



NORWEGIAN PETROLEUM  
DIRECTORATE



# Inter linkages between Short Term and Long Term Technology Needs within Geology and Recovery Processes in the Oil and Gas Sector

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# Contents

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## Concentrating on reservoir related issues

- ◆ Needs in relation to the Norwegian Continental Shelf
- ◆ The IEA Collaborative Project on Enhanced Oil Recovery
- ◆ Examples

# In general for the Oil and Gas sector, where the activity is very *dependent on oil prices*:

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Short term technology needs

Long term technology needs



IOR



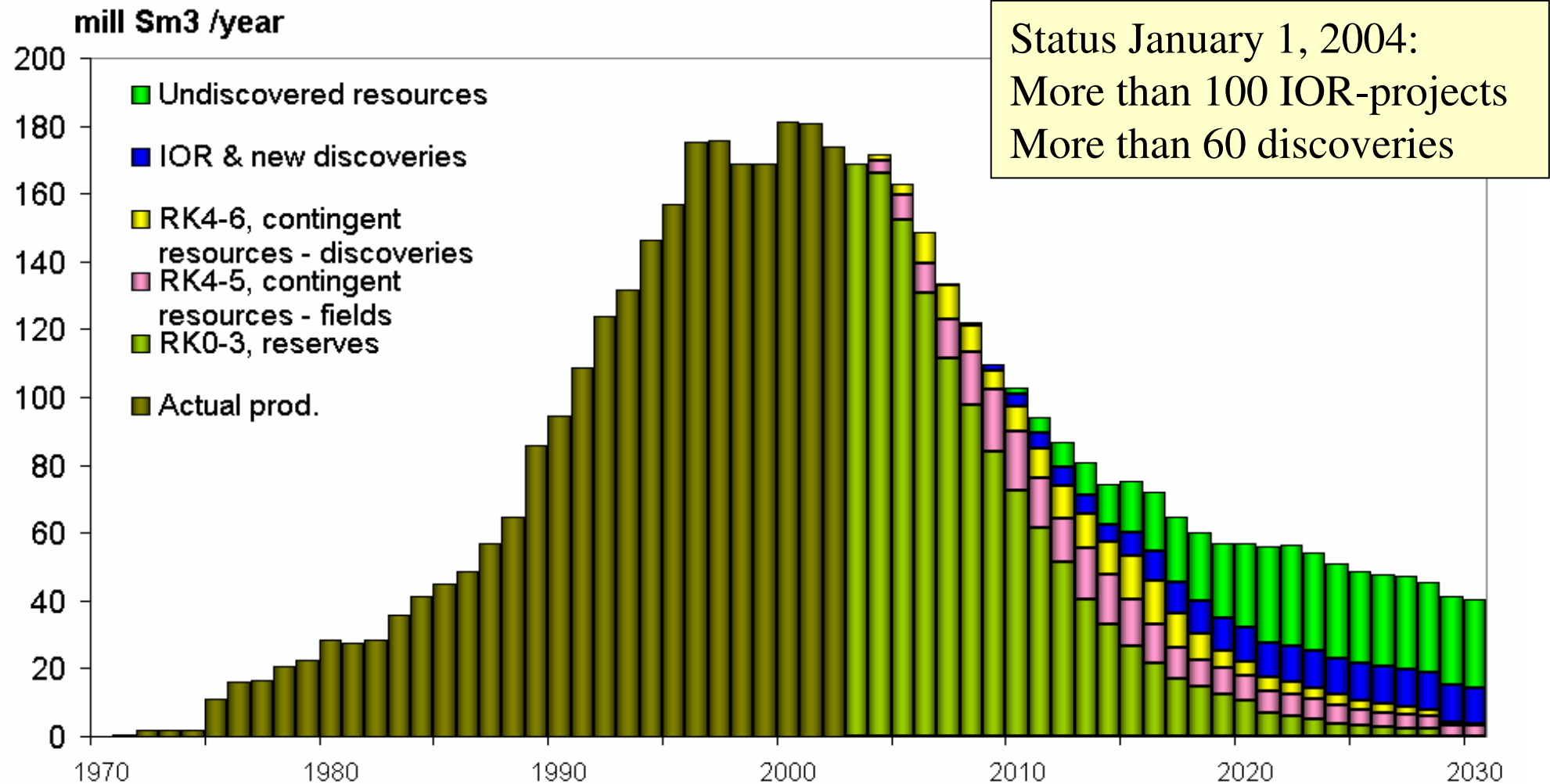
◆ Industry is pushing and gets the results

- ◆ Target Remaining Oil Pockets:  
4D / 4C seismic and geo-modelling  
Drilling and interventions of wells
- ◆ Advanced wells:  
Multi-branches, remote control

