



NORWEGIAN PETROLEUM
DIRECTORATE



How to open "window of opportunities" on NCS

By

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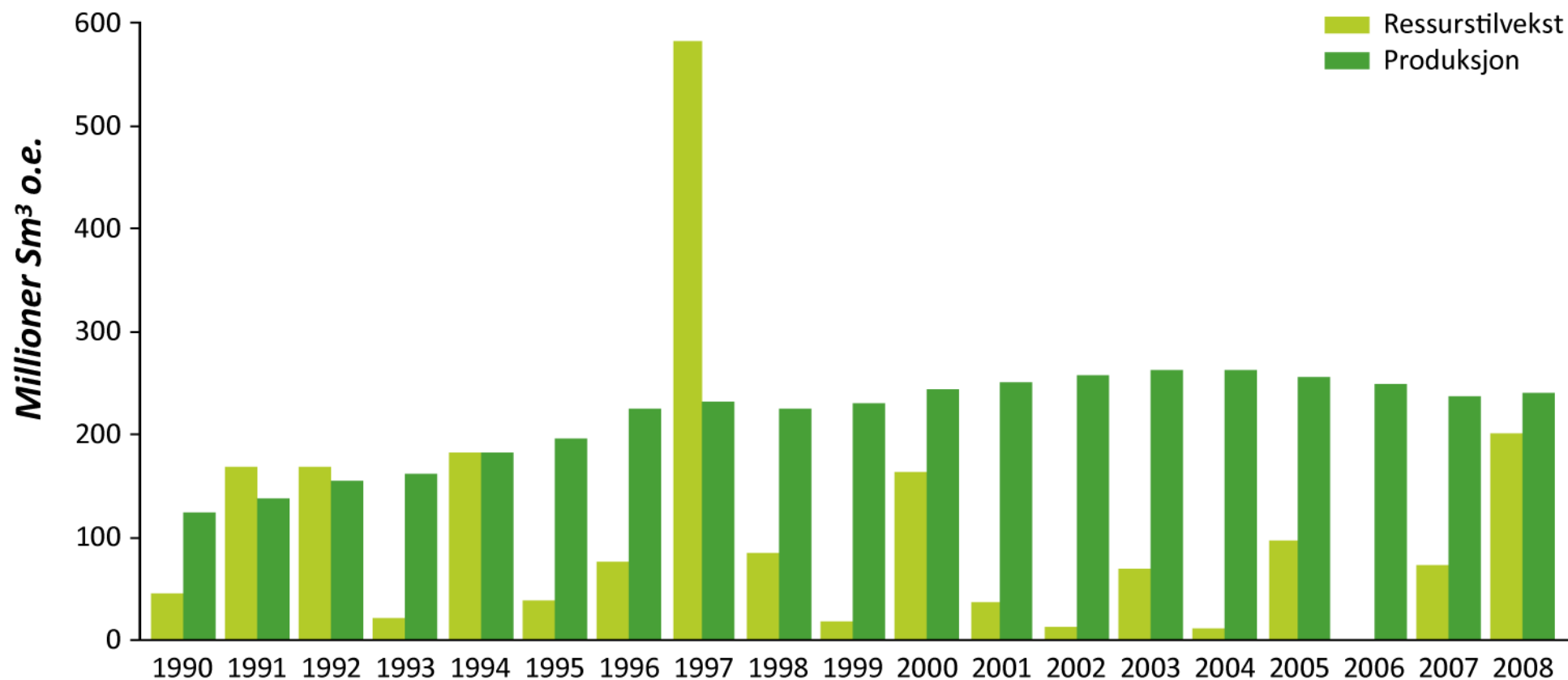
Norwegian Petroleum Directorate

ODs hovedmål for økt utvinning

Anbefalt målsetting:

