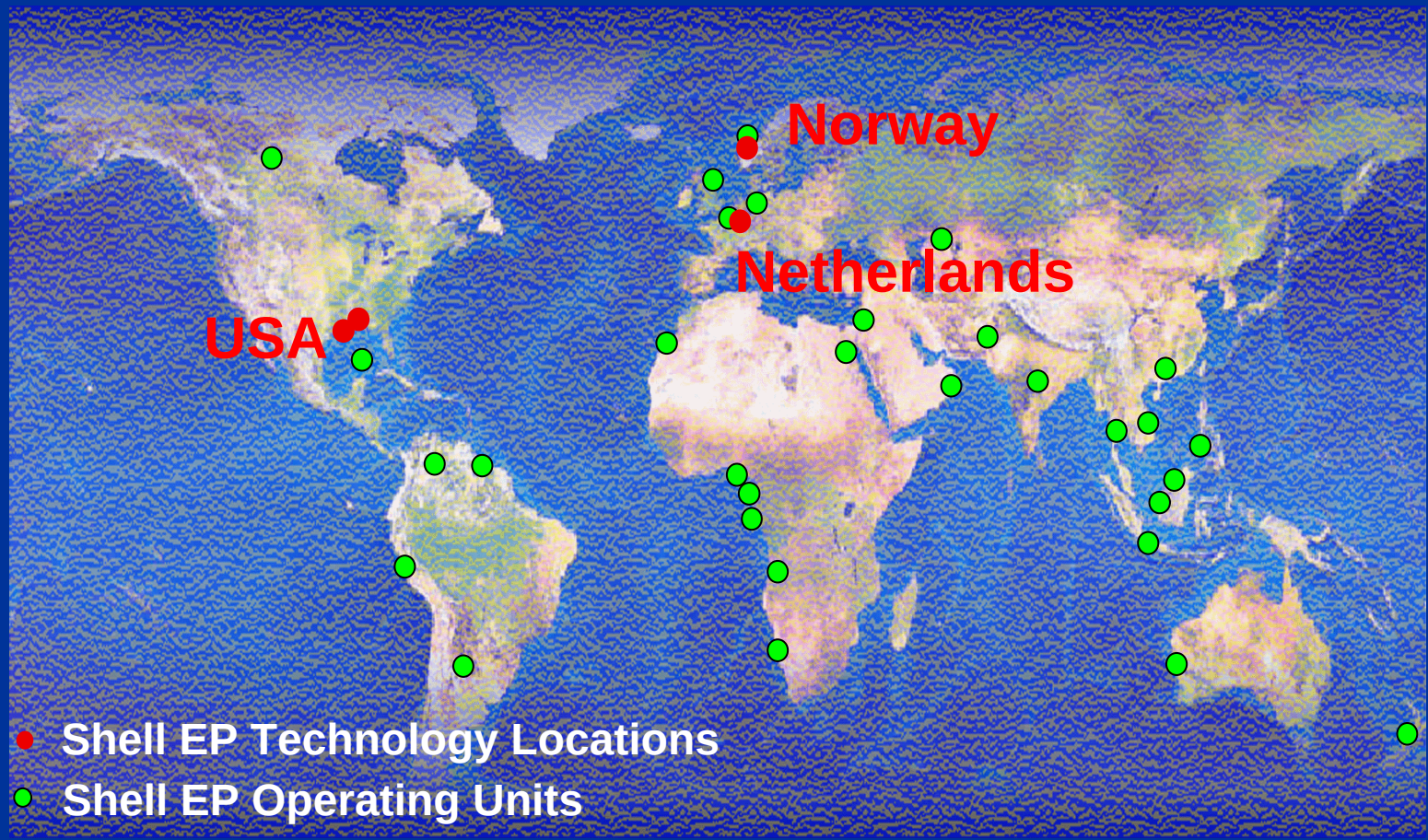
Shell Technology Norway AS

Cleaner Production

Discharge to Sea
Emissions to Air

Anne-Mette Hilmen

Cooperation within Shell



Shell EP R&D Technology focus areas

- Seeing in the Earth

  Geology, seismic sensing, HC-detection