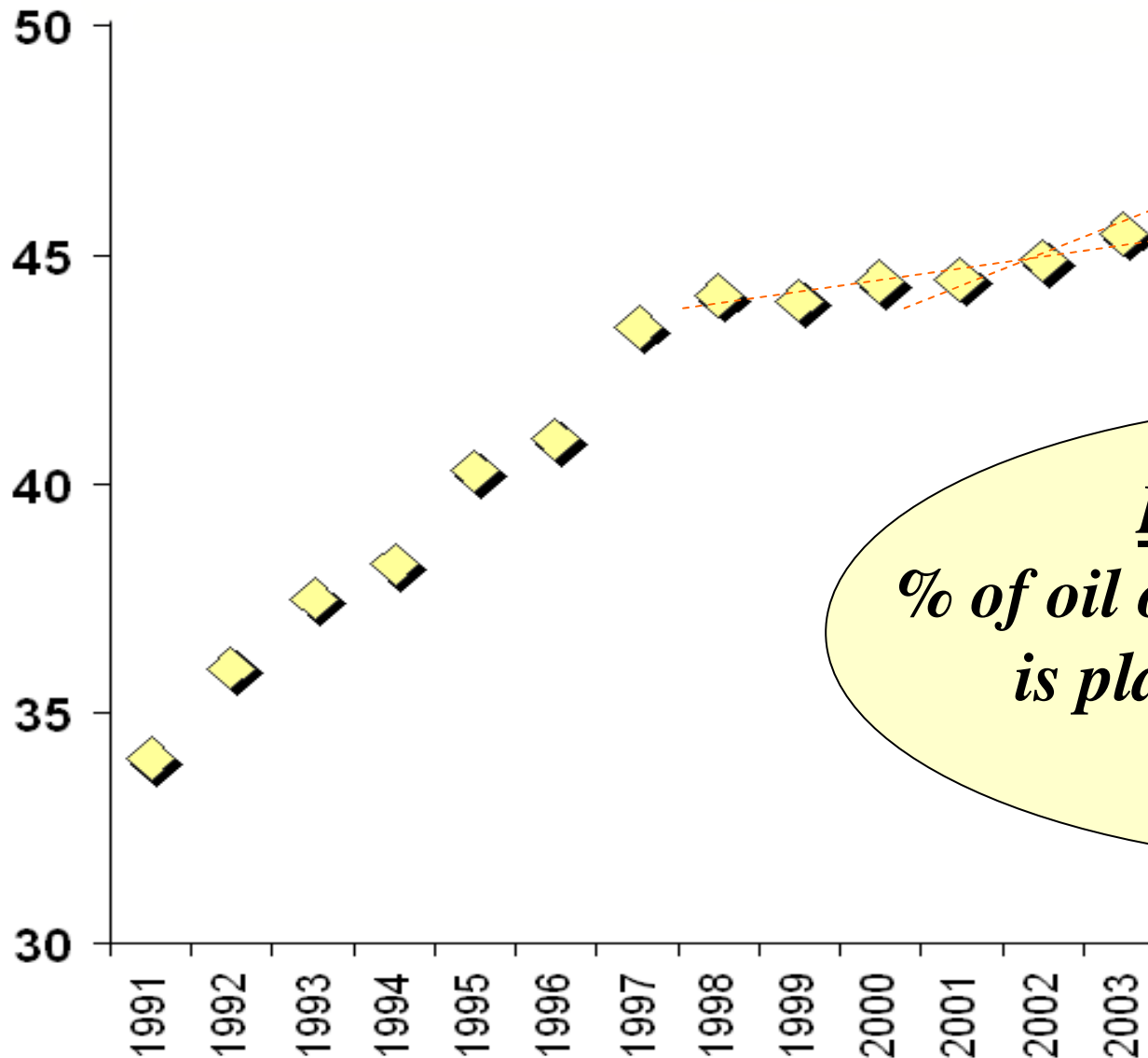
◆ Low involvement by industry and little focus on

- ◆ EOR: measures to increase the recovery factor  
“Stimulated recovery”
- ◆ Educational consequences:  
Need for competence and experts

