diagrams. Each factor is plotted along a separate axis that starts in the centre of the chart and ends on the outer ring using the scale of 1 to 10. Three examples are given to illustrate different types of stranded fields.

Figure 2a. shows a stranded field of which the main reason for non-development is the field size. Field size is often a factor that is not a standalone showstopper. For example distance to infrastructure is often a showstopper in combination with small size of a field. Many of the stranded fields have been discovered several decades ago and little technical work has been done since. Sometimes this is reflected in a large volumetric uncertainty which implies that there might be scope for upside. A new subsurface evaluation and investing in new field delineation technology (e.g. new seismic acquisition or seismic reprocessing) can narrow down this uncertainty and prove upside. Example number 2 (figure 2b) shows a stranded field where poor reservoir quality appears the bottleneck for development. Here sweet-spot identification using seismic or reservoir stimulation might be the way to unlock this field. The 3th example (figure 2c) depicts an example where 3 factors are hampering further activity. In addition to tight reservoir rock, reservoir compartmentalisation and the large distance to infrastructure are bottlenecks in development.

**Population analysis**

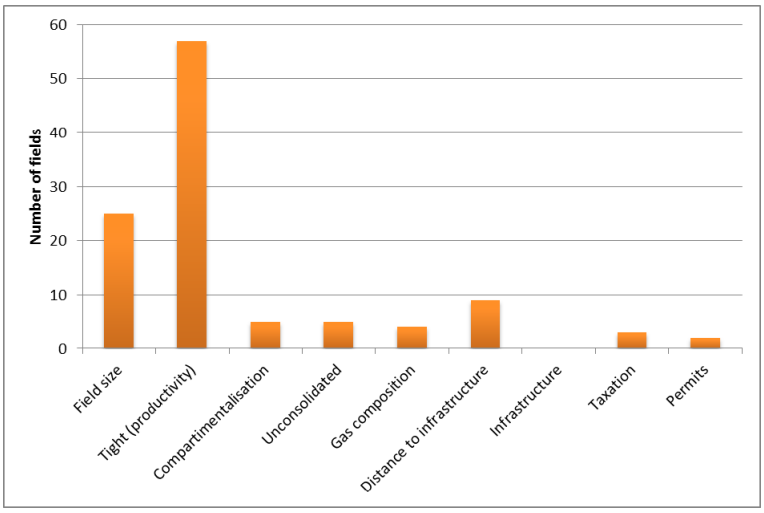



***Figure 3*** *9 Blockers preventing development of the stranded fields. The breakdown is based on the main blocker.*

For the entire population of stranded fields the principal factor that blocks development is summarized in Figure 3. The barchart shows the number of stranded fields per category. It is clearly visible that the main challenge is low productivity (low permeable reservoirs), the so called "tight gas fields".

In the industry the definition of tight gas fields varies. For the purposes of EBN's analysis we have adopted as definition "any field that cannot produce gas in economic quantities without stimulation treatments" (Schulte et al., 2011). Using this definition, more than half of the stranded gas field portfolio is tight. These tight fields represent a relatively large portion of the stranded resources not just in number, but also in total volume. Some three quarters of the 180 BCM GIIP contingent gas are located in the tight fields. On average tight fields contain 3 BCM GIIP, which is significantly higher than the 1.7 BCM GIIP in the average stranded field. In order to develop this type of stranded fields, hydraulic fracturing is a promising technique that can get these stranded fields on stream.
Hydraulic fracturing improves the flow of gas and/or oil towards production wells in poorly permeable, tight reservoirs. Recent technological improvements, combined with horizontal wells, have enabled large-scale development of tight reservoirs around the world. The sustainable flow rate of a horizontal, multiple-fractured well in the Netherlands is typically some ten times higher than that of a non-fractured well. EBN is involved in several research initiatives that can help to improve the understanding of these reservoirs.