- Accessing the Earth

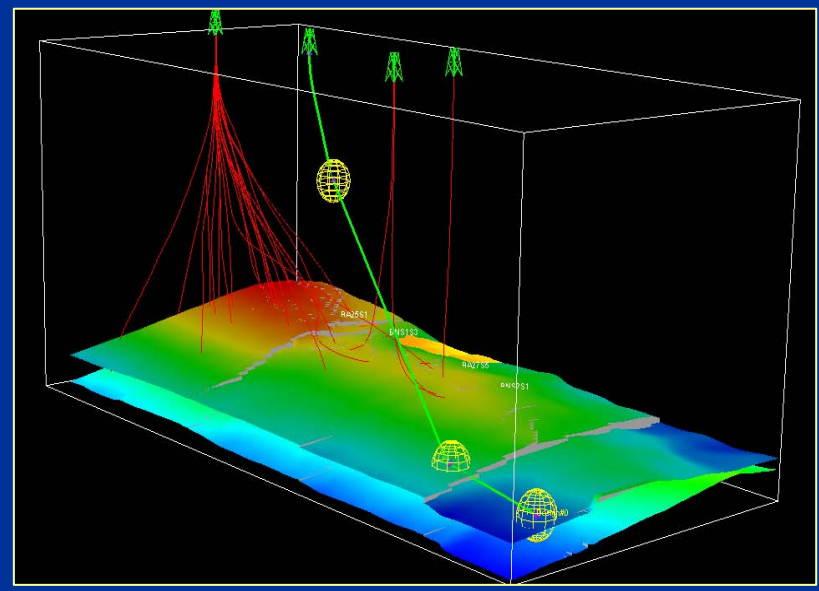
  UB drilling, well engineering

- Draining the Earth

  Int. res. modelling, time lapse seismic, smart fields

- Processing & Transporting fluids

  Infrastructure offshore, Deep water technology



3D viewer