# Norwegian Oil Production



# Average recovery factor for oil, Norwegian Continental Shelf (NCS)

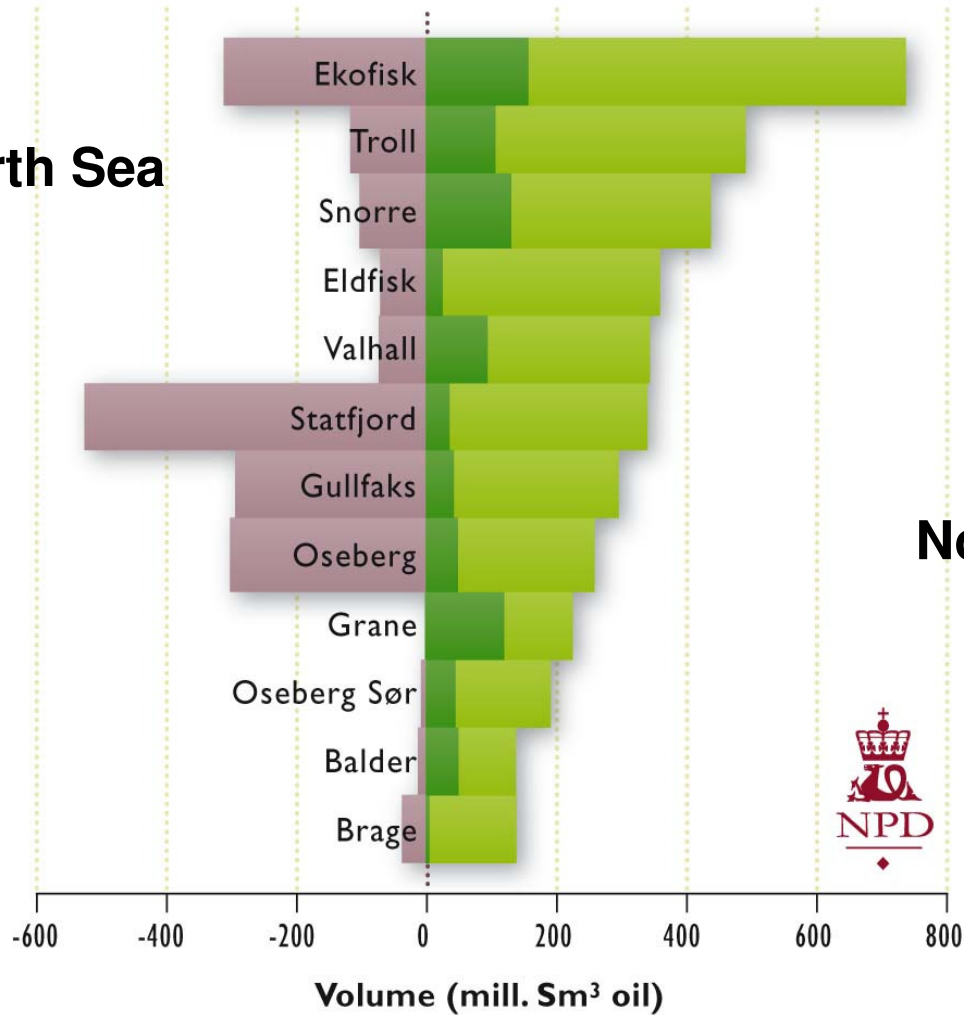


**Recovery factor:**  
*% of oil originally in place which  
is planned to be produced  
(decided on)*

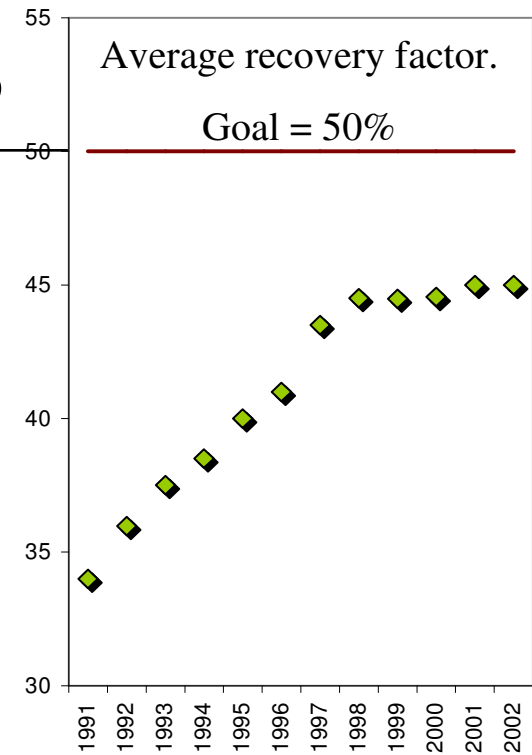
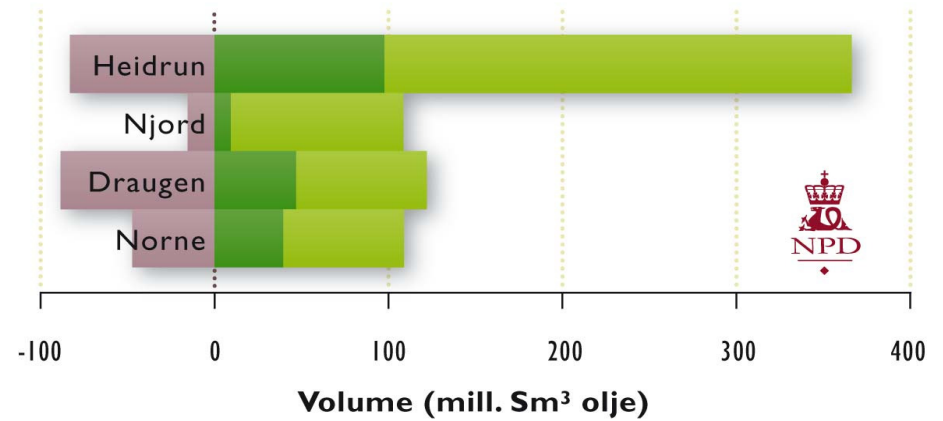
# Large values in mature fields, NCS



