Statistics on Wells in the Netherlands

What do we learn?

Guido Hoetz EBN B.V.

With contributions from Henk Koster,
Michiel Harings & Pieter Slabbekoorn.

EAGE Copenhagen 2012

Statistics on Wells in the Netherlands

What do we learn?

- Introduction: the role of EBN
- Exploration statistics
- Drilling statistics
- Depth prediction bias
- Drilling Hazards
- Summary

EBN: who, what, where?

~70 employees

- Large E&P player in NL via NOV's
- 100% owned by ministry of Economic Affairs
- Focus on oil & gas exploration & production
- Optimise use of assets & knowledge of subsurface
- Drivers: financial, reliable supply, clean
- Serve the interest of society

EBN key figures

amounts	2011	2012*
Sales volume, EBN share (bcm)	30	31
Sales (mln €)	7103	8891
Investments (mln €)	611	729

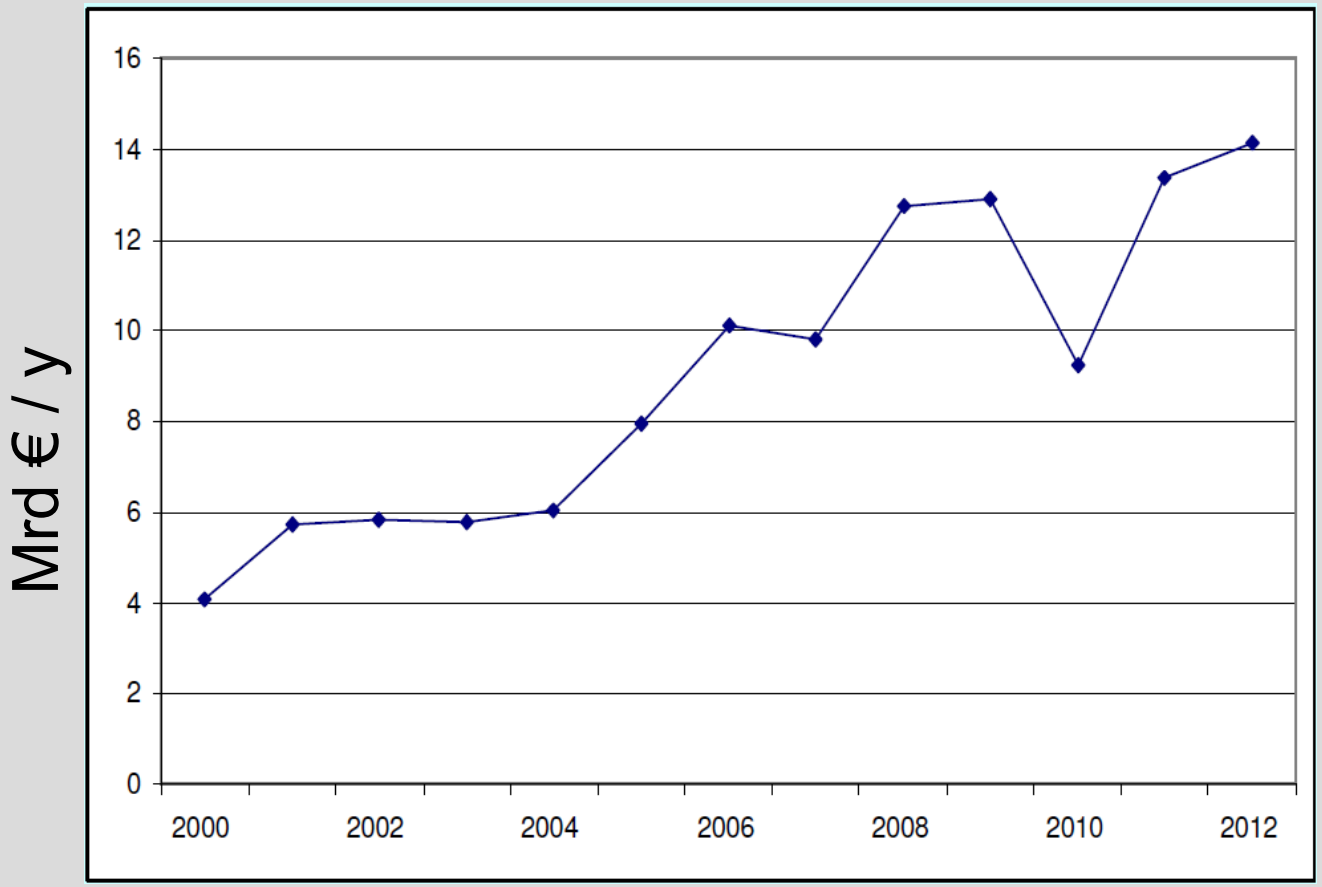
* budget

EBN participates in:

- 254 gas fields
- 3 oil fields
- 126 production licenses
- 48 exploration licenses
- 5 offshore gas transport pipelines
- 4 gas storages (1 under construction)

Source: EBN 2011 annual report

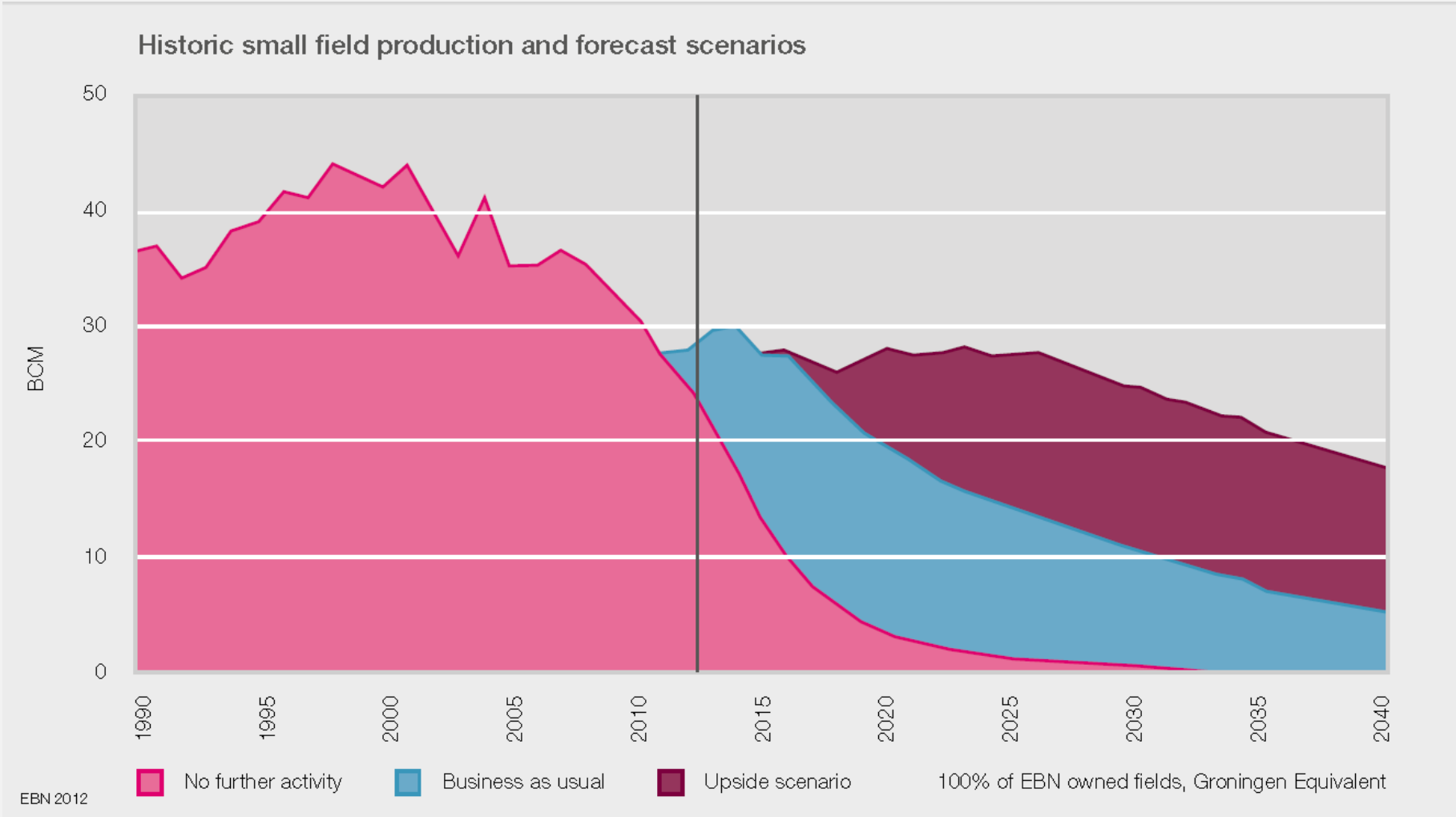
Gas Matters



Governement gas revenues (annually)