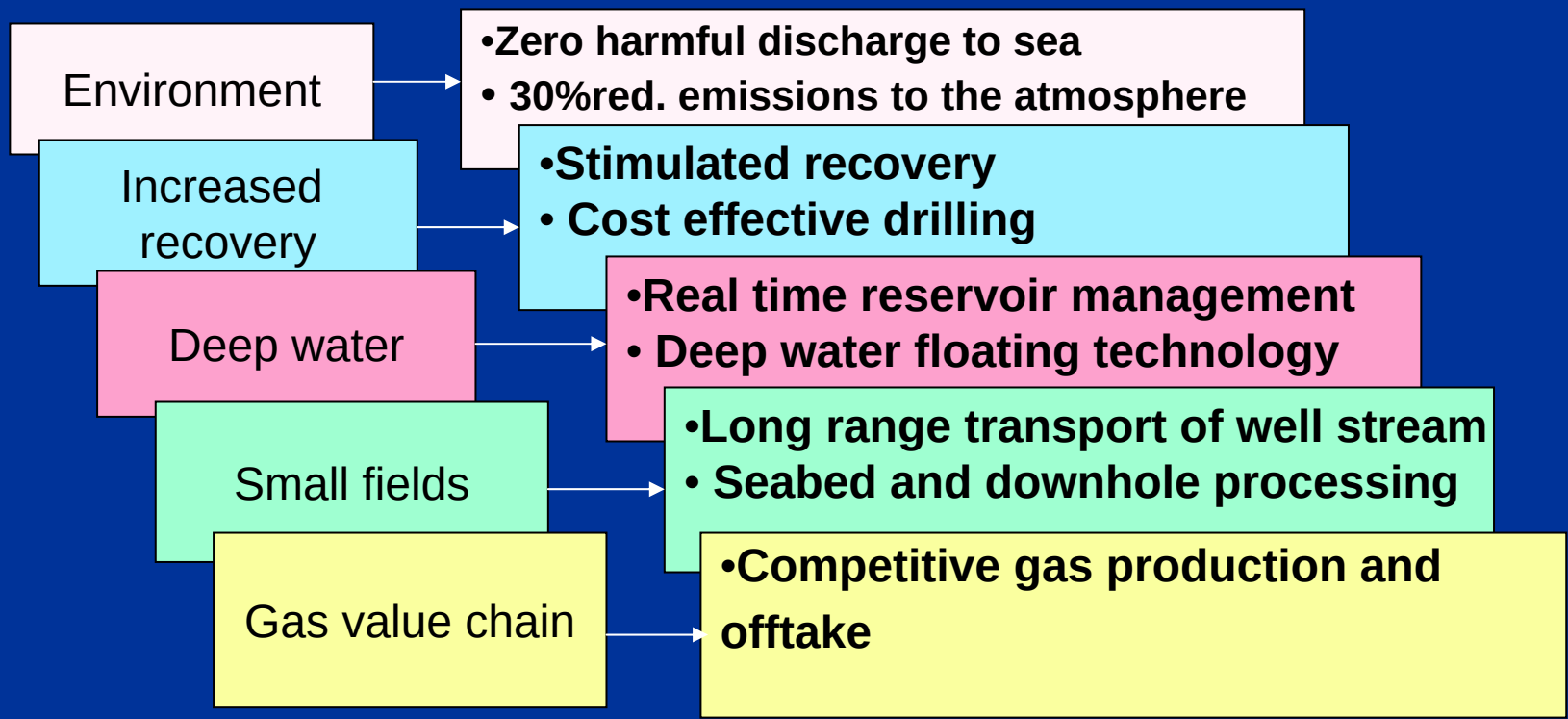
Shell Technology Norway A/S

- Key Business: Technology development
- Key Focus: Where Norwegian industry is leading
- Key Goal: Rapid application of successful technologies in the Shell Group
- Aspiration: *Window for Norway into the Shell Group*