## North Sea



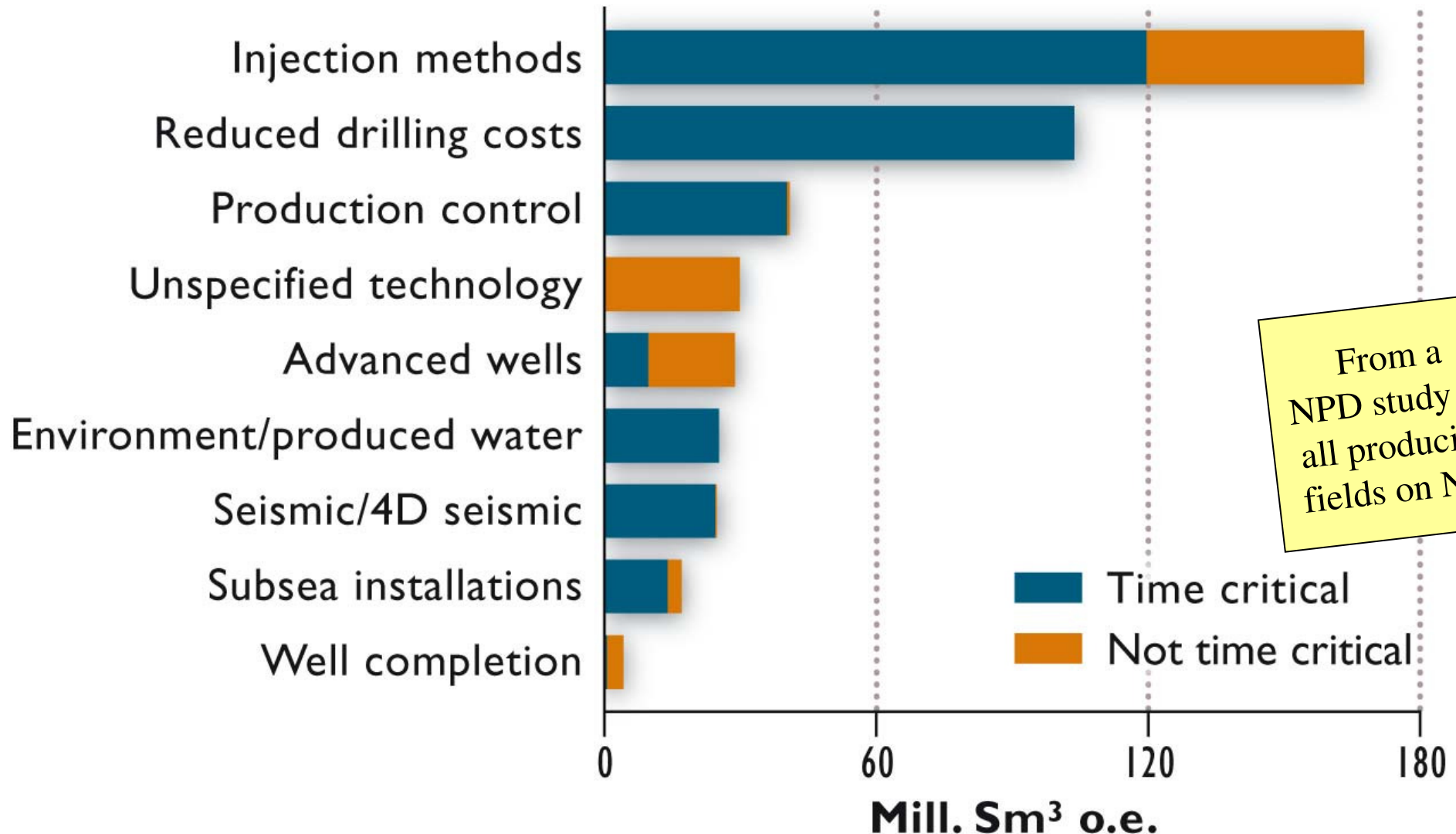
## Norwegian Sea



- Resources remaining in the fields after planned shutdown
- Reserves
- Produced

# Improved Oil Recovery ( IOR )

## – technologies which can make a difference



# EOR – which injection methods ?

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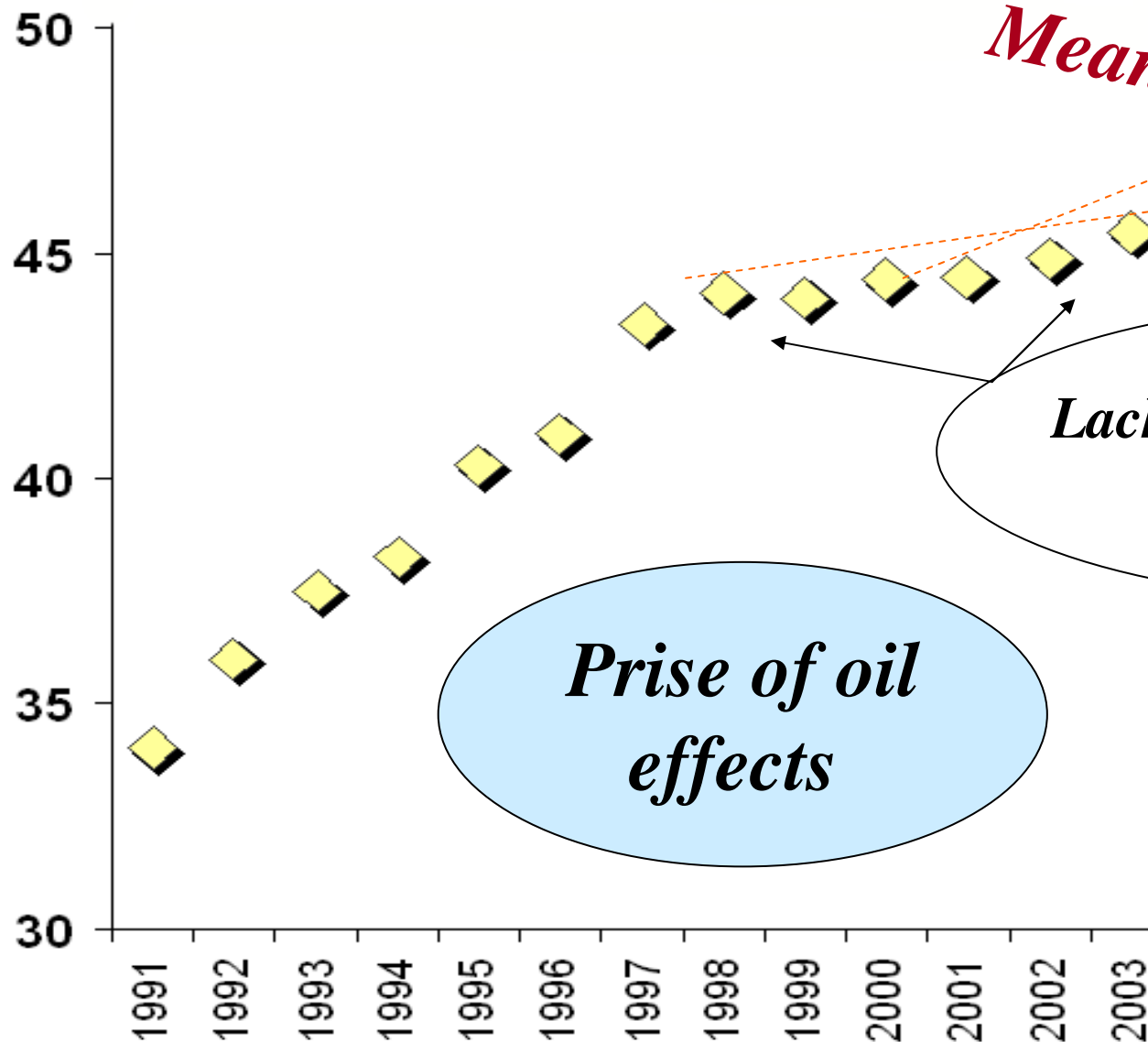
*Obtain more efficient recovery with*

- ◆ *water* (also with additives: surfactants, polymers, *etc* )
- ◆ *gas* (lean HC-gas, rich HC-gas, CO<sub>2</sub>, N<sub>2</sub>, - also with additives)
- ◆ *water + gas* (WAG, SWAG, FAWAG)
- ◆ *obtaining miscible processes is important*
- ◆ *other advanced methods* (bacteria/MEOR, air, *etc*)
- ◆ *''unknown'' methods ?*

