



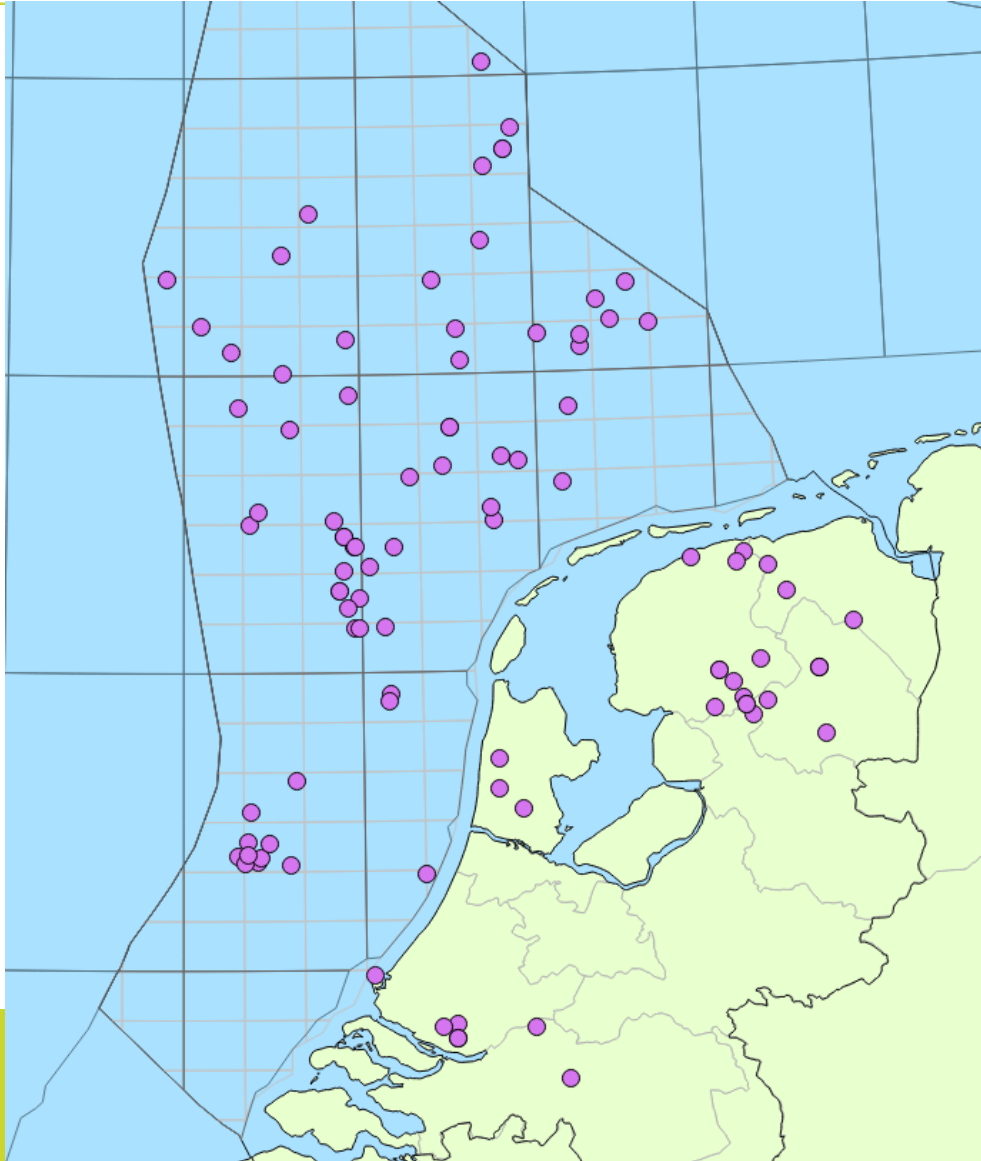
Henk Koster 18.02.2016

***2005 – 2014:
a review of 101
exploration wells***

Outline

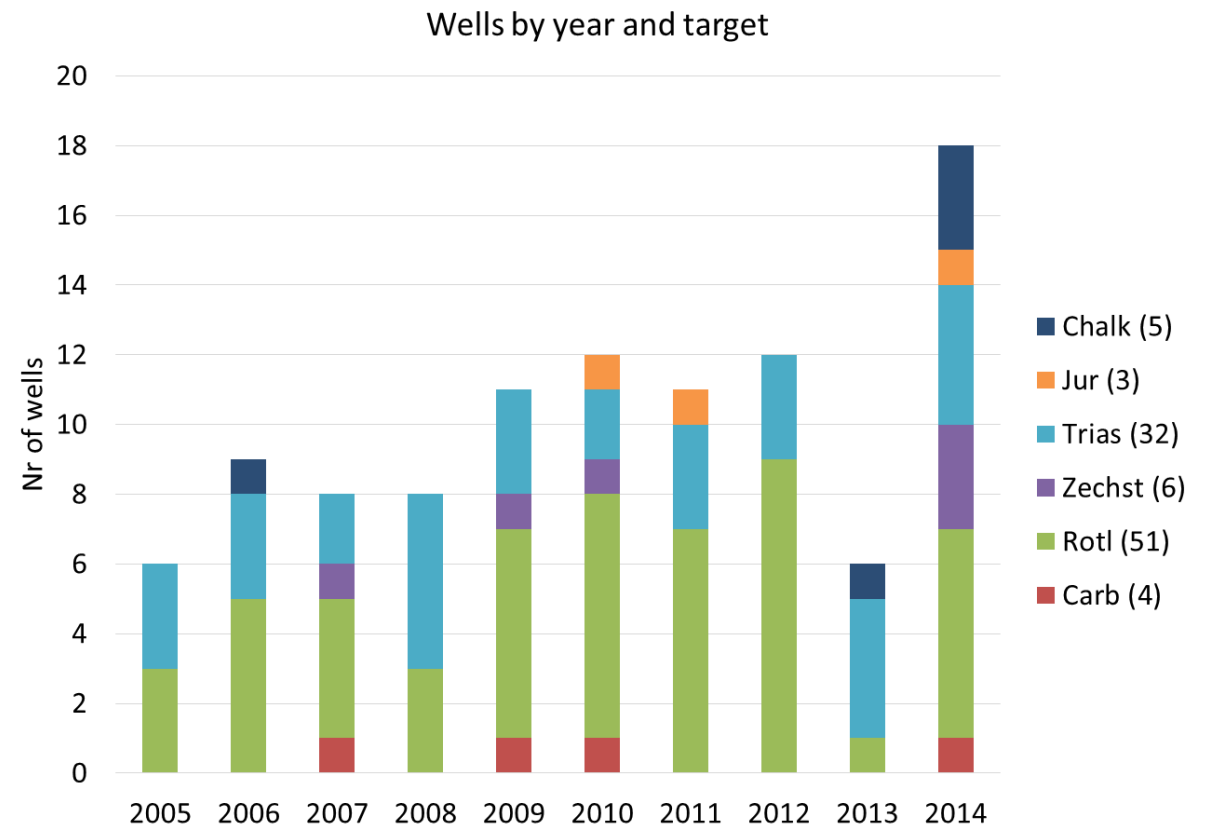
- Results:
 - POS and success ratios
 - Volumes: predrill vs actual
- Depth forecasting at target level
- Success ratios and depth accuracy; creaming curves
- UK results
- Conclusions and recommendations