Source: EL&I letter to parlement 7 nov 2011

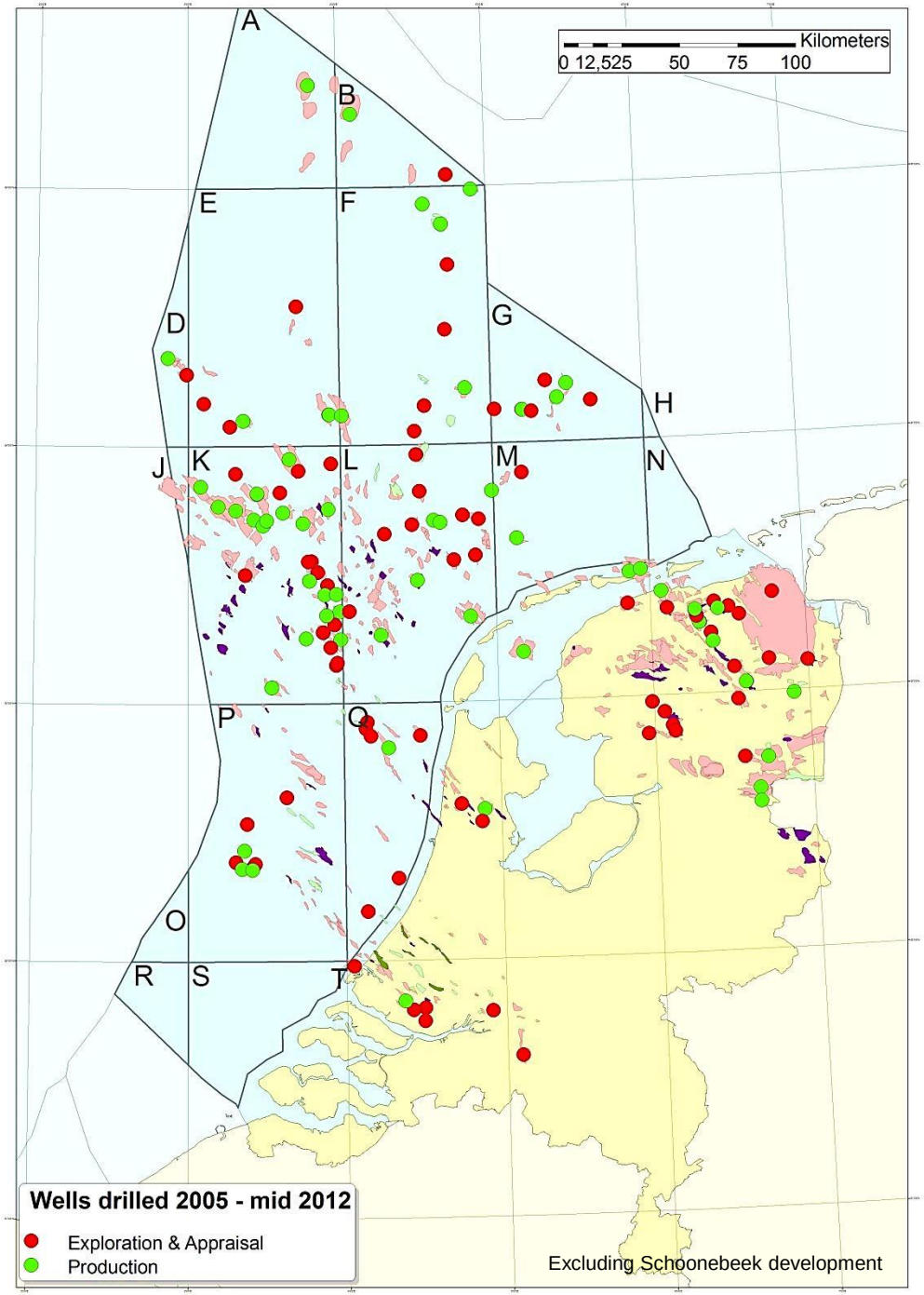
30-30 Ambition: maintaining plateau



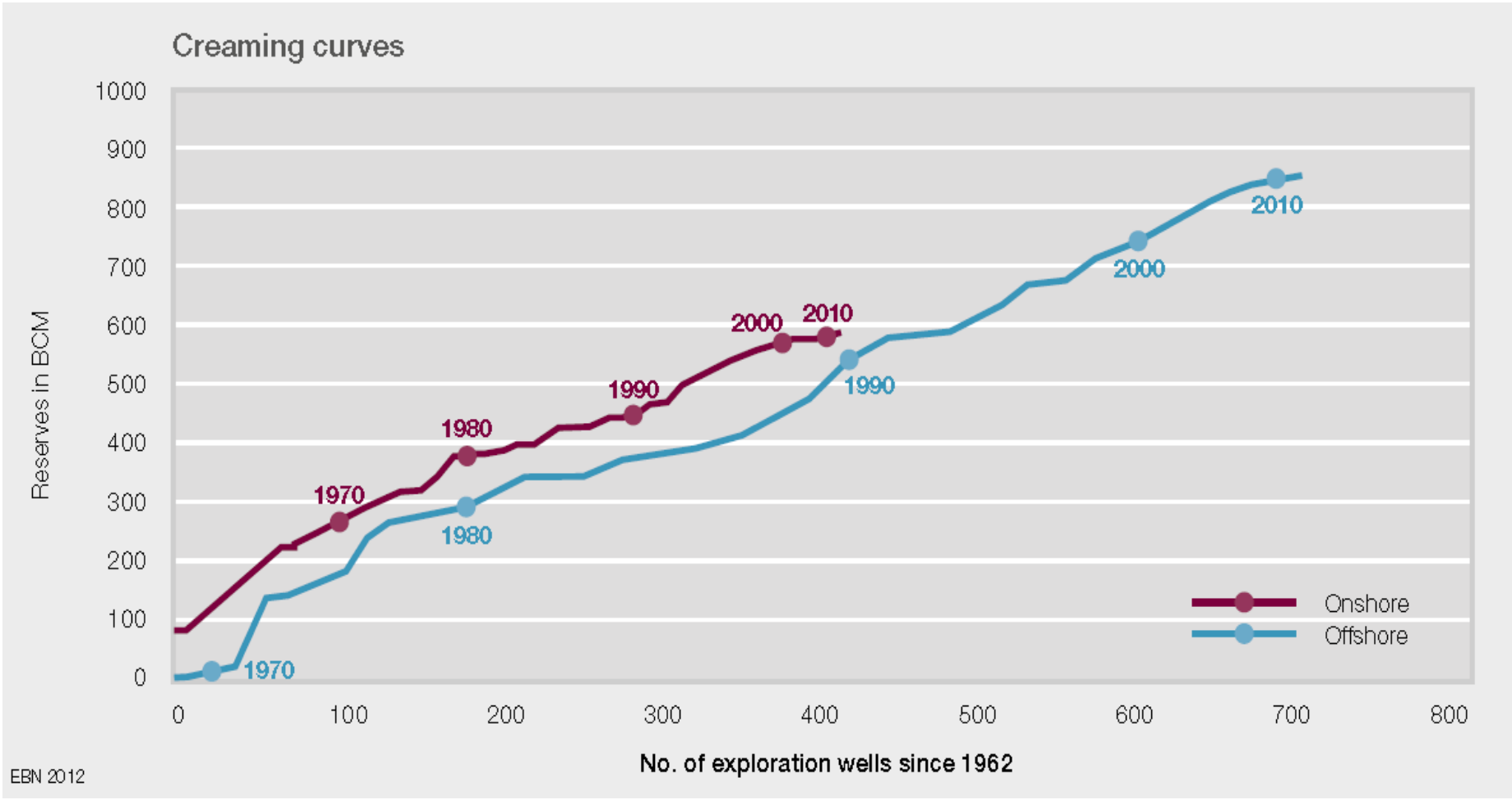
30 bcm / y until 2030 (outside Groningen)