*in large or small scale,*

*or combinations, in the same field*

# Average recovery factor for oil (NCS)



*Means to further increase ?*

*Lack of cost-efficient methods  
- R&D low on EOR*

*Prise of oil  
effects*

*More challenging  
reservoir  
conditions !!*



Ongoing for 25 years  
- plan for 5 more

12 member countries  
in 2004

***EOR***  
(Enhanced Oil Recovery)



## *IEA Implementing Agreement on EOR*

# **A Programme of Research, Development and Demonstration on Enhanced Recovery of Oil**



### Objectives:

Evaluate and disseminate the results of R & D

and to undertake demonstration, laboratory and field tests

### *Contribute to technology development within oil industry*

- Increase the recovery of oil originally in place
- Improve economics of EOR

# *IEA Implementing Agreement on EOR*

## **Members 2004:**



**Delegates to ExCom represent the following categories:**

### *Industry / (national) oil companies:*

**Austria, China, Venezuela**

### *Research Institutes / Universities:*

**Denmark, France, Russia, Canada**

### *Governmental departments and agencies:*

**Australia, Japan, Norway, UK, US**

## *IEA Implementing Agreement on EOR*

**No transfer of funds. Task sharing collaboration**



Members take turns hosting the **annual meeting**:

- ***Workshop*** where members present and discuss accomplished own research. Transfer of results
- ***Symposium*** on the topic of the host nation's choice at the end of the workshop. Industry included and invited to give presentations. Aims at a good 2-way communication between researchers and industry people
- ***ExCom*** meets to evaluate current and plan for future activities.

*IEA Implementing Agreement on EOR*  
**Tasks to be reported at Workshops:**



- A. Studies of Fluids and Interfaces in Porous Media
- B. Fundamental Research on Surfactants and Polymers
- C. Development of Techniques for Gas Flooding
- D. Thermal Recovery
- E. Dynamic Reservoir Characterization
- F. Emerging Technologies

## *IEA Implementing Agreement on EOR*

### **Nature of work reported:**



- Papers / information exchange from activities in member countries  
(from national R&D programmes, company sponsored R&D etc).
- *Mostly fundamental research to understand and model dynamic processes in oil reservoirs. Some applied work, including field pilots on EOR.*
- *CO<sub>2</sub> EOR with storage is addressed through Task C*

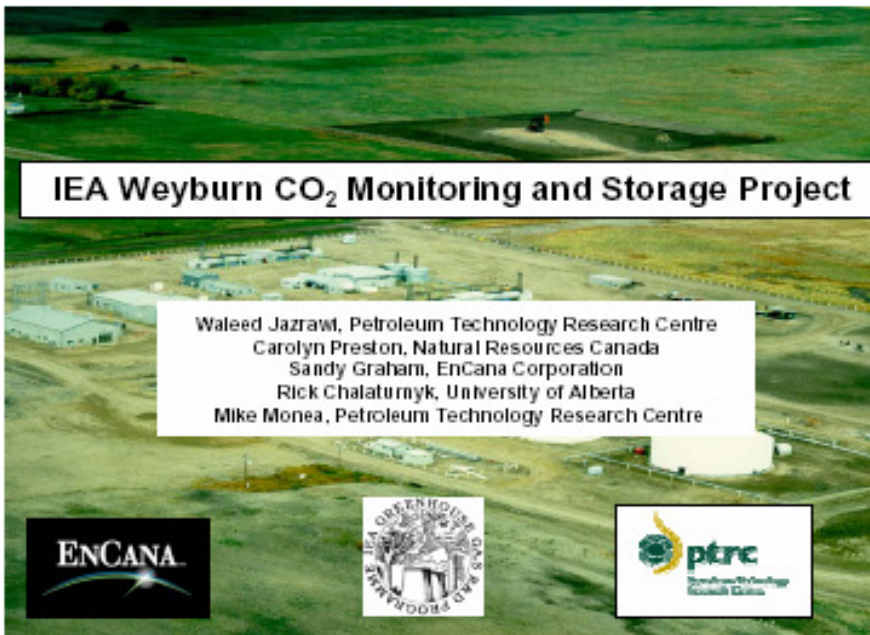


## *IEA Implementing Agreement on EOR*

### **Symposium Topics:**

- 2000 Advances in Drilling, Completion, and Stimulation and their Impact on EOR (UK)
- 2001 Mature Fields: Chance and Challenge (Austria)
- 2002 Optimizing Recovery in High Pressure, High Temperature Reservoirs (Venezuela)
- 2003 Geological Storage of CO<sub>2</sub> (Canada)
- 2004 Improved Recovery from Chalk / Carbonate Reservoirs (Norway)
- 2005 *“Advancement of Simulation Technologies for Improved Oil Recovery” planned in Japan*