Shell Technology Norway A/S

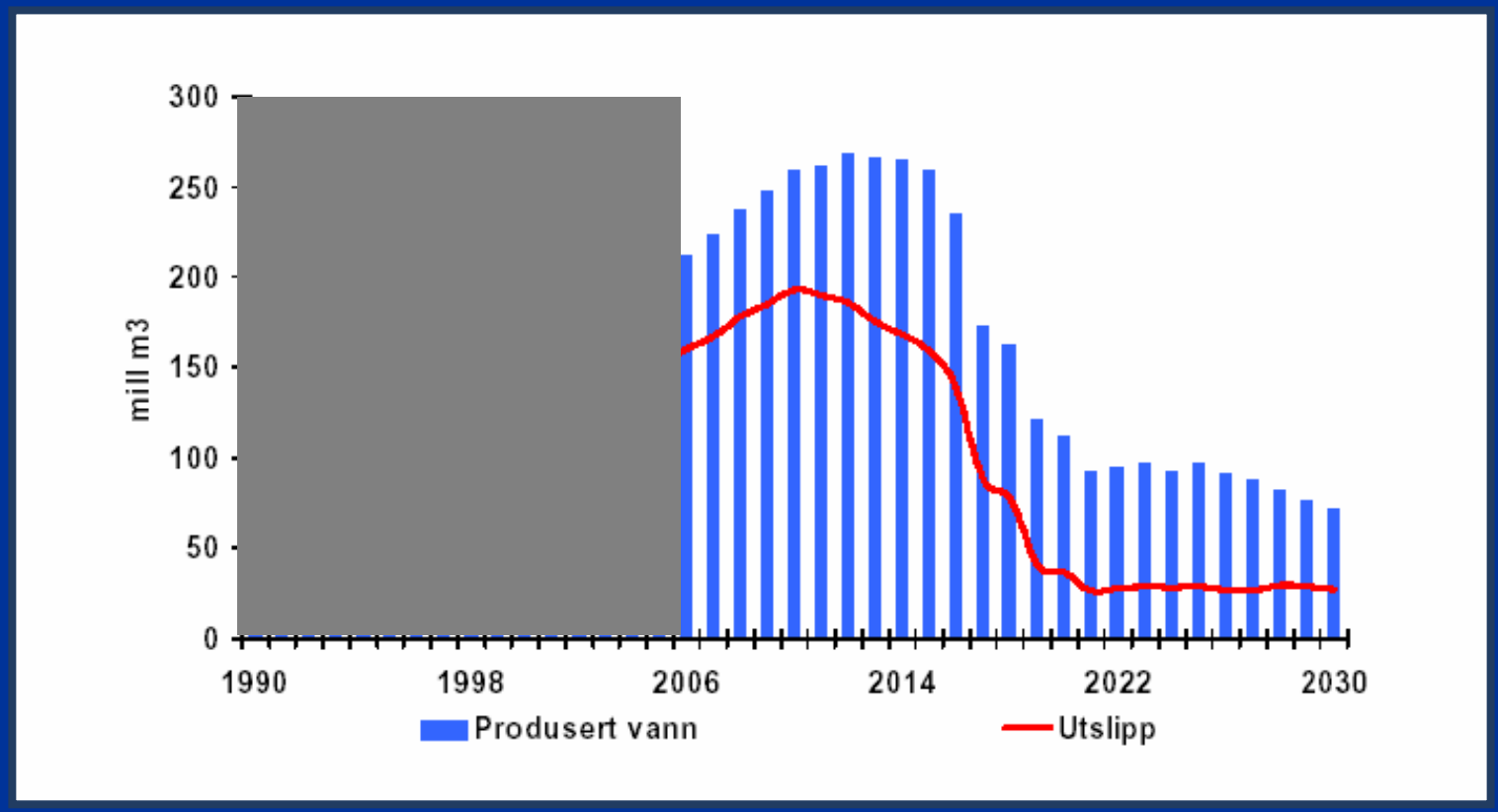
	Technologies	Resources
Key areas	Subsea processing Systems Equipment Installation Cleaner Production Discharge to Sea Emissions to Air	80 %
Technology support areas	Deepwater Smart fields Gas utilisation	15 %
Facilitation	Subsurface Other	5 %

OG_{21} - Focus Areas & Technology Targets Areas (TTA)