**Detailed studies stranded fields, opportunities in open acreage; an example**
To illustrate some of the factors that are preventing fields from development, an example of stranded fields is discussed below. The Tulp East and Lelie fields are two stranded fields, discovered in the early nineties, located in the E12 block which is open acreage, in the Northern Dutch offshore. In the surrounding area several leads have been identified (Fig. 4a). The fields have been discovered by

wells E12-3 and E12-4. Tulp East and Lelie contain respectively a GIIP of 1.2 BCM and 2.5 BCM (expectation). The reservoir formations are the Slochteren Fm (Permian) and the Millstone Grit Fm (Carboniferous), see Fig. 4b. Main challenge for development of these fields is the gas composition, because of the high nitrogen contents of the fields. Since the economic climate has improved and a tax incentive form the Dutch government for small fields is in place it becomes more attractive to start looking into the development of these two stranded fields. New technologies are available to deal with low cal gas and the economics for these fields may be improved by combining their development with those of surrounding prospects.

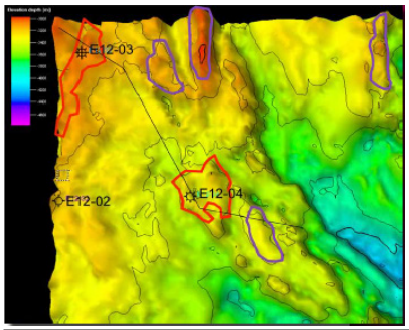
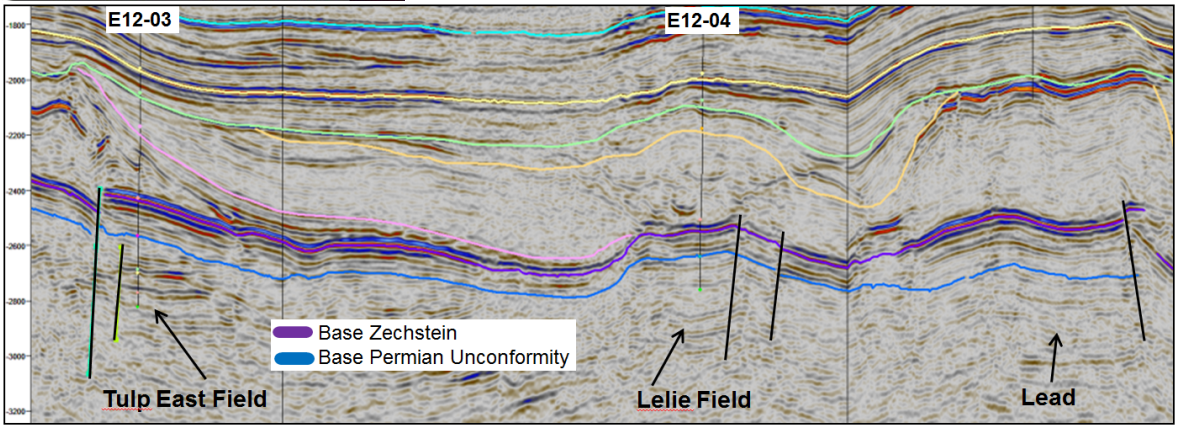



***Figure 4a*** *Tulp East and Lelie fields are outlined in red, leads outlined in purple and wells that reached the Carboniferous are shown on a base Zechstein map (TVD).*

***Figure 4b*** *Seismic line through the Tulp East and Lelie Fields.*




**Conclusions**

Since the start of hydrocarbon exploration in the Netherlands over one hundred fields have been discovered without being developed. At the time of discovery they were often classified as uneconomic. Given the technical improvements and changes in economic climate stranded fields might become commercially interesting to develop. The nine blockers that have been analysed can help to identify key challenges for the stranded fields with the goal to facilitate development.

One of EBN's major focus areas will be tight stranded fields, which represent the largest part of the stranded fields portfolio. This represents 75% part of the 180 BCM in the stranded portfolio and may be accessed using hydraulic stimulation techniques which are already successfully applied around the world. Other blockers like anomalous gas composition, might also be resolvable with technology advances.

**References**

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