- ◆ **OD skal bidra til størst mulig verdier for samfunnet gjennom økt utvinning av olje og gass.**
 - ◆ **Reservevekst på 800 mill Sm³ olje fra 2005 til 2015 skal realiseres ved at reserveøkning på felt bidrar med minst 500 mill Sm³.**
 - ◆ **I tillegg skal OD bidra aktivt til at forholdene er lagt til rette for en videre reservevekst og økning i utvinningsgrader for olje og gass etter 2015.**

Årlig ressurstilvekst og produksjon



OD 0812024

2008:
Foreløpige
tall

Current situation; Norwegian continental shelf



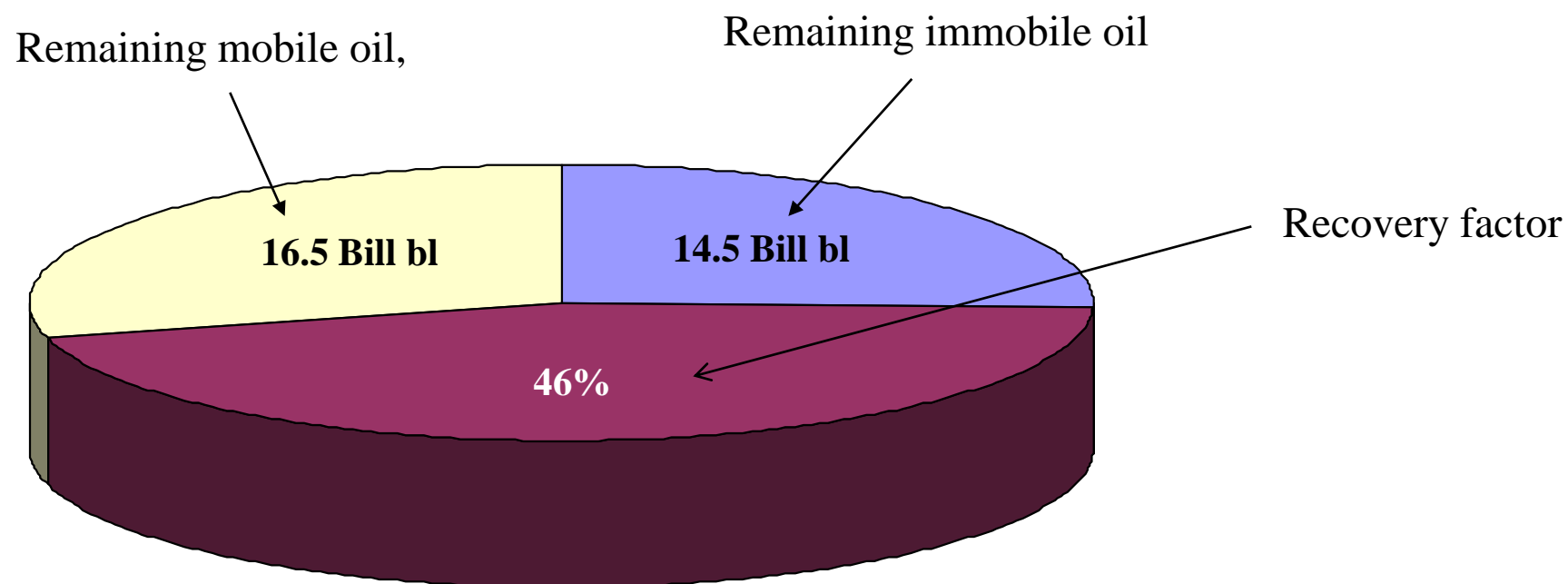
◆ Exploration

- ◆ Near infrastructure, small but often commercial
- ◆ Open areas away from infrastructure, high risk for commerciality
- ◆ None open areas, promising potential
- ◆ Tax incentives to maintain activity
- ◆ Increasing number of small independent companies

◆ Production

- ◆ Major fields in tail production
- ◆ Average current final recovery factor 46%; (20 – 70%)
- ◆ Remaining STOOIP connected to production facilities significant larger than exploration potential
- ◆ Life expectancy dependant on oil price, cost reduction, IOR and EOR success.
- ◆ Large remaining oil volumes situated in reservoirs with excellent properties
- ◆ EOR efforts, extremely time critical