Discharge to Sea

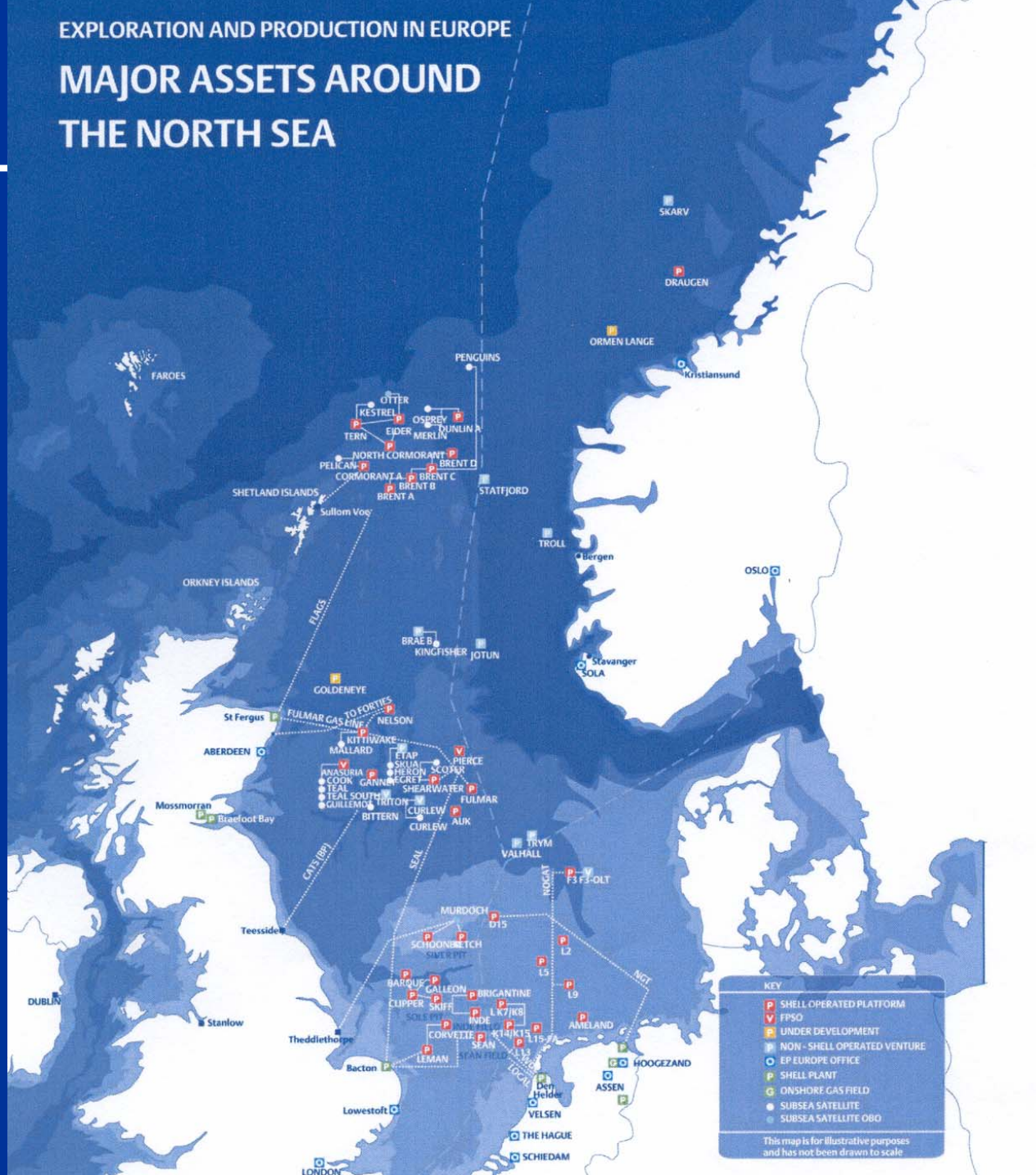
Projected water production on NCS



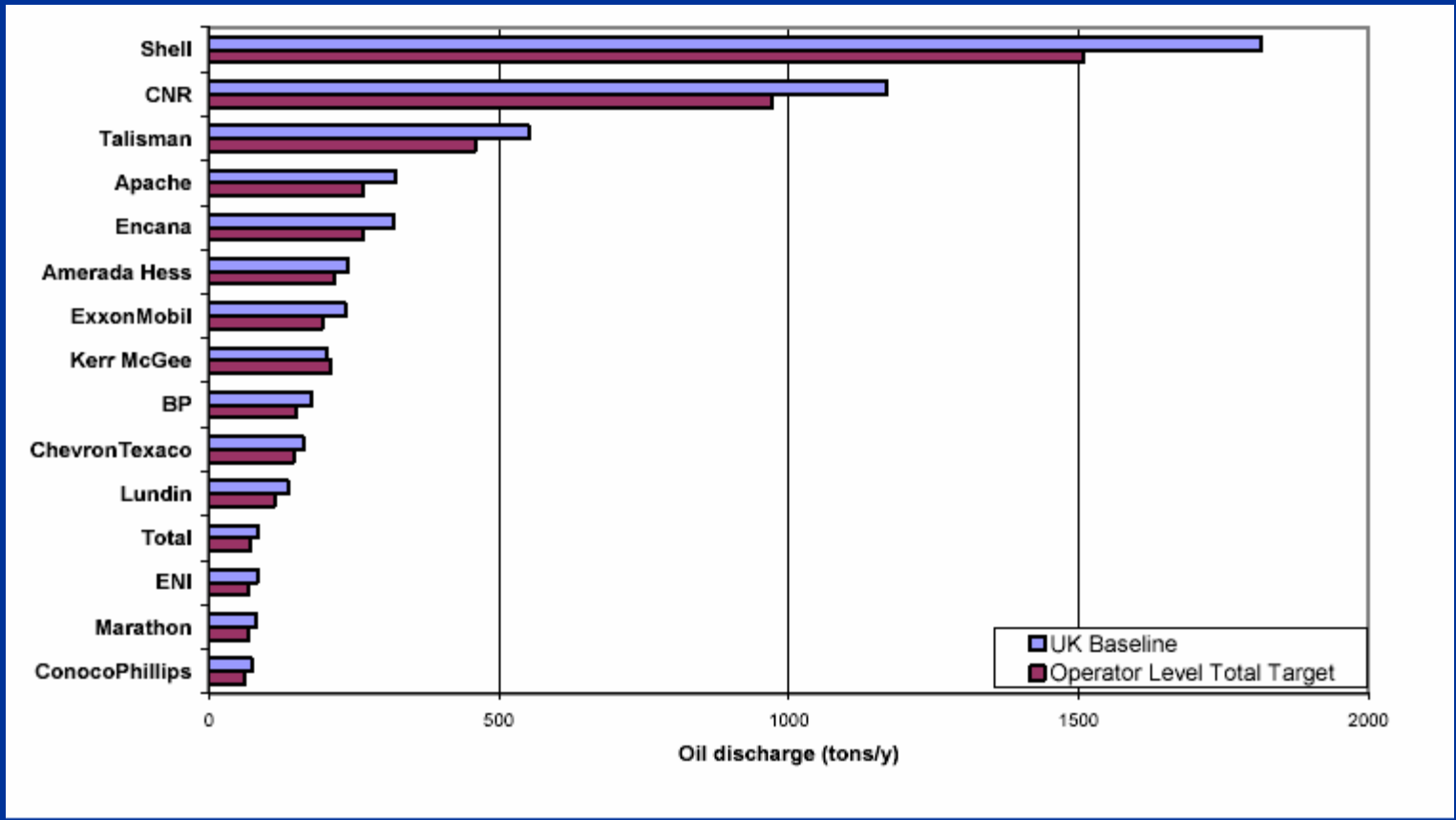
Source: OED/OD, 2004

EXPLORATION AND PRODUCTION IN EUROPE

MAJOR ASSETS AROUND THE NORTH SEA



UKCS – OSPAR baseline/targets



OSPAR requirements

Current requirements:

- 15% reduction of oil discharge from PW by 2006 compared to 2000
- BAT/BEP should be used on each installation
- 30 mg/l oiw from 2006 (currently 40 mg/l)

By 2020, Contracting Parties should achieve:

a) a reduction of oil in produced water discharged into the sea to a level which will adequately ensure that each of those discharges will present no harm to the marine environment;

b) in accordance with the objective and the timeframe of the OSPAR Strategy with regard to Hazardous Substances, a continuous reduction in discharges of hazardous substances *via* produced water, by making every endeavour to move towards the target of cessation of discharges of hazardous substances with the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances."