# IEA Implementing Agreement on EOR 2003 Symposium on CO<sub>2</sub>:



Status and findings also presented annually to IA on EOR



## Project Mission

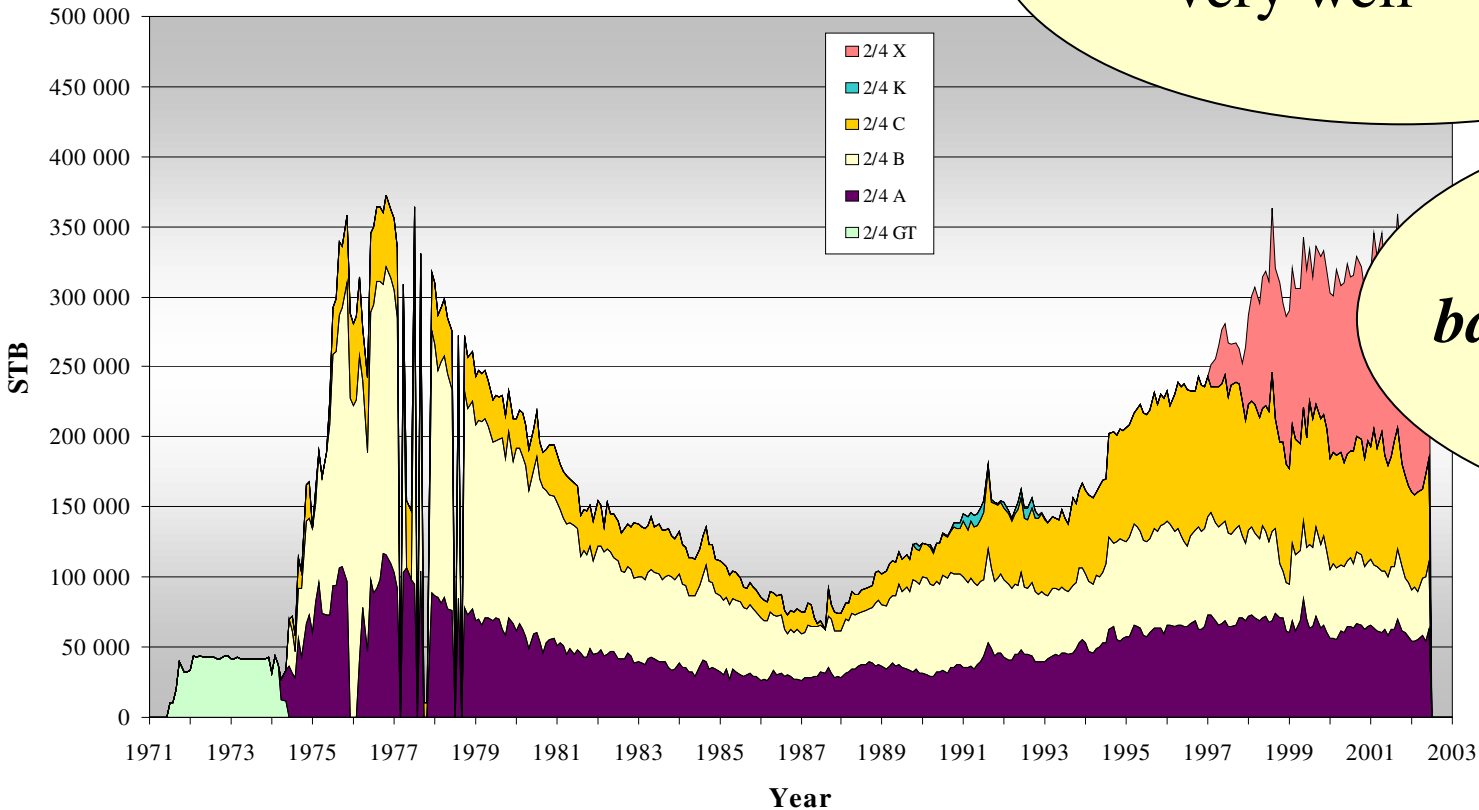
Predict and verify the ability of an oil reservoir to securely and economically store CO<sub>2</sub>.

# IEA Implementing Agreement on EOR

## 2004 Symposium on Chalk / Carbonate:



### Ekofisk production profile



Water injection is working very well – *why* ?

*Paper from long-term basic research might have given the answer*

- base for new EOR method ?



**25th Annual Workshop & Symposium  
Collaborative Project on Enhanced Oil Recovery  
International Energy Agency**

**SOLA STRAND HOTEL, STAVANGER, NORWAY    SEPTEMBER 5 - 8, 2004**



Paper at the IEA-EOR-2004 Symposium:

***“Seawater as IOR-fluid in fractured chalk – A summary of ongoing experimental activities within COREC”***

**T. Austad, S. Strand, E. J. Høgnesen, P. Zhang**  
Stavanger University, Post box 8002, 4068 Stavanger, Norway.

## Research Activities related to Ekofisk EOR

### International Center for Improved Oil Recovery (COREC)

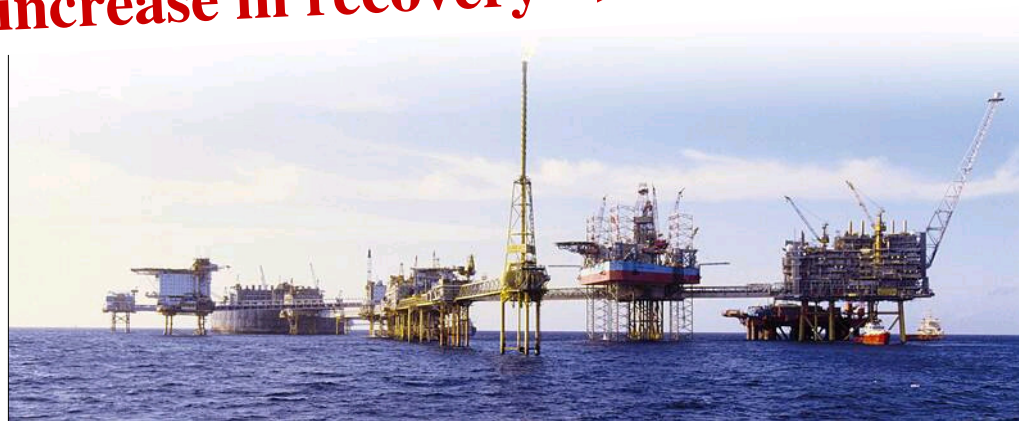
- Water additives
- Depressurization
- Gas injection options