Recent Drilling activity

- > 35 wells annually
- of which 15 exploration wells
- Detailed statistics 2005-2011

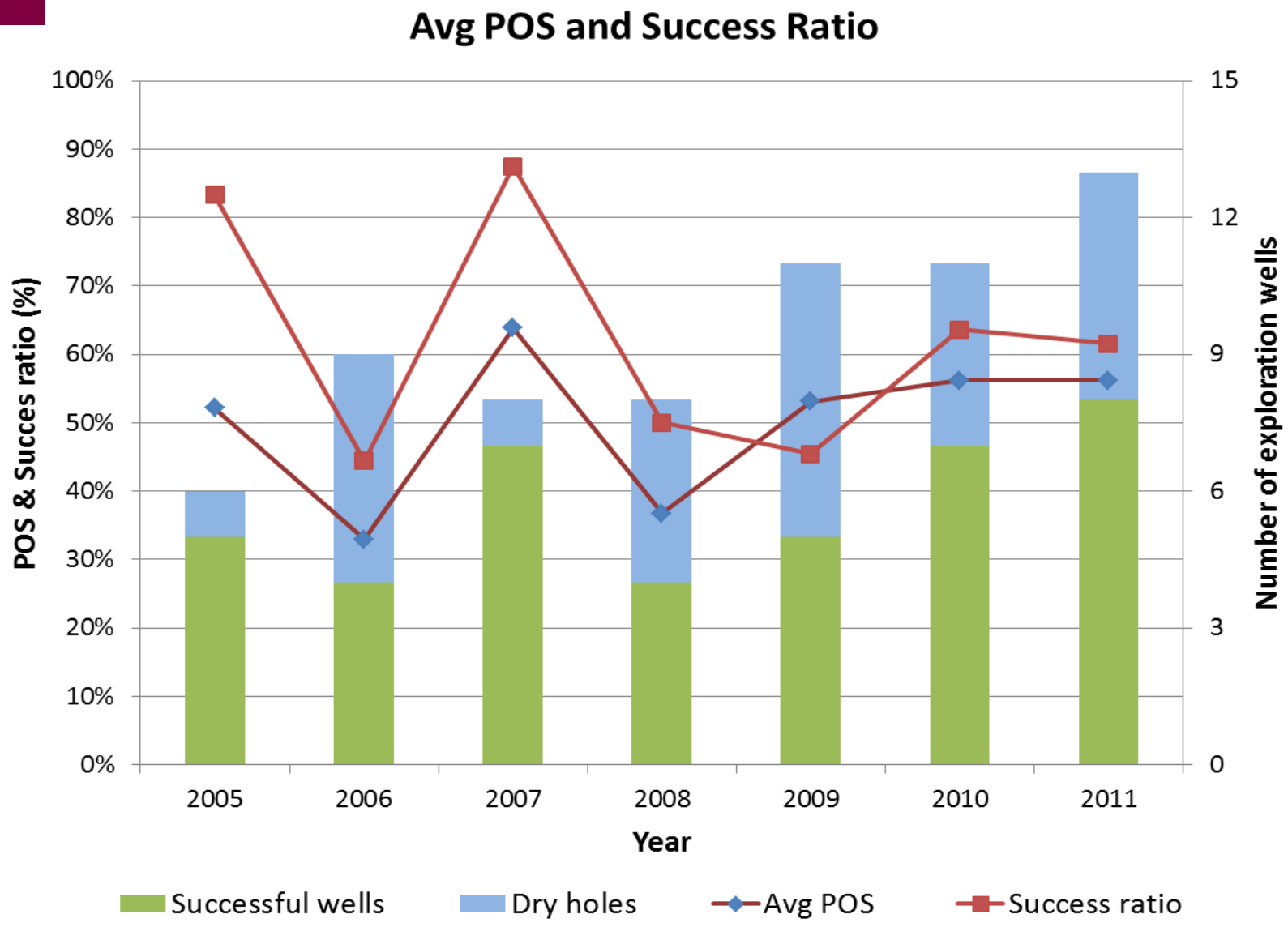


Creaming Curves



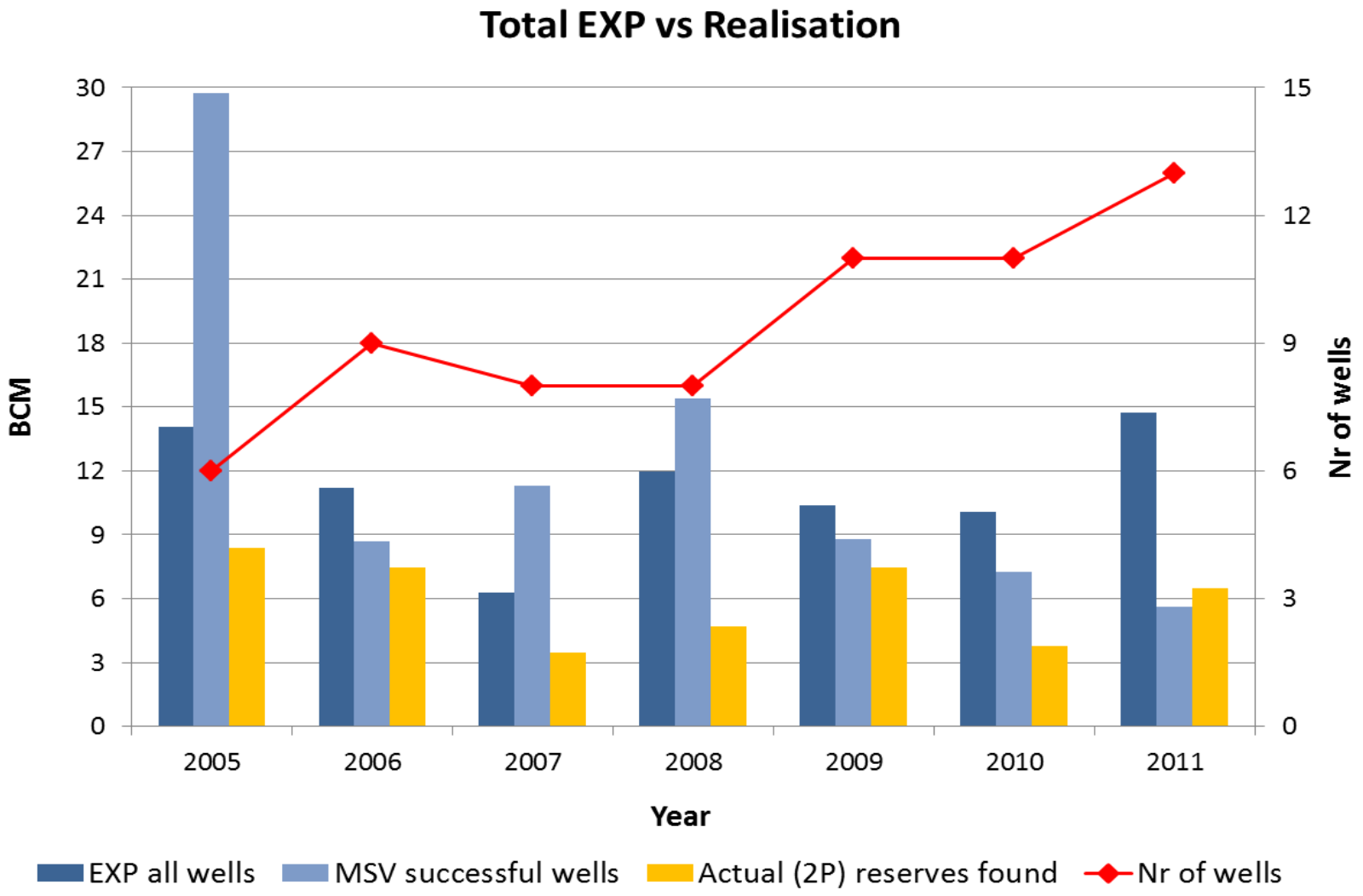
Source: Focus on Dutch Gas 2012 EBN