Exploration wells 2005 - 2014



101 wells with EBN participation (110 wells in total) - onshore 30, offshore 71

Actuals: 20,8 rig years, ~ € 2,4 bln



Results

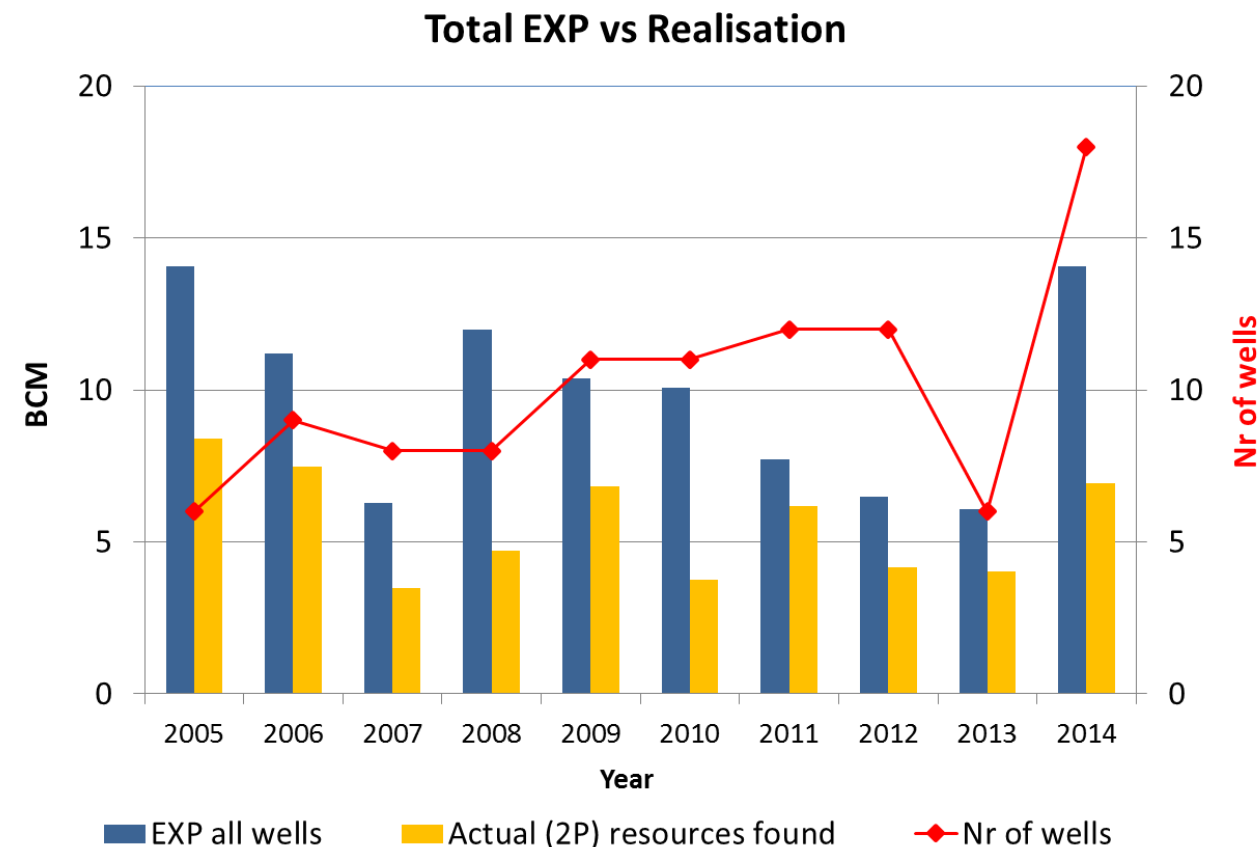
- EXP (Expectation) = Mean Success Volume (MSV) * Probability of Success (POS)
- With sufficient wells we should find $\Sigma(\text{EXP})$

Volumes in BCM			
$\Sigma(\text{EXP})$	98,3	100%	
Post-drill (technical) - 64 wells	55,9	57%	
Post-drill (commercial) - 56 wells	54,1	55%	

- Commercial success: producing, development ongoing or expected

Too optimistic on POS, MSV or both?