STN Discharge to Sea - Program objective

STN to coordinate/lead development of technology to reduce discharge to sea from E&P activities

All activity aimed at achieving maximum benefit at minimum cost (environmental risk assessment)

Enable access to new areas

Existing Assets

- De-bottlenecking
- Remote operation
- Monitoring

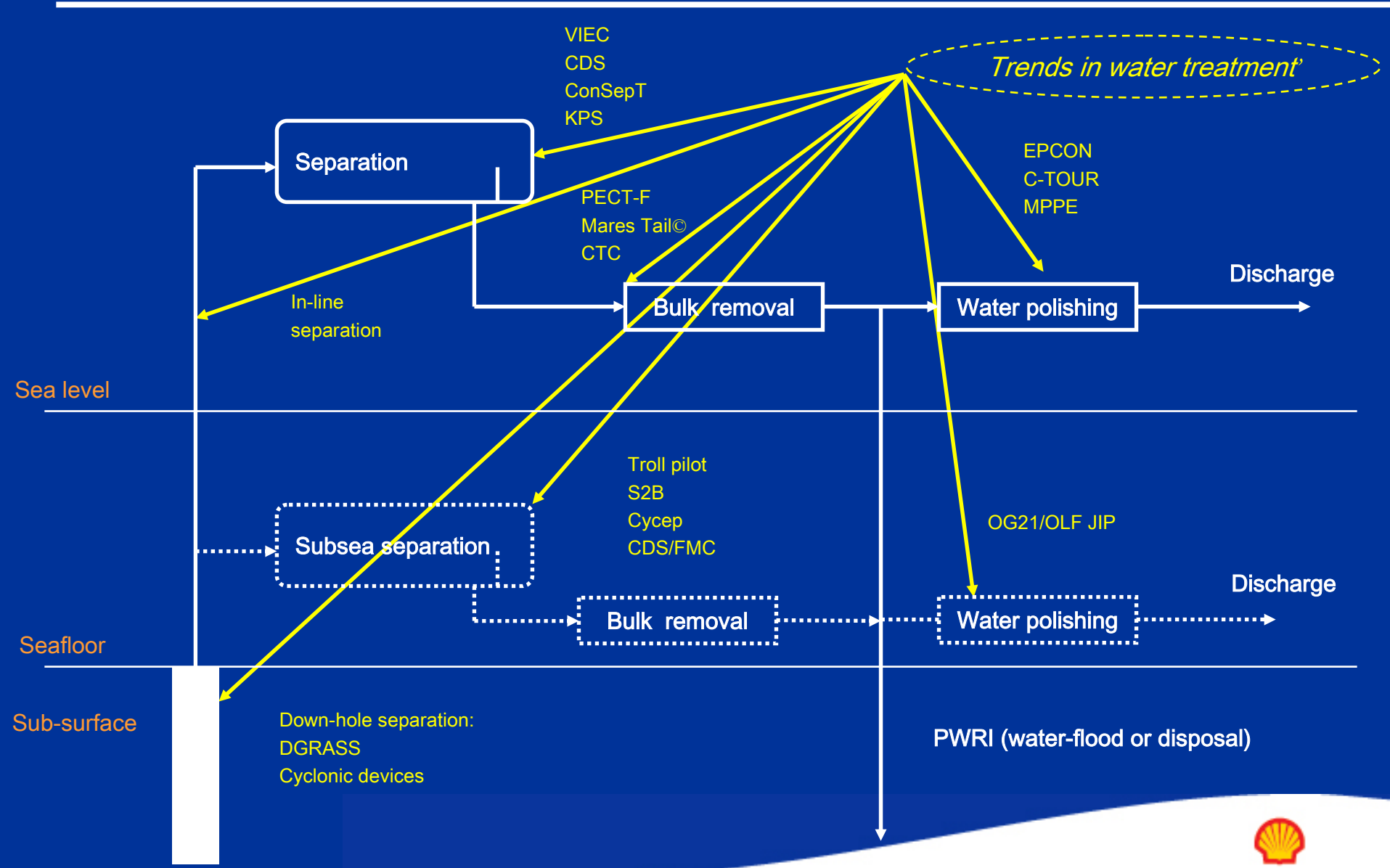
New Developments

- Subsea systems
- Remote operation
- Drilling and well operations
- Enabling technology