### EU Thermie Air injection

### Joint Chalk Research

- Fundamental chalk research
- Forum for experience transfer

**5 % increase in recovery => more than 300 mill bbl extra oil !**





## *Oil & Gas in the 21st Century*

Ministry initiative, industry participating:  
*Aim: to cover the whole value chain  
- from fundamentals to applications*

OG21:

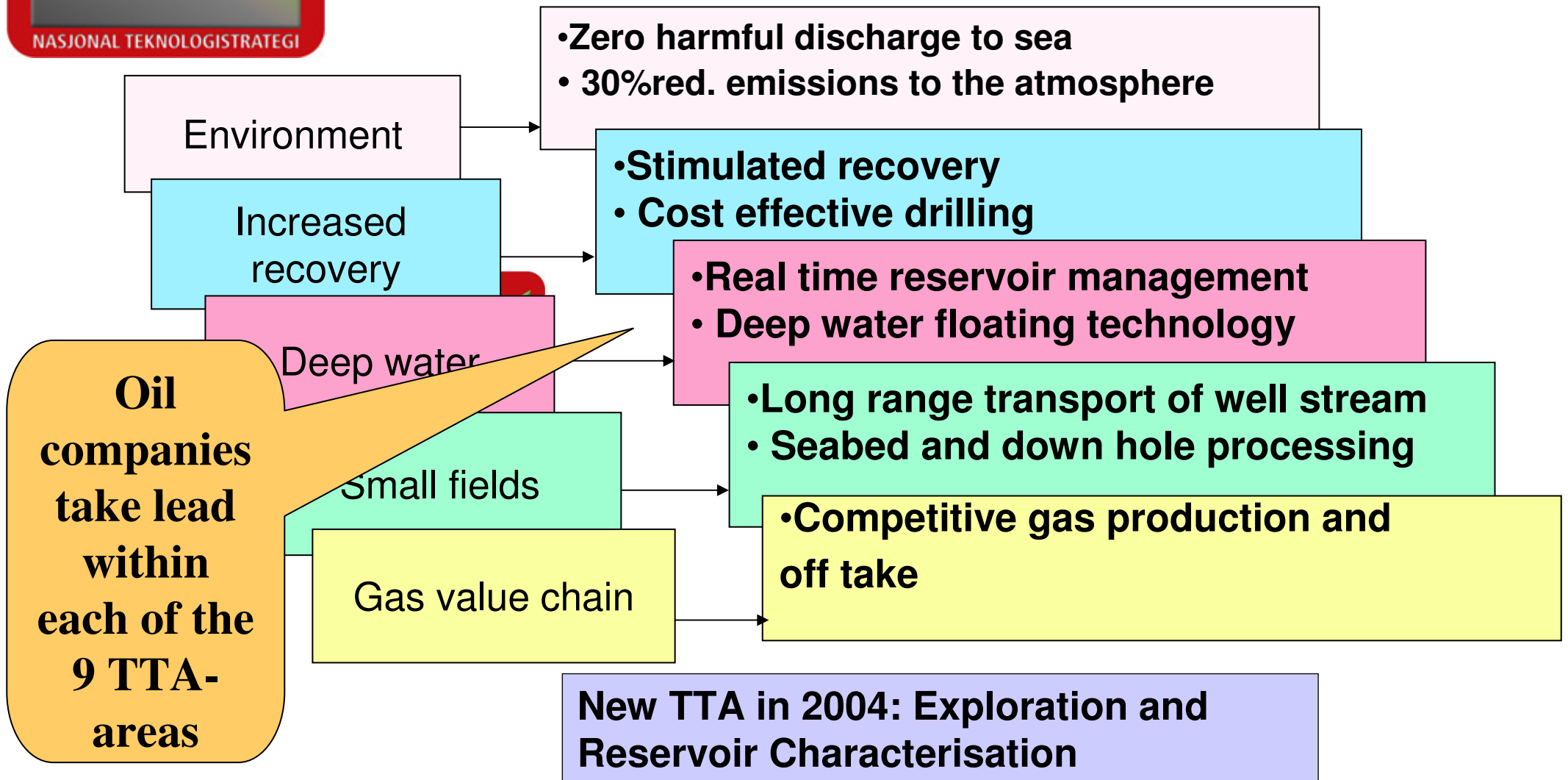
National Technology strategy

for the Norwegian Oil & Gas Industry

[www.OG21.org](http://www.OG21.org)



# Focus Areas & Technology Targets Areas



# Norwegian R & D & Technology programmes

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◆ *Petromaks*

◆ *DEMO 2000*

Norwegian  
Research Council

◆ *Joint Chalk Research (JCR)*

◆ *COREC*

Oil  
Companies



*forum for cooperation and experience transfer*

Oil  
Companies

## ◆ PETROMAKS SCOPE

- ◆ Basic research and technology development, with special attention to the supply and service industry

## ◆ PETROMAKS 2004

- ◆ Concentrate on exploration and increased recovery
- ◆ The first call for proposals resulted in applications totalling a project volume of 900 mill. NOK over the entire project period

## ◆ PETROMAKS 2005

- ◆ Expanding into other thematic areas to cover most of the upstream petroleum areas and also HSE.
- ◆ As a guidance for this expansion PETROMAKS will aim at implementing as much as possible of the strategies and plans laid down by the government initiative OG21