NB: oil in BCM Groningen equivalent gas



Success ratio > POS

Average POS (101 wells): 52%

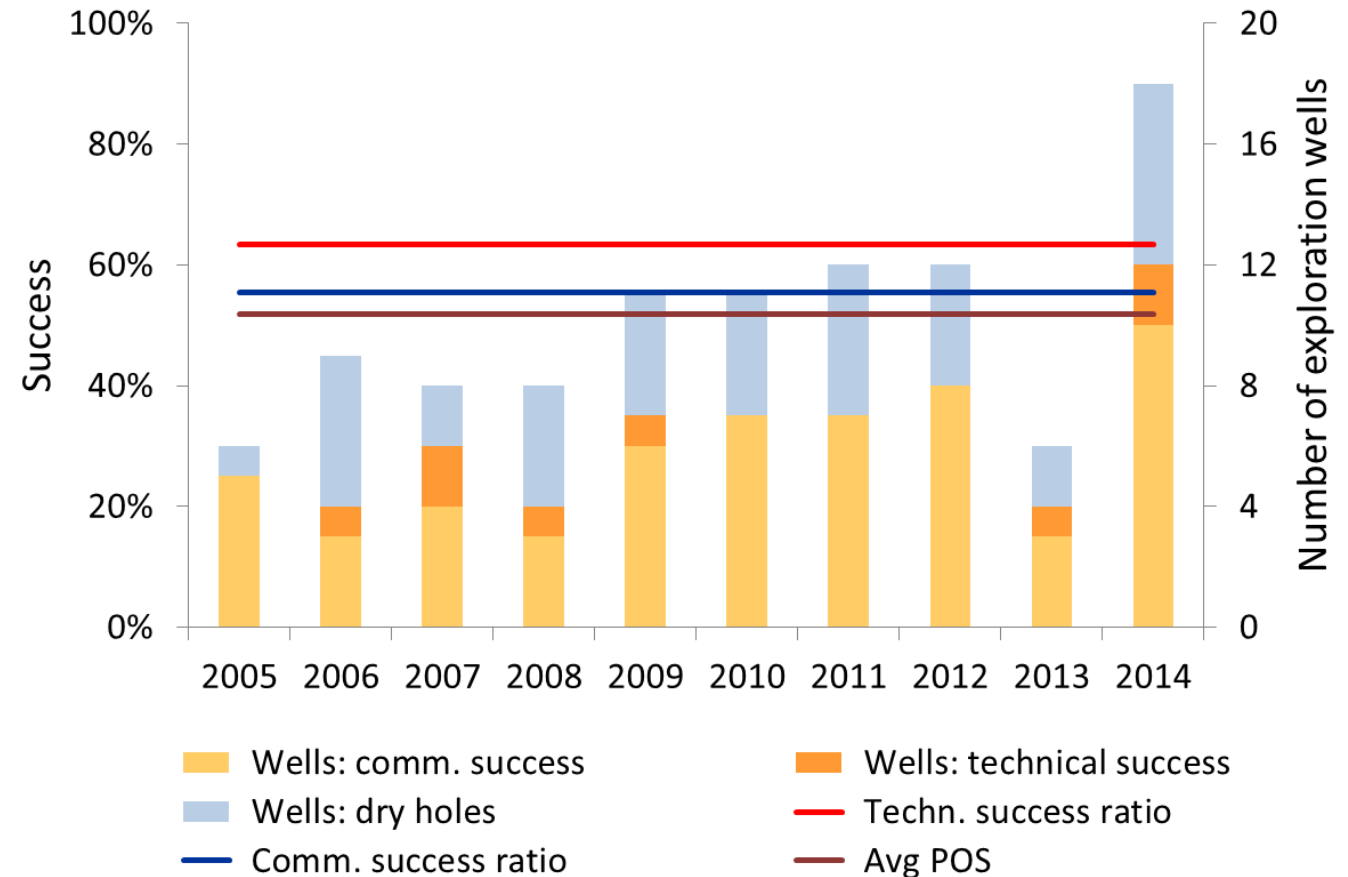
Technical success: 64%

Commercial success: 55%

Success ratio is larger than avg **POS**

In other words: we are more successful than we anticipate! POS equals roughly commercial POS, not technical POS

Average POS and success ratios 101 wells



Success by target

	Wells	Successful	Ratio	EXP	Postdrill EUR	Ratio	Vol./succ. well (BCM)
Rotliegend	51	36	71%	45.1	34.2	76%	0.95
Bunter	32	18	56%	36.8	11.4	31%	0.63
Other	13	7	54%	7	5.4	77%	0.77
Other =DC, JU, ZE excl CHK, offsh. excl CHK							
Onshore	29	22	76%	10.8	11.4	106%	0.52
Offshore	72	42	58%	87.5	44.5	51%	1.06

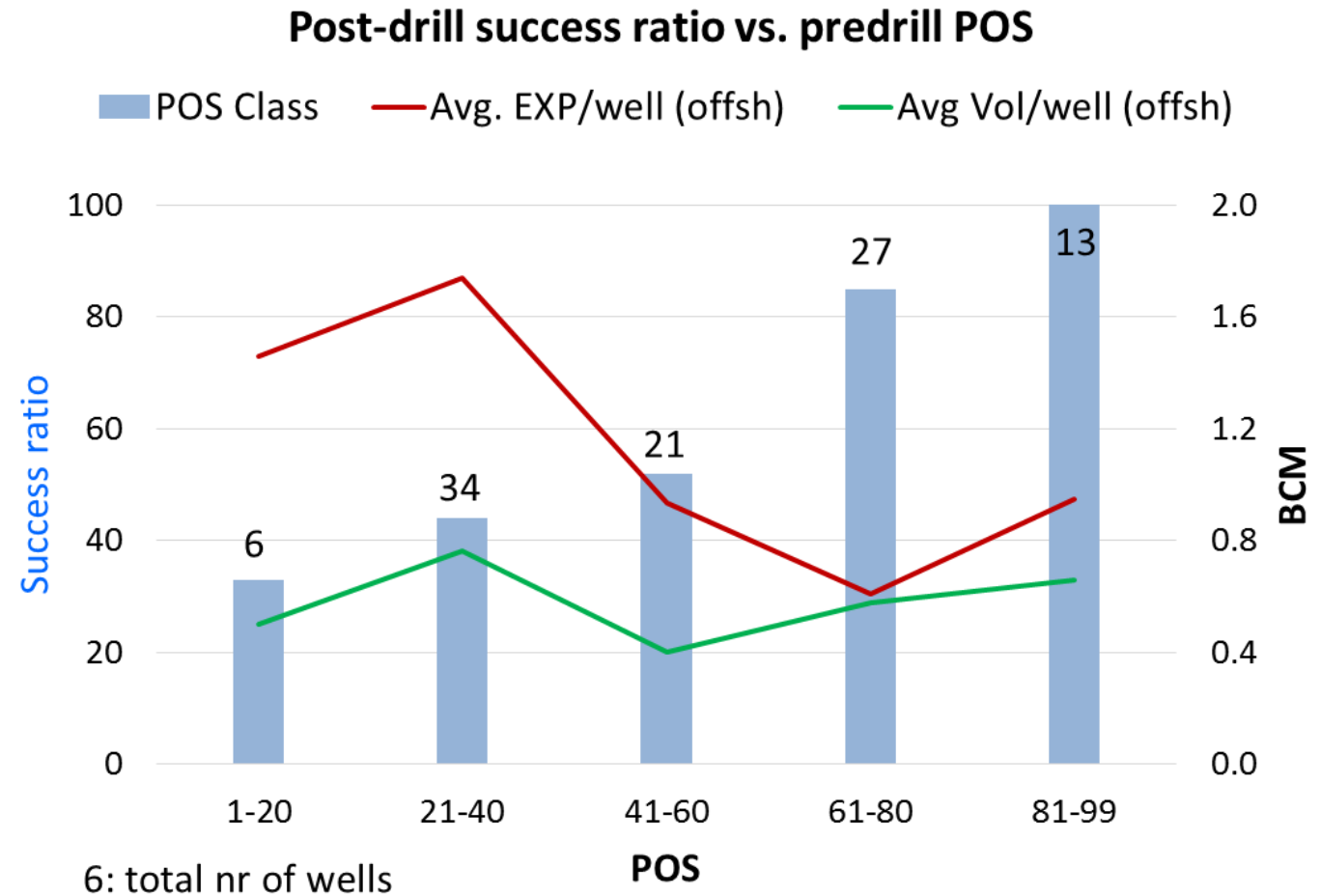
- 53 years after Groningen the Rotliegend still is the most important (and successful) target
- Bunter: half of wells is successful, but with only 1/3 of the forecasted volumes