Persistently high succes ratios



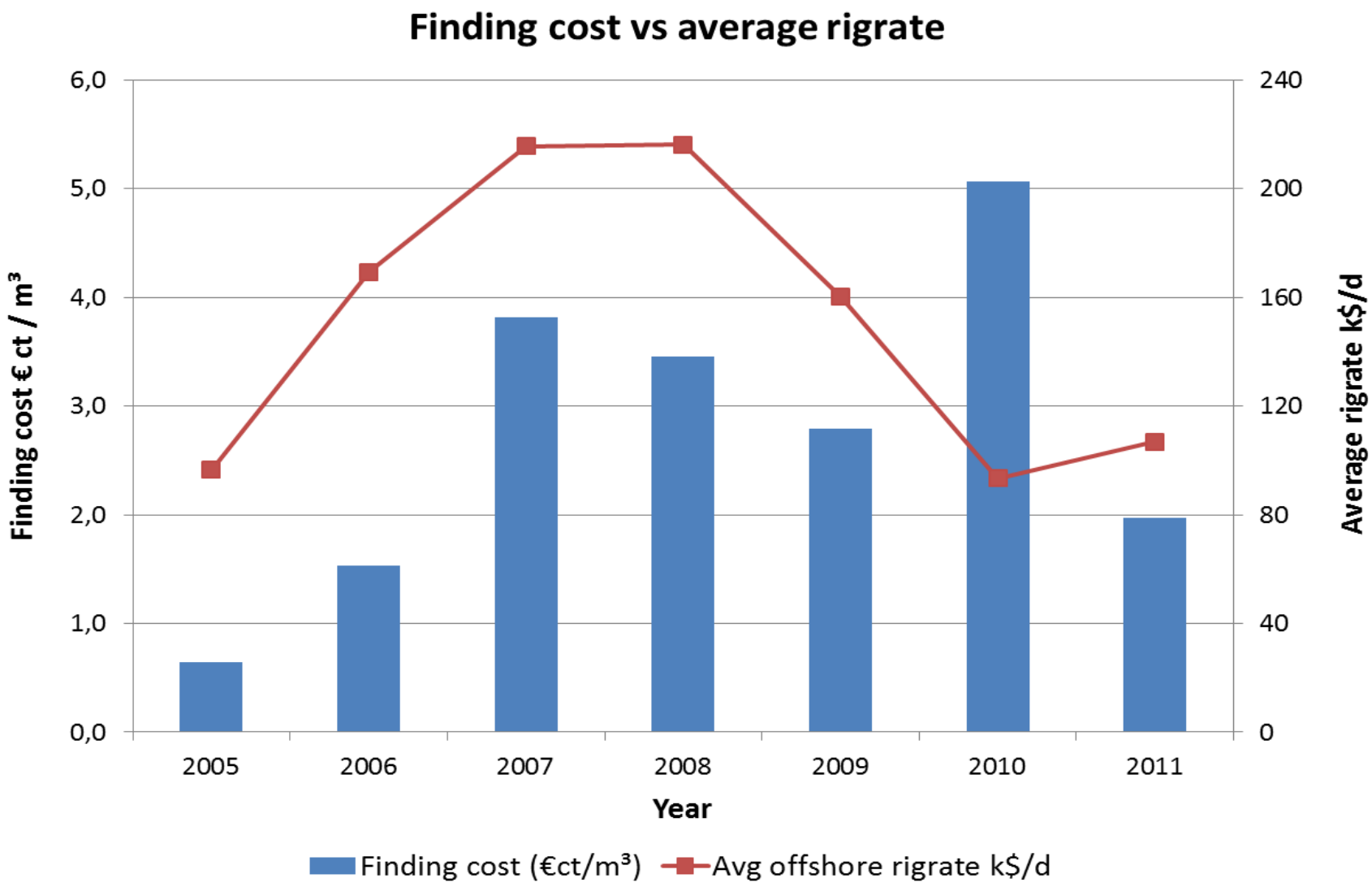
Source: Focus on Dutch Gas 2012 EBN

Exploration keeps contributing…



Source: Focus on Dutch Gas 2012 EBN

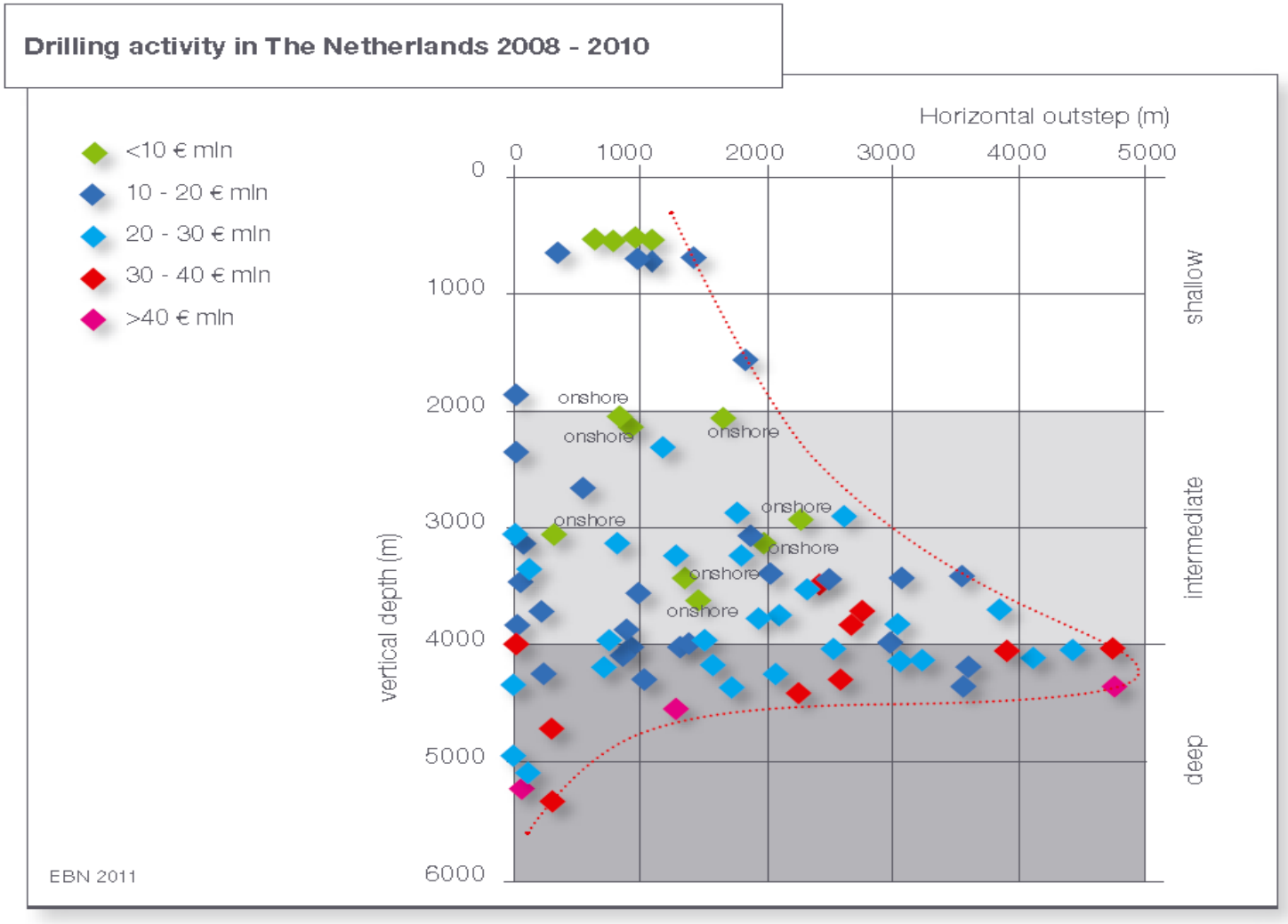
Exploration finding costs