NPDs estimate for remaining mobile and immobile oil, end field life, for 41 oil fields



Fundamental Requirements for EOR/IOR Success



- ◆ Significant reserves increase from fields in production (10 – 20%) can only be achieved technically by:
 - ◆ Increasing volumetric sweep efficiency (Gels/more drainage points) and/or
 - ◆ improve displacing phase microscopic displacement efficiency
- ◆ Licensees which basically fail to change their reservoir development strategy i.e. current well pattern, seawater injection will only, for a fixed STOOIP and with current oil prices, be able to increase their predicted reserves marginally, and in some instance stand the risk of being unable to produce these reserves within the rapidly diminishing lifespan of the field.
- ◆ Fields in tail production needs to assess the technical potential for reserves increase by a reservoir redevelopment strategy which is not hampered by existing infrastructure, current well pattern or injection strategy. This is basically the starting point of a reactivation effort
- ◆ If new technology is considered essential, necessary studies tests and pilots should be planned for and executed.
- ◆ Reactivation is basically an exercise which integrates injection technology well pattern utilization of existing infrastructure with new builds as required.
- ◆ Mature fields in the same area usually will respond to the same “medicine”. Sharing of cost both in piloting and new development as well as sharing of existing infrastructure will significantly reduce the unit cost.

FACTS for NCS

- Significant volumes of oil remains in the ground after predicted abandonment on mature NCS fields
- The oil remains in reservoirs of high quality
- Most of these fields are clustered in distinct areas
- Almost all fields have water injection as the prime recovery mechanism
- For most of the major reservoirs, EOR is extremely time critical
- Geographical proximity and similarity in development strategy, opens up for cooperation

Reserves Replacement options

- ◆ Exploration
- ◆ IOR; Application of qualified Technology for fields in production
- ◆ EOR; Qualification and Implementation of new technology

EOR Value Chain



EOR Technique Options

Water based

- Salinity design
- PASF(Polymer assisted surfactant flooding)
- Polymers
- Permeability modifiers

Gas based

- Hydrocarbons
- CO₂
- Air
- Nitrogen

Gas and Water based (WAG)