Success ratio > POS

POS binned in classes of ~20%

- POS too negative, but:
- Higher POS means higher EXP
- Since we find less than $\Sigma(\text{EXP}) \rightarrow$

MSV must be (far) too optimistic

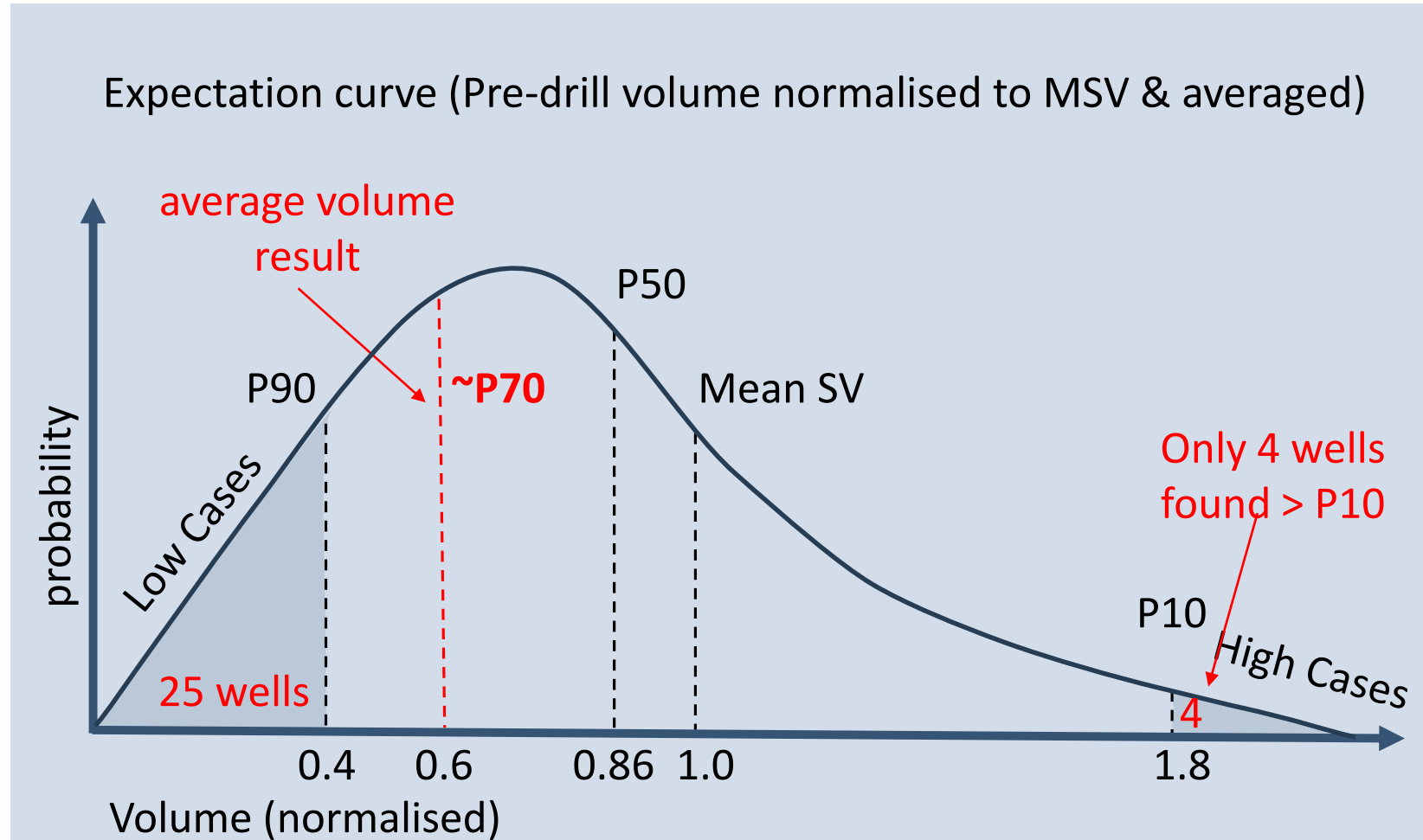


MSV too optimistic

EBN's prospect database averages show:

- LSV (P90) = $0.4 \times \text{MSV}$
- P50 = $0.86 \times \text{MSV}$
- HSV(P10) = $1.8 \times \text{MSV}$

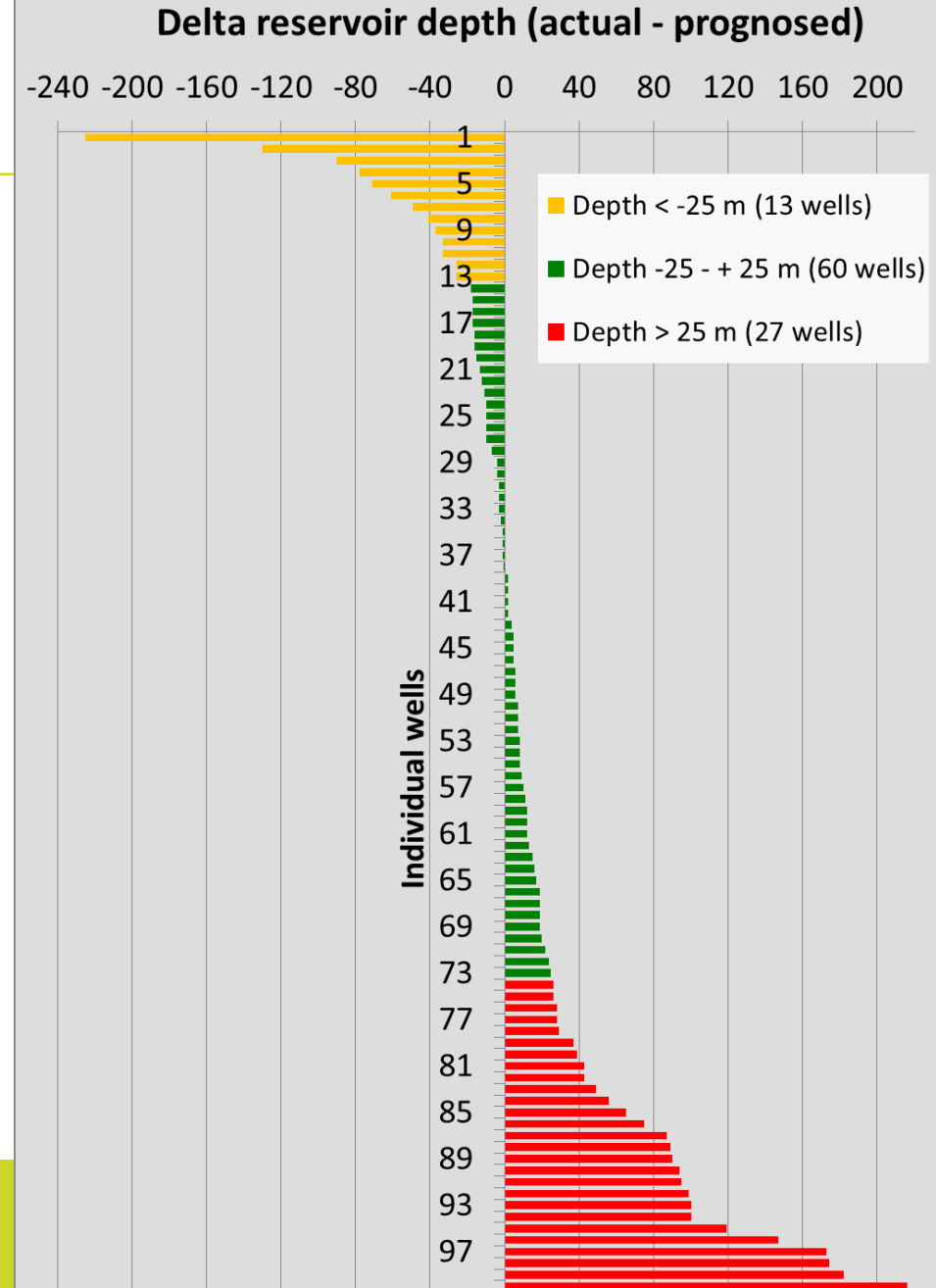
Skew drives Mean to high end.
Does this cause overestimation
of actual success volume?
*I.e. are we overestimating
HSV / P10?*