Statistics on Wells in the Netherlands
What do we learn?

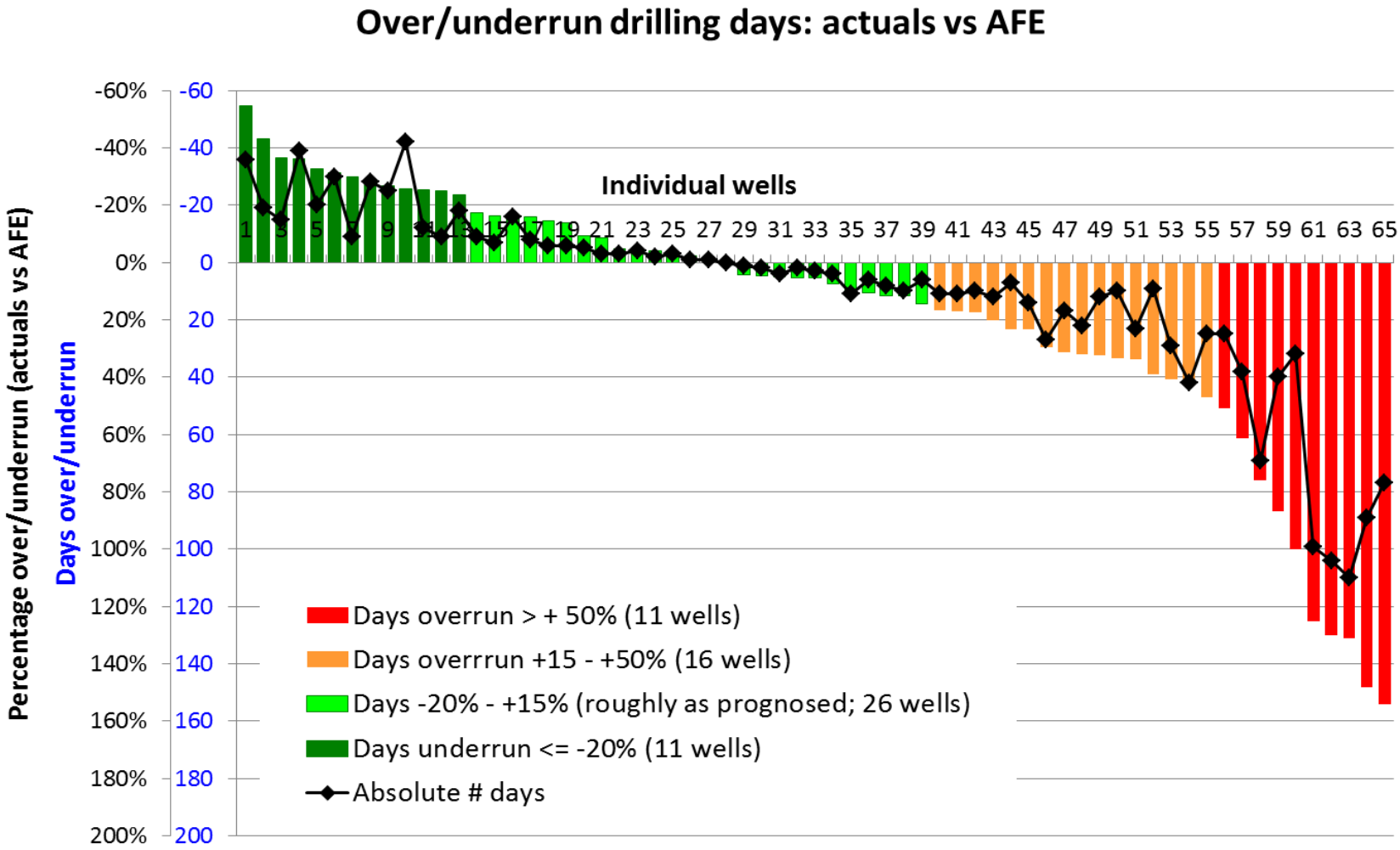
- Introduction: the role of EBN
- Exploration statistics
- **Drilling statistics**
- Depth prediction bias
- Drilling Hazards
- Summary