# DEMO 2000 (Norwegian Research Council)

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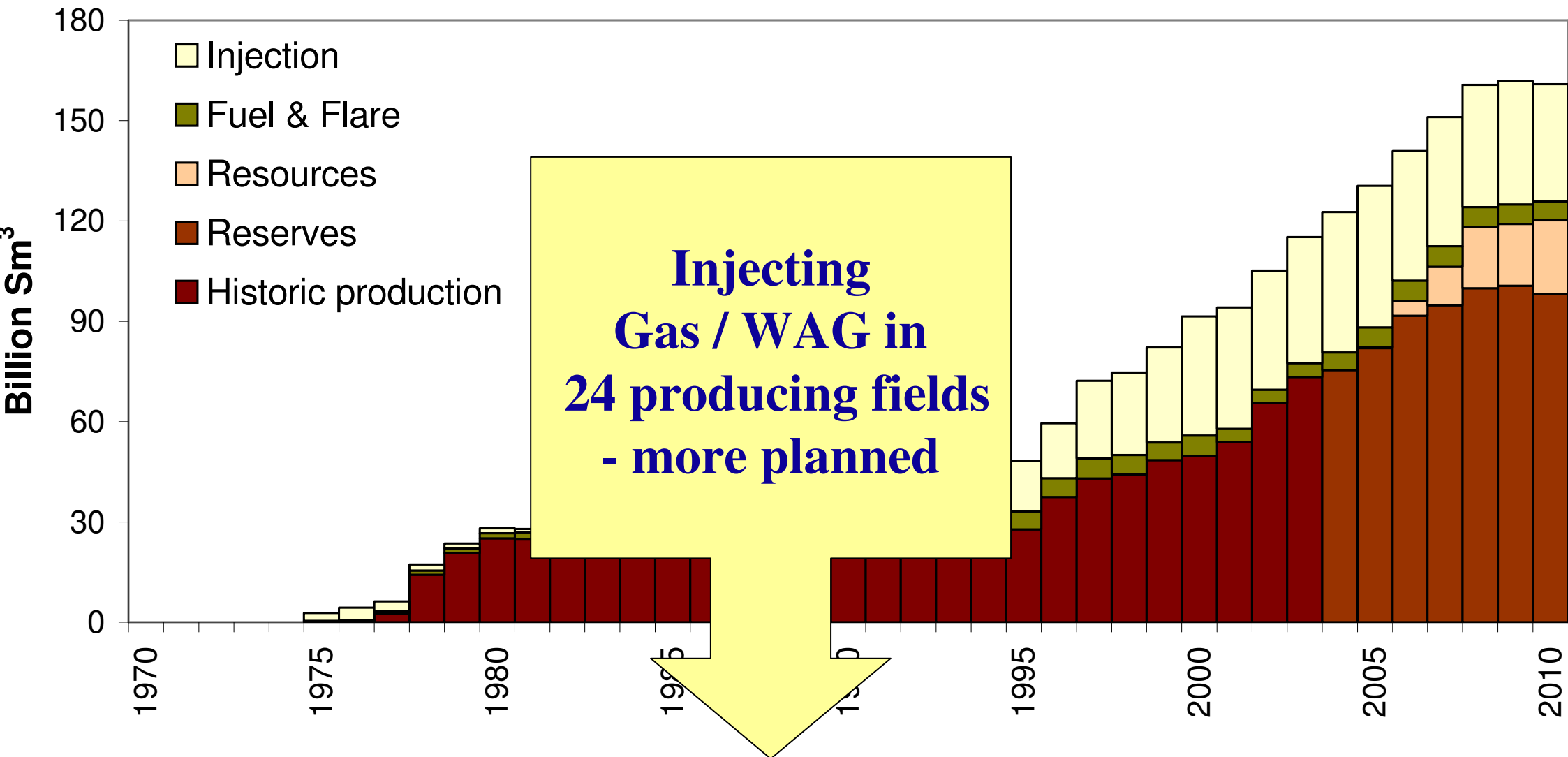


- ◆ Accelerate uptake and commercial use of new technology
- ◆ Share risk in piloting of solutions
- ◆ Provide testing ground for new products, systems and solutions
- ◆ Help new technology become qualified ("Field proven") and competitive
- ◆ Important for deployment, use and export of Norwegian products

*Forum for reservoir characterisation, reservoir engineering and exploration technology.*

- ◆ **Started in 1995. Now decided on 3 more years**
- ◆ **Members: all leading oil companies on NCS**
- ◆ **Initiated by the NPD, and secretariat in NPD**
- ◆ **FORCE initiates co-operation. Experience transfer**
- ◆ **Active involvement of members**
- ◆ **Process of continuous improvement**

# Gas balance Norwegian Continental Shelf



Source: NPDs Fact-pages, RNB200

# *CO<sub>2</sub> for EOR:*

*Focus high – commerciality low !*

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## **Miscible gas. Gives additional volumes of oil**

- ◆ *Gullfaks*: extensive studies, not commercial as stand alone
  - ◆ Need lower costs on CO<sub>2</sub> delivered at platform
- ◆ *Ekofisk*: an option for the late recovery phase ?
  - ◆ Value of combining the fields in sequence

## *CO<sub>2</sub> – injection projects, but NOT for EOR:*

- ◆ *Sleipner CO<sub>2</sub> separation from produced gas and re-injection - experience transfer*
- ◆ *Snøhvit CO<sub>2</sub> separation and re-injection is coming*

## **Needs:**

### **Fast and reliable modelling tools for Miscible Gas Injection**

- **Streamline models vs traditional compositional models (Eclipse)**

# Conclusions:

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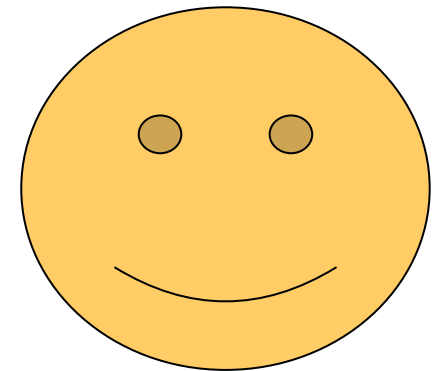
**Industry takes care of short term needs**

**Long term needs is mainly related to:**

⇒ **How to stimulate recovery from oil reservoirs (EOR)**

⇒ **Basic research ↔ Education**

**Highly needed supply of competence and experts**





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# Thank you for your attention!



[www.npd.no](http://www.npd.no)