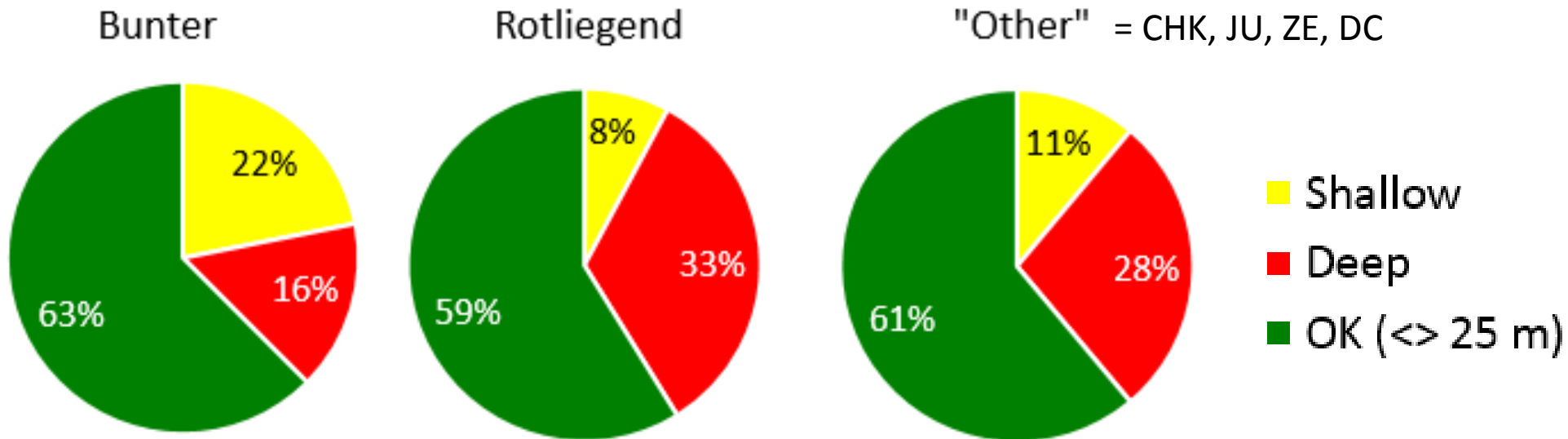
MSV too optimistic

- 13% of well targets come in too shallow (>25 m)
- 27% of well targets come in too deep (>25 m)
- 60% OK
- Coming in too deep can affect reservoir quality, column height, possibly juxtapositions
- Unlikely to explain 40% lower volumes (pre- vs postdrill)
- Is depth error related to the target?