Extended Reach Drilling
performance statistics



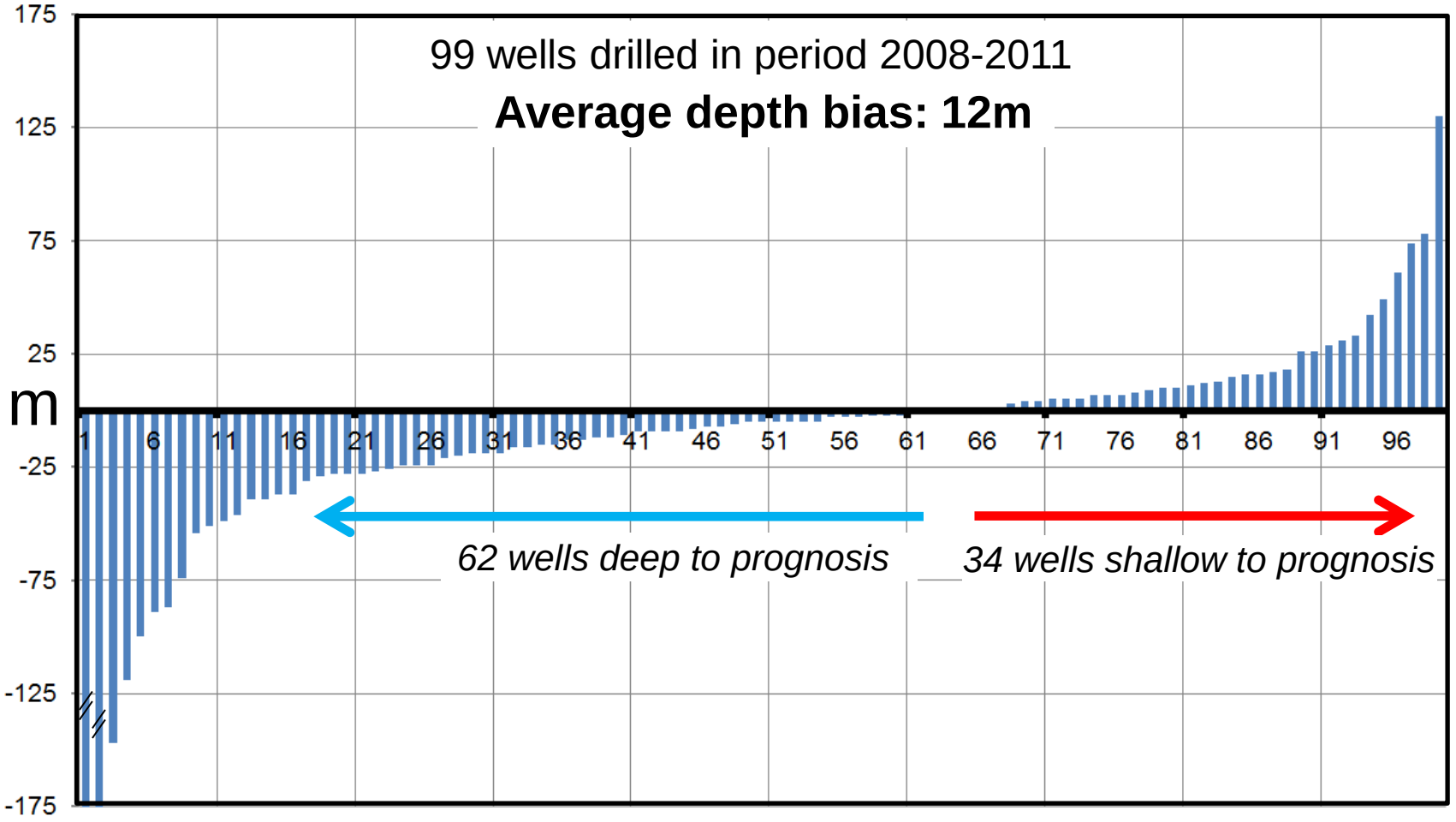
Noseplot: describes operating envelope for Extended Reach Drilling

Wells cost tracking



Exploration wells 2005-2011

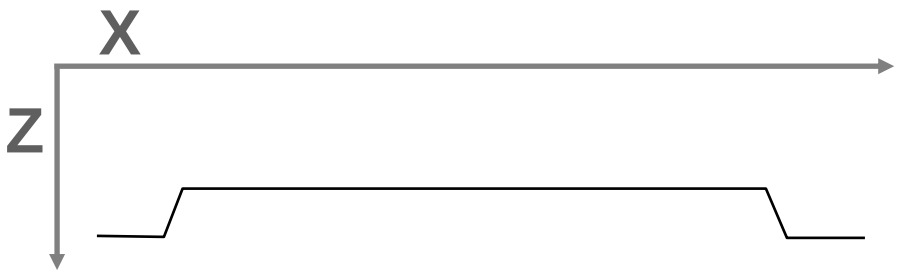
Depth prognosis statistics



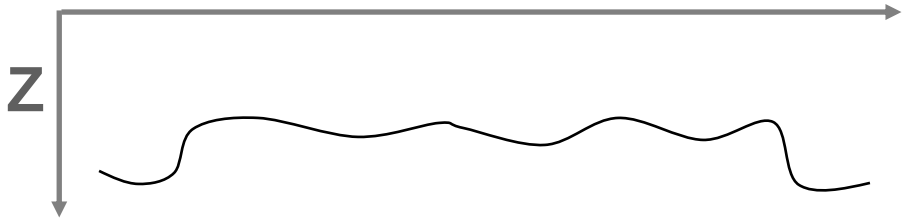
Why bias in Depth prognosis?

Why biased estimates?

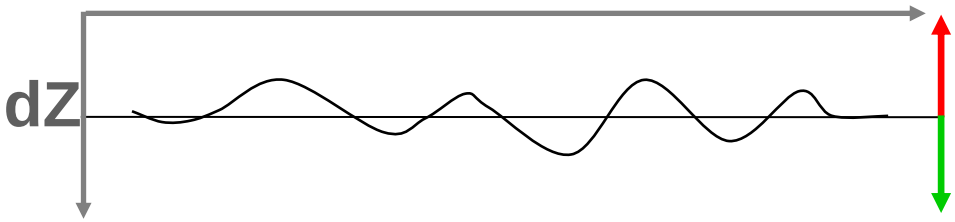
Seismic maps contain noise



real surface



seismically mapped surface



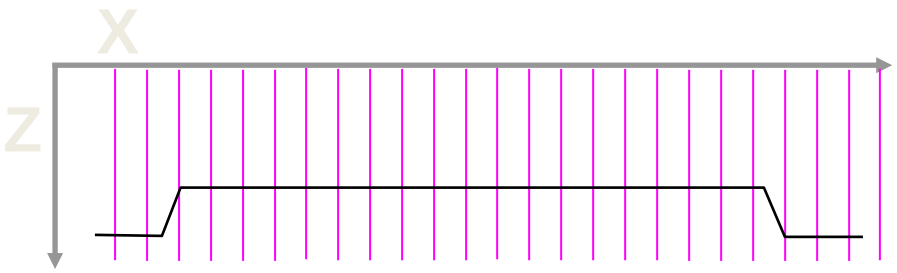
Actual deep
to prognosis

real *minus* mapped surface

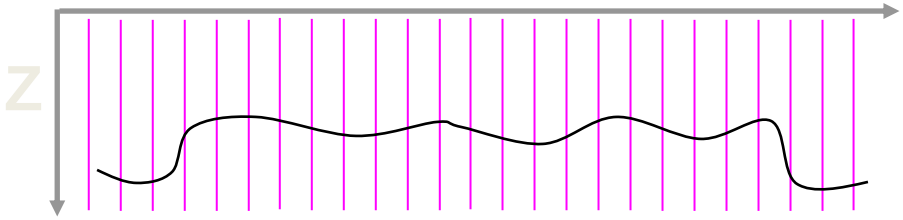
Actual shallow
to prognosis

Why biased estimates?

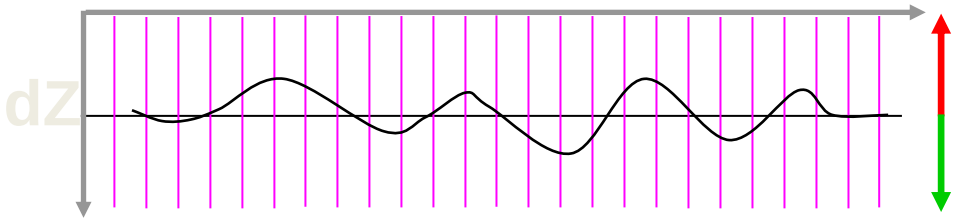
random sampling: no bias



real surface



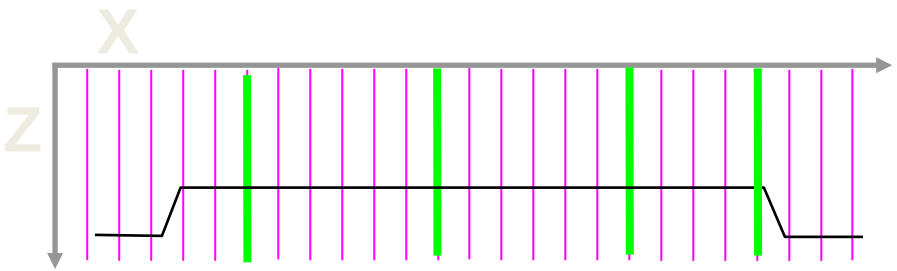
seismically mapped surface



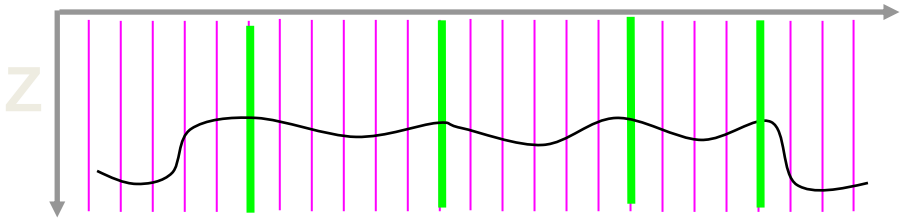
real *minus* mapped surface

Why biased estimates?