- HC
- CO₂

TECHNOLOGY LEVEL: 2

INTEGRATED WATERBASED METHODOLOGY



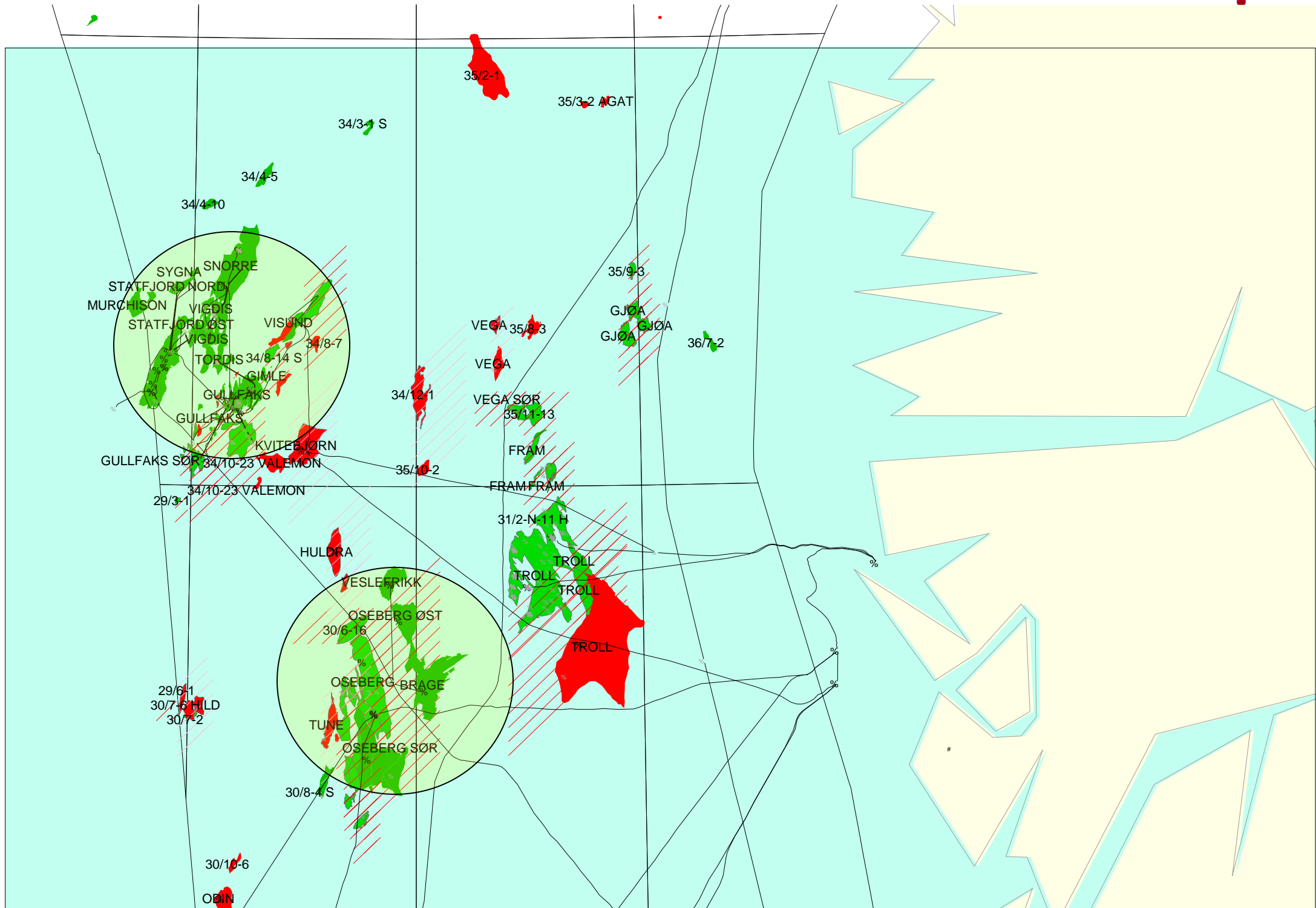
- ◆ Basic reservoir parameters to be improved:
 - ◆ Volumetric sweep efficiency
 - ◆ Microscopic sweep efficiency (Sor)
- ◆ Means to improve:
 - ◆ More drainage points (Wells)
 - ◆ Chemical injection cocktail (Low salinity PASF)
 - ◆ Gel injection for in depth water shut off.
- ◆ ALL THESE METHODES NEEDS TO BE INTEGRATED
IN ORDER TO DISPLAY FULL RESERVOIR POTENTIAL

FIELD LEVEL: 3

INTEGRATION OF ALL RESERVOIRS



- ◆ Reactivation economics will improve significantly due to:
 - ◆ More cost efficient use of existing infrastructure
 - ◆ Reduced unit cost due to higher reserves
 - ◆ Lower energy consumption (Less circulation of water)
 - ◆ Reduced need for water treatment; reinjection of produced water
 - ◆ Improved and accelerated oil production
 - ◆ Lower injection volumes per produced barrel of oil
 - ◆ Delayed decommissioning due to increased life spend