NB: 1 well did not reach its target



Forecasting reservoir depth



Conclusion: *forecasting depth is in 40% of the cases inaccurate*

- 23% of the wells more than +/- 50 m off

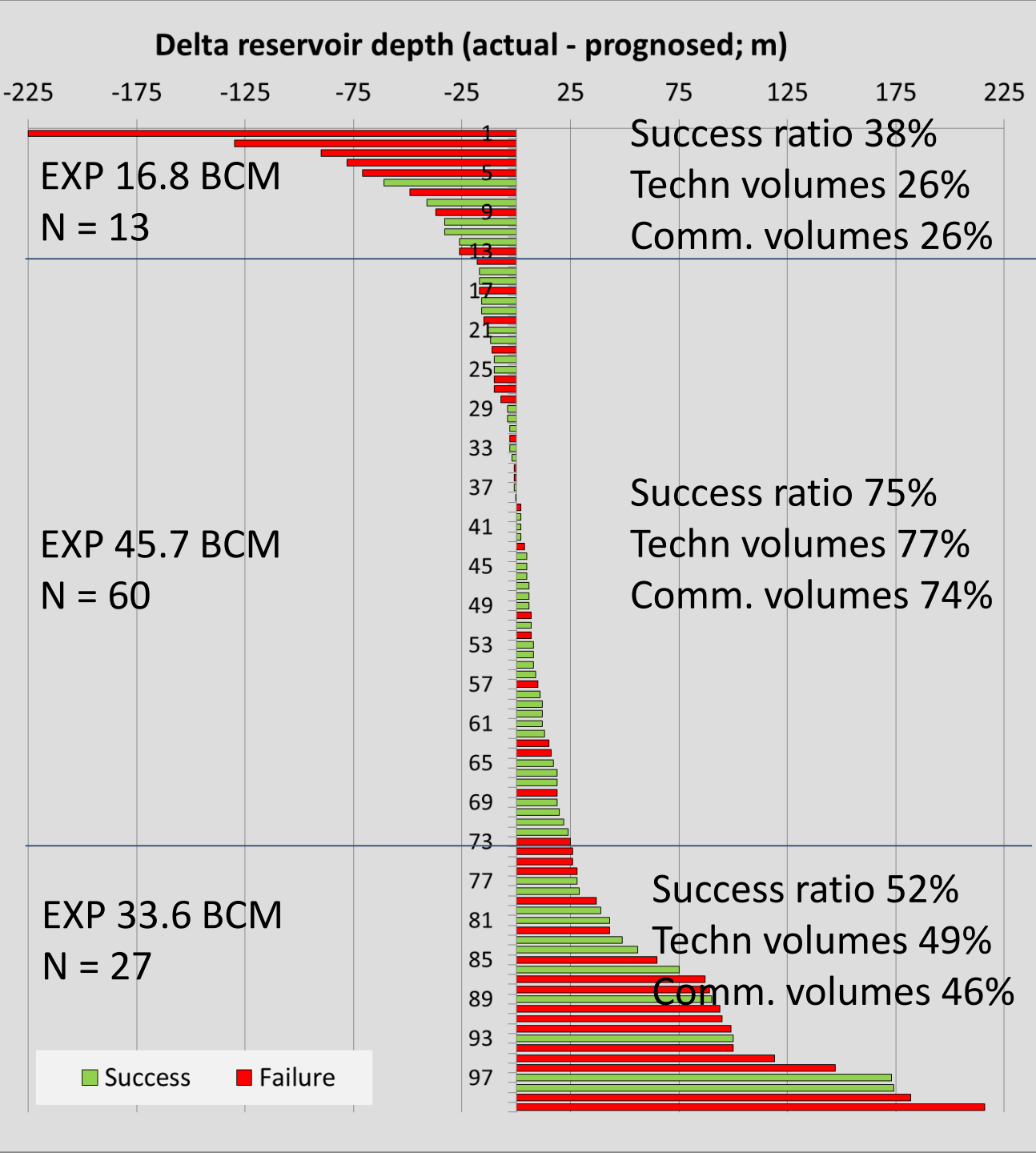
Depth errors vs. success

Conclusion:

Error in depthing has serious consequences for realised volumes and success ratio

(rises to 75% <> 25 m from 63% overall)

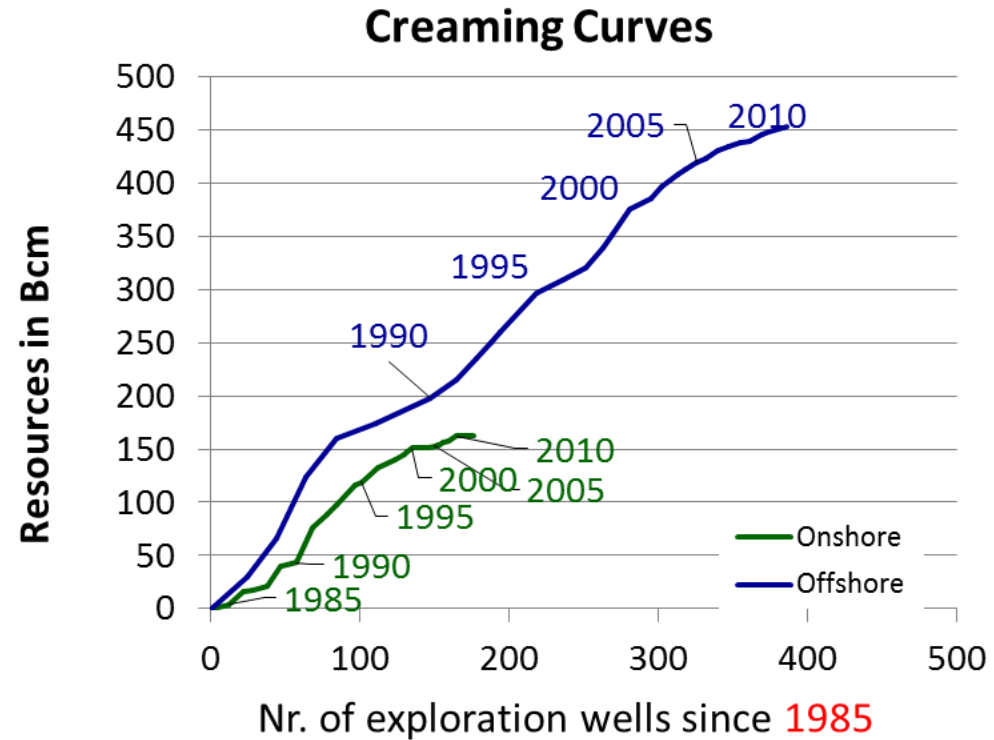
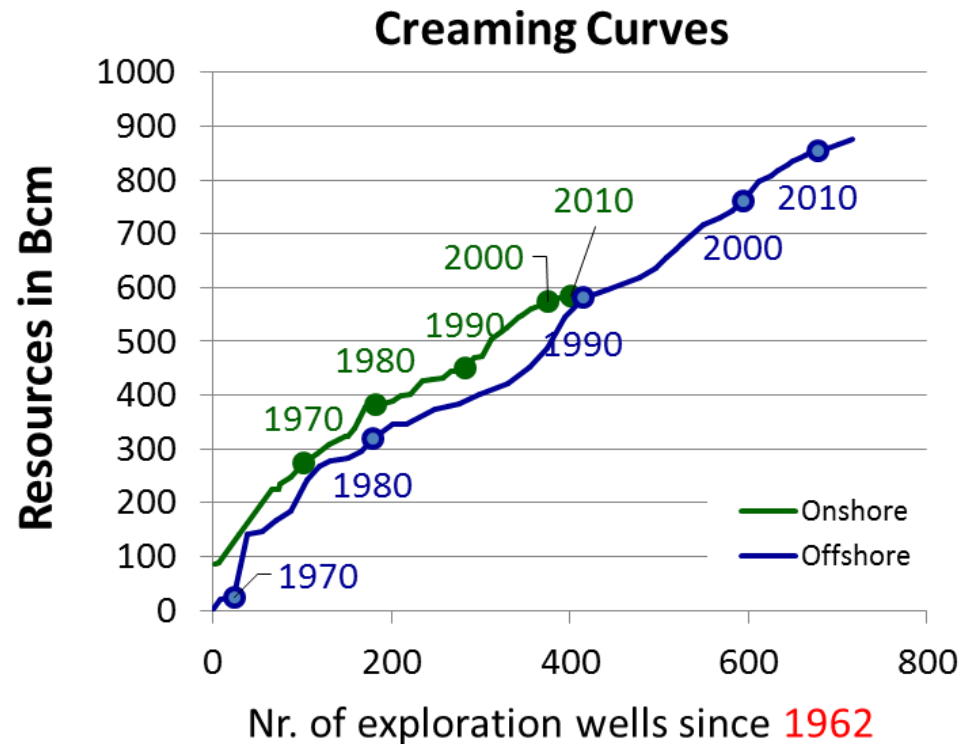
NB: 1 well did not reach its target



Creaming curves (incl. 2014)

Creaming curve: number of wells vs added resources. ~1400 BCM discovered since 1962.