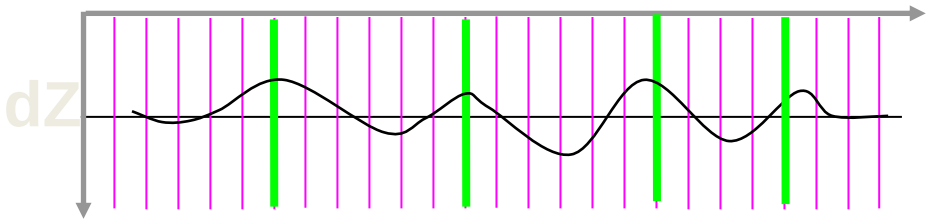
*selective sampling: bias**



real surface



seismically mapped surface



Actual deep to prognosis

real *minus* mapped surface

Actual shallow to prognosis

**** Structural height is an important selection criterion***

Statistics on Wells in the Netherlands
What do we learn?

- Introduction: the role of EBN
- Exploration statistics
- Drilling statistics
- Depth prediction bias
- **Drilling Hazards**
- Summary

Well After Action Reviews

Well	Operator	Well type	Target formation	Summarized well results	1 Tech-nical	2 Reser-voir
		E	Volprie sst.	water bearing; P&A		
		E	ROSLU	ROSLU within range; ROSLL water bearing		
		E	ROSLL	delayed due to coring & high gas levels in Volprie; logged behind casing due to obstructed WL		
		E	Z3 Carb.	Z3 is tight; Z2 has over 500 ppm H2S; Vlieland is tight, but fraccable; SL column is small		
		E	ROSLL	small column; tight reservoir; P&A		
		E	ROSLL	severe mud losses in Volprie; high pressure; tight reservoir; P&A		
		E	Bunter	small column; tight reservoir; P&A		
		E	Tersch.	reservoir within expectation range; reservoir damage after re-completion		
		E	RO	results in low-mid case range		
		E	Bunter	total losses in Chalk; results around mid-case		
		A	Bunter	unforeseen casing mid NS; low perm reservoir		
		A	ROSLU	depleted reservoir: formation pressure = 78 bar; will be produced		
		P	ROSLU	sidetracked 2X: [1] minor ST in NS. [2] cemented tool in reservoir: shallow ST with kick off in NS; section drilled,		
		P	ROSLU	water bearing; suspended for future sidetrack		
		P	ROSLU	results within expectation range		
		P	ROSLU	60 bar depletion; results within range		
		P	ROSLU	economic development; no H2S produced		
		P	ROSLU	sidetracked 3X in NS; unconsolidated formation; operational issues; disturbed drilling area; plugged		n.a.
		P	Carbon.	results within expectation range		

Analysing Wells results for:

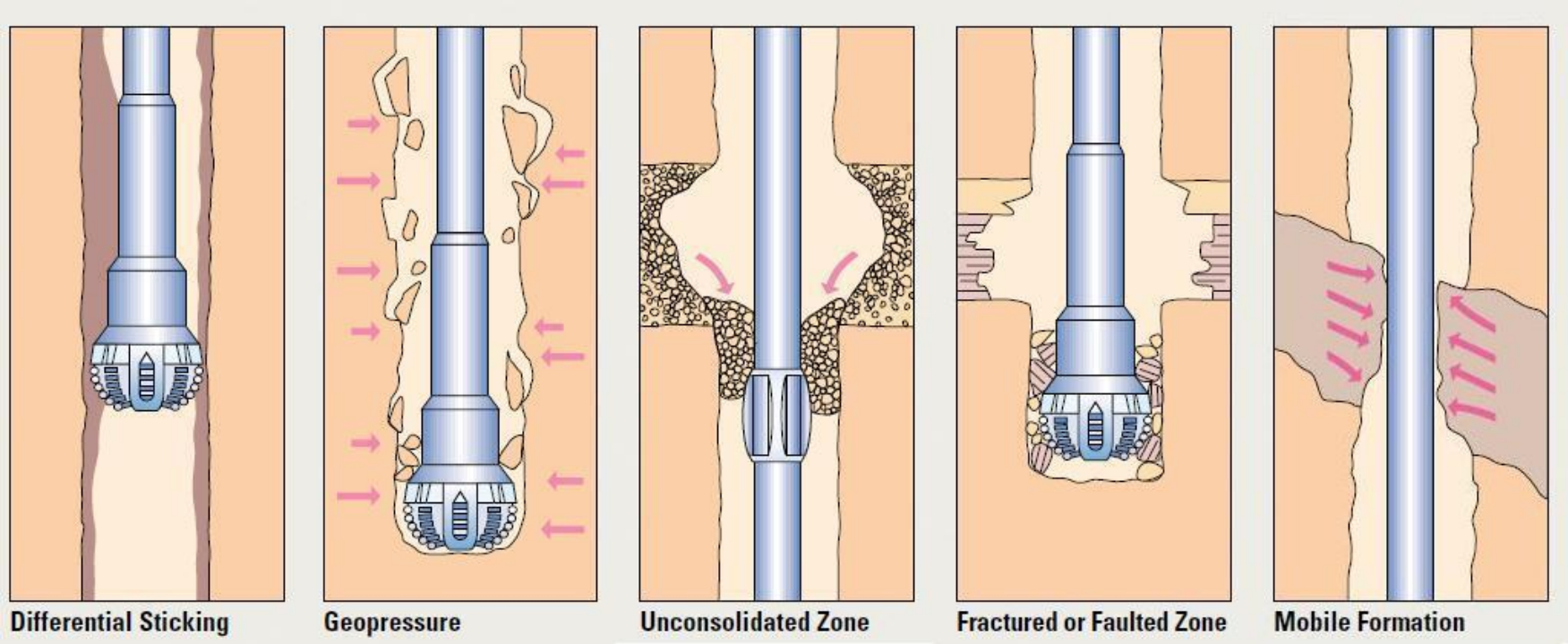
1) Operational Performance

2) Reservoir Performance

Findings shared (anonymised)