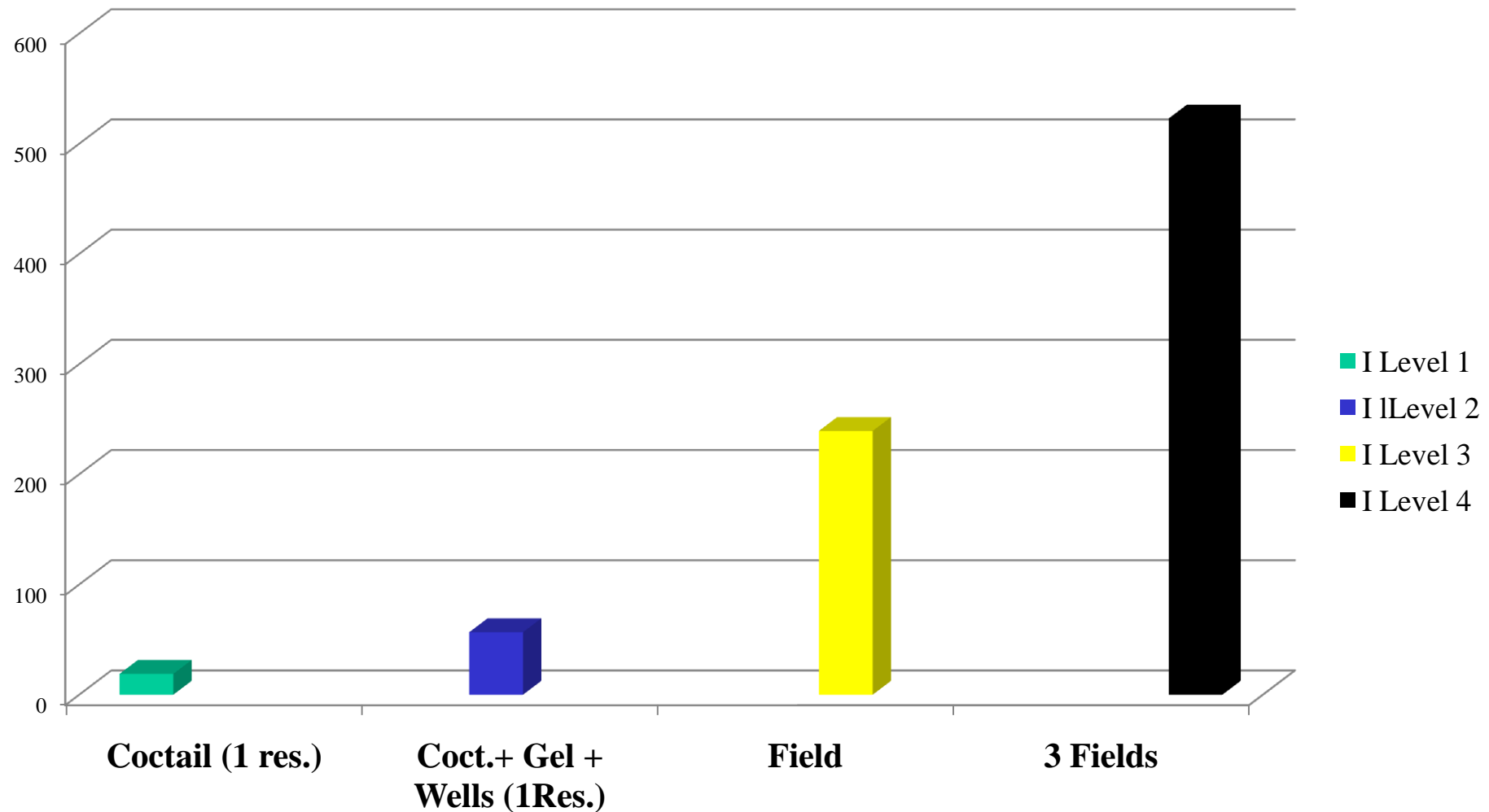
AREA LEVEL: 4

INTEGRATION OF NEIGHBOURING FIELDS

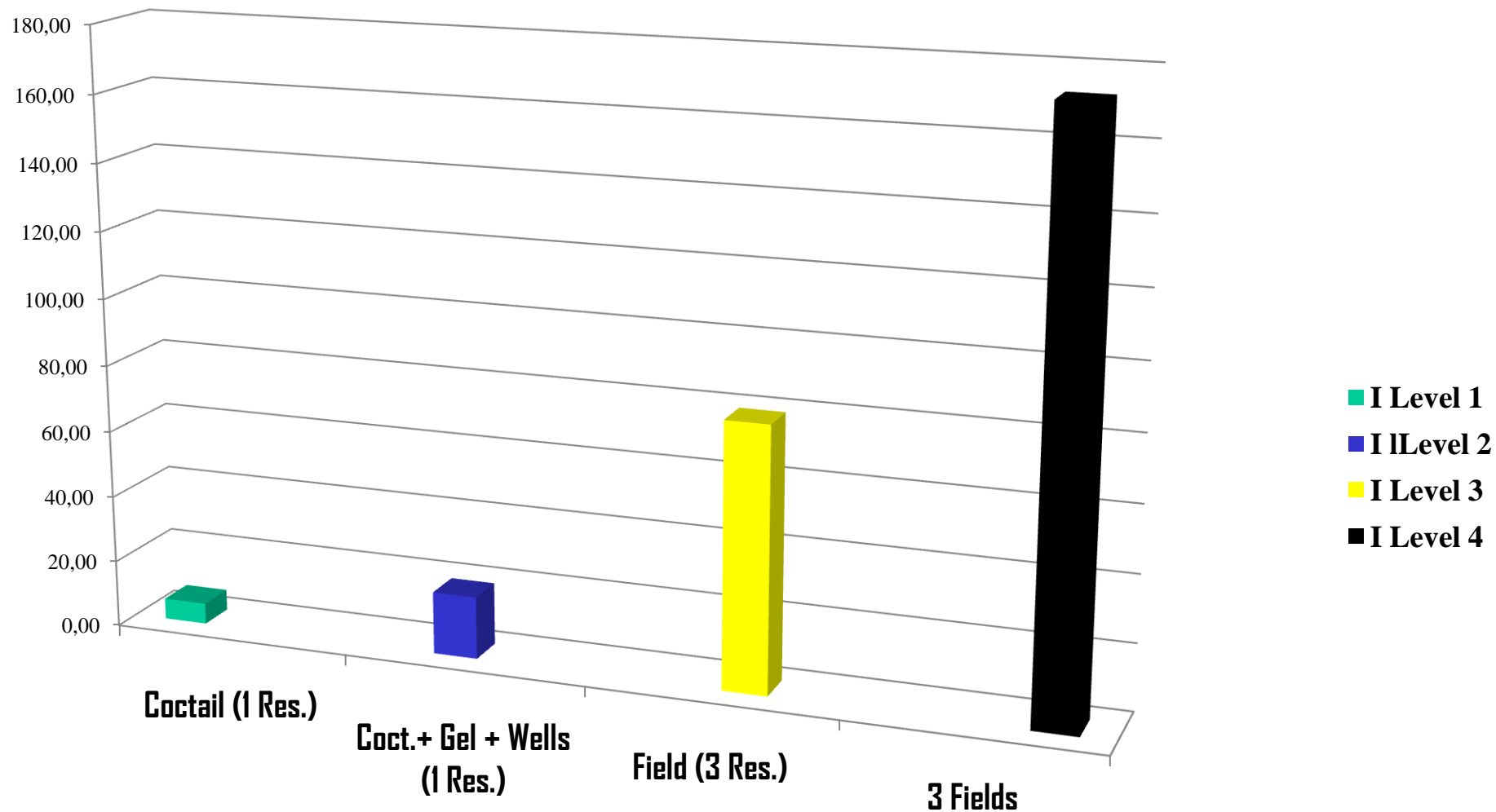


- ◆ Areal field integration improves significantly reactivation economics due to:
 - ◆ Optimized utilization of all parties infrastructure
 - ◆ Lower new development cost/bl due to higher reserves basis
 - ◆ Lower OPEX/bl due to scale of economics and higher reserves.

EOR Reserves (Mill bl) as a Function of Level of Integration



Gross value comparison (BNOK) @ 60USD/BI



Relativ utvikling av reservevekst sammenlignet med utviklingen av CAPEX og enhetskostnader