Onshore: creaming off? - but 76% success ratio! Offshore: not (yet)



UK results

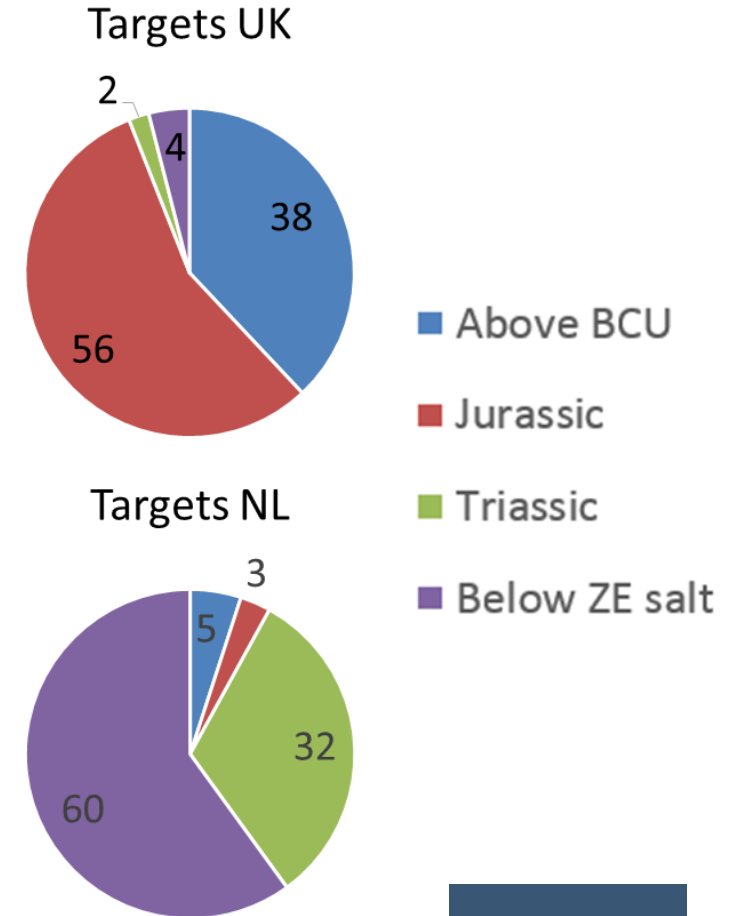
Mathieu: analysis of 98 exploration wells (2003 – 2013; Moray Firth and CNS):

- 55% targeted strat traps, 45% structural traps
- Mathieu: "*volumewise we only find ~P70*"

2nd Pitfalls Conference:

- ~87 exploration wells in UK 2010-2014
- Success ratio > 50%, but only 20% is commercial

Christian Mathieu (OGA)- Exploration Well Failures from the UK North Sea (Petroleum Geology Conference of NW Europe 2015), also in: 2nd Pitfalls Conference (OGA 2015) - [handouts](#)



Conclusions

POS & Volumes

- POS underestimated by 12 percentage points compared to success ratio (52% vs. 64%)
- Commercial success slightly better than average POS (55% vs. 52%)
- Rotliegendes still most successful (71% success ratio and 76% of EXP)
- EXP is overestimated – only ~60% of predrill estimates found → *MSV seriously overestimated*

Depth

- In 40% of wells the predrill depth estimate is over 25 m out, 23% is over 50 m out
- Average success ratio for all wells 64%, for wells <> 25 m depth error this rises to 75%
- Commercial volumes rise from 55% to 75% of the EXP for wells <> 25 m
- *Exploration success correlates with the accuracy of the depth prognosis*