Drilling Hazards **responsible for large cost overrun in 20% of wells!**

Well After Action Reviews:
drilling hazards statistics

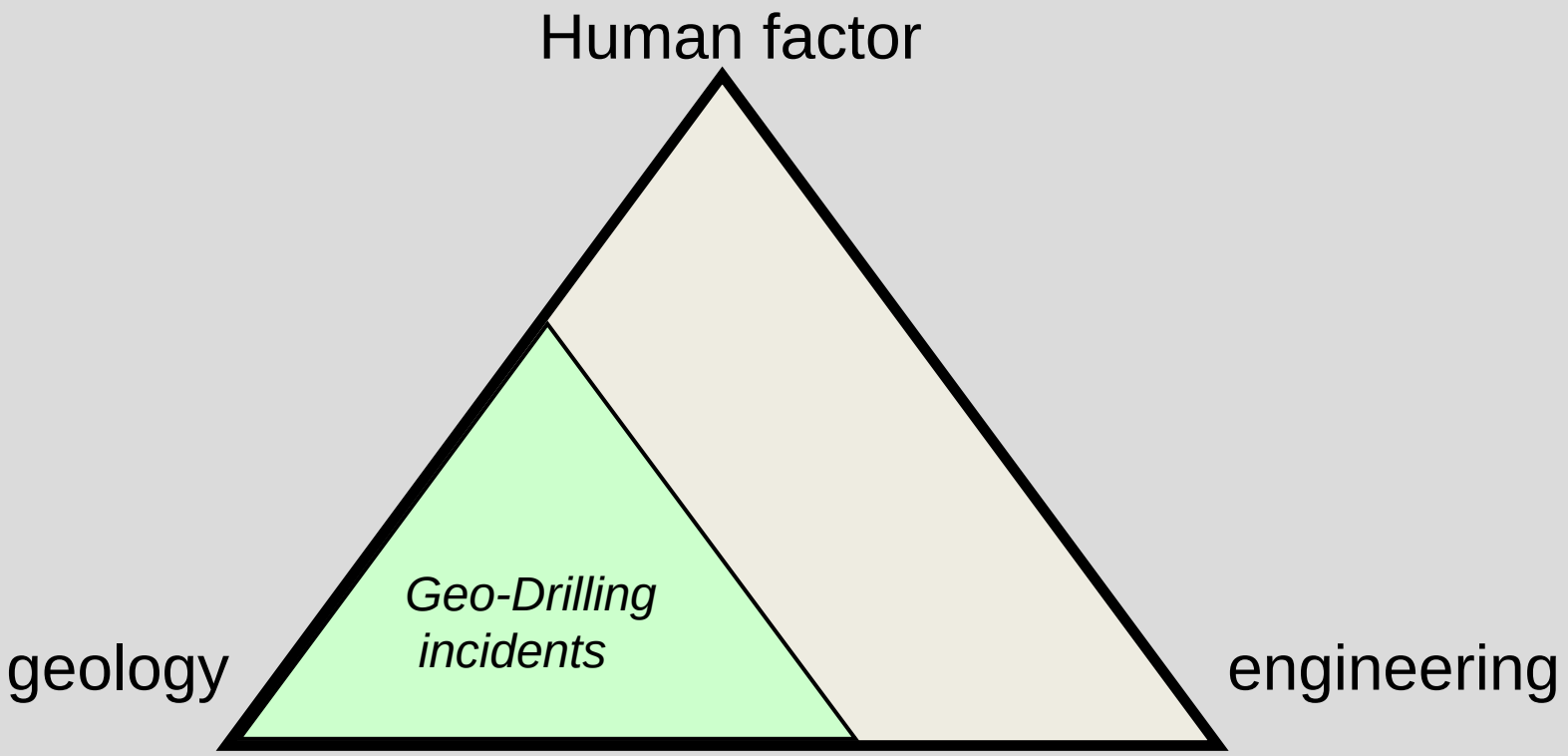


Examples of Geo-Drilling Hazards

→ Drilling Hazard Database being developed (TNO JIP)

Drilling Incident Triangle

Drilling incidents have one -or more- causes



Geo-Drilling incidents:

- *have significant geology component in the cause*
- *require geoscientists for understanding*
- *can often be avoided by doing geological homework*

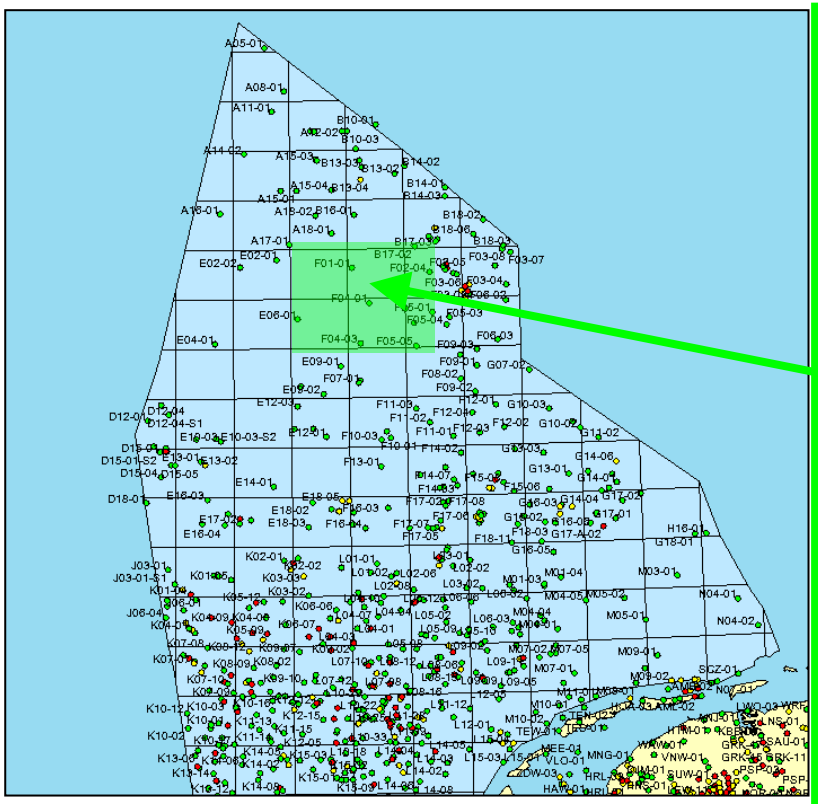
Drilling Hazards Classification scheme

Drilling Incidents coding based on:

observation and interpretation

Type of Drilling Incident: based on observation		Cause of Drilling Incident based on analysis
Type	*Description*	Cause
1 High Torque / Overpull	High friction experience and vertical resistance of the drill string and/or during casing running in the borehole which can lead to stuck drillstring and/or stuck casing	1A Differential Sticking
		1B Mobile Formation
		1C Cavings
		1D Boulders
		1E Junk
		1F Undergauge Hole
		1G Key Seating
		1Z Other
2 Bit Wear	Excessive wear of the drillbit resulting in reduced rate of penetration.	2A Abrasive Formation
		2B Boulders
		2Z Other
3 Kicks	Flow of formation fluid into the borehole due to a higher formation fluid pressure than drill fluid pressure in the borehole. In the worst case a kick can lead to a blow out	3A unexpected geopressures
		3B Drill fluid inadequate
		3Z Other
4 Losses	Flow of drill fluid into the formation	4A unexpected geopressures
		4B Drill fluid inadequate

Quick access to incidents of Geo- Drilling Hazards



GIS interface to database

Recorded incidents
(table format summary for selected AOI and/or stratigraphic interval)

Strat unit	F19-1	F19-2	F19-4	F19-5	F20-2
N S	1C (fault mappable)	No problems reported	unknown	No problems reported	No problems reported
Chalk	No problems reported	No problems reported	unknown	2A chert	2A Massive chert
Triassic	No problems reported	6A Gasshows in RBMVL (not tested)	unknown	No problems reported	No problems reported
Zechstein	3A Squeezing salts caused csg collapse	No problems reported	unknown	3B	3A Floater gas kick remedied with MW 1.9 sg
Rot-liegend	No problems reported	1A Depleted reservoir	8 Sand problems During production	5A Hole at wrong side of fault (migration problem)	1A Differentia-lly stuck (reservoir depleted)

example

ebn

Statistics on Wells in the Netherlands
What do we learn?

Summary

- E&P in NL still very active and *profitable*.
- Key role EBN allows extensive *well learnings*.
- EBN Data compilations useful in *benchmarking*.
- Statistical bias in depth prognosis can be explained by *Selection Bias*.
- Significant Non-Productive Time & costs in drilling due to *Geo Drilling Hazards*.
- Setting up Geo *Drilling Hazards Database* started as Joint Industry Project with TNO.