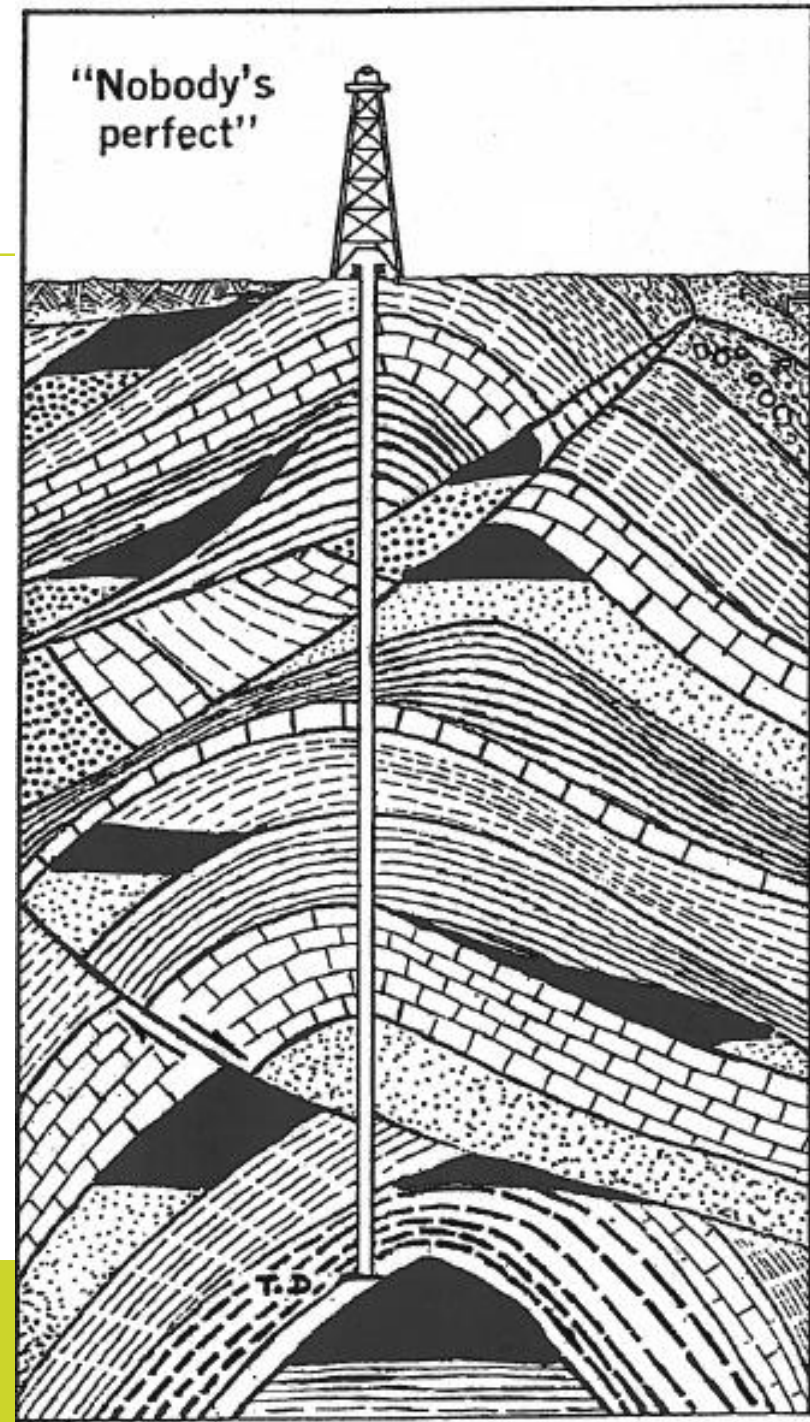
Recommendations

- Proper time/depth conversion is essential
- Don't be too negative on risking
- Pay attention to the (parameters for) High Success Volumes (>P10): are these realistic or do they cause an unfounded drift of the Mean to the high end
- Proper post-well analyses - we must learn from our mistakes (and our successes)
- Co-operation: talk to other operators with similar wells; trade wells and seismic
- Peer reviews
- Remember: people are your best asset - staff turnover can lead to loss of corporate memory and regional knowledge

Nevertheless,
success can be elusive...

Thank you for your attention.
Any questions?

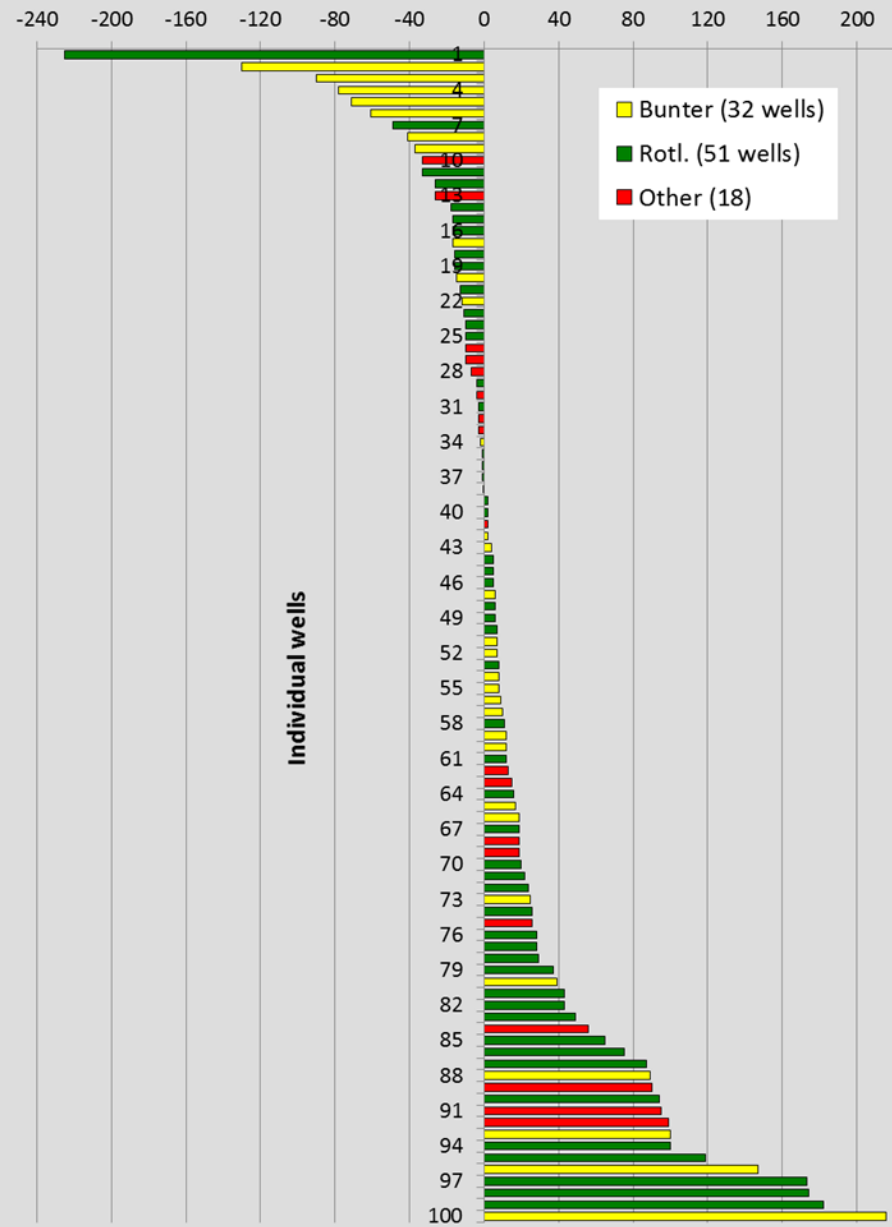
Thanks to Guido Hoetz for constructive reviews



Backup

Delta reservoir depth (actual - prognosed)

Actual - prognosed in m, coloured by reservoir



Bunter and Rotliegend targets only

82 wells in total, 66 % successful

- 4 out of 11 (36 %) shallow successful
- 11 out of 22 (50 %) deep successful

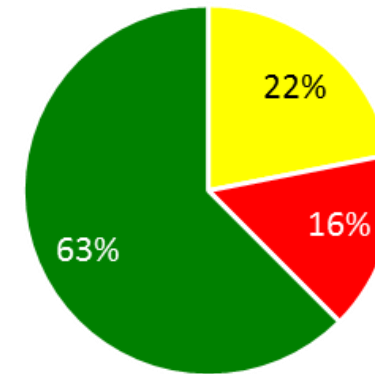
Shallow/deep: well below average success ratio of 63,4%, but *limited population (33)*

- 39 of 49 (80%; within 25 m) successful
- 15 of 33 (45 %; more than 25 m deep or shallow) successful

Conclusion:

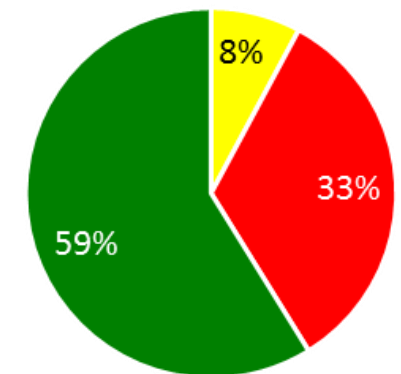
Error in depthing has serious consequences for having success or not

Bunter depth vs prognosis



- Bunter shallow
- Bunter deep
- Bunter OK (+/- 25 m)

Rotl. depth vs prognosis



- Rotl. shallow
- Rotl. deep
- Rotl. OK (+/- 25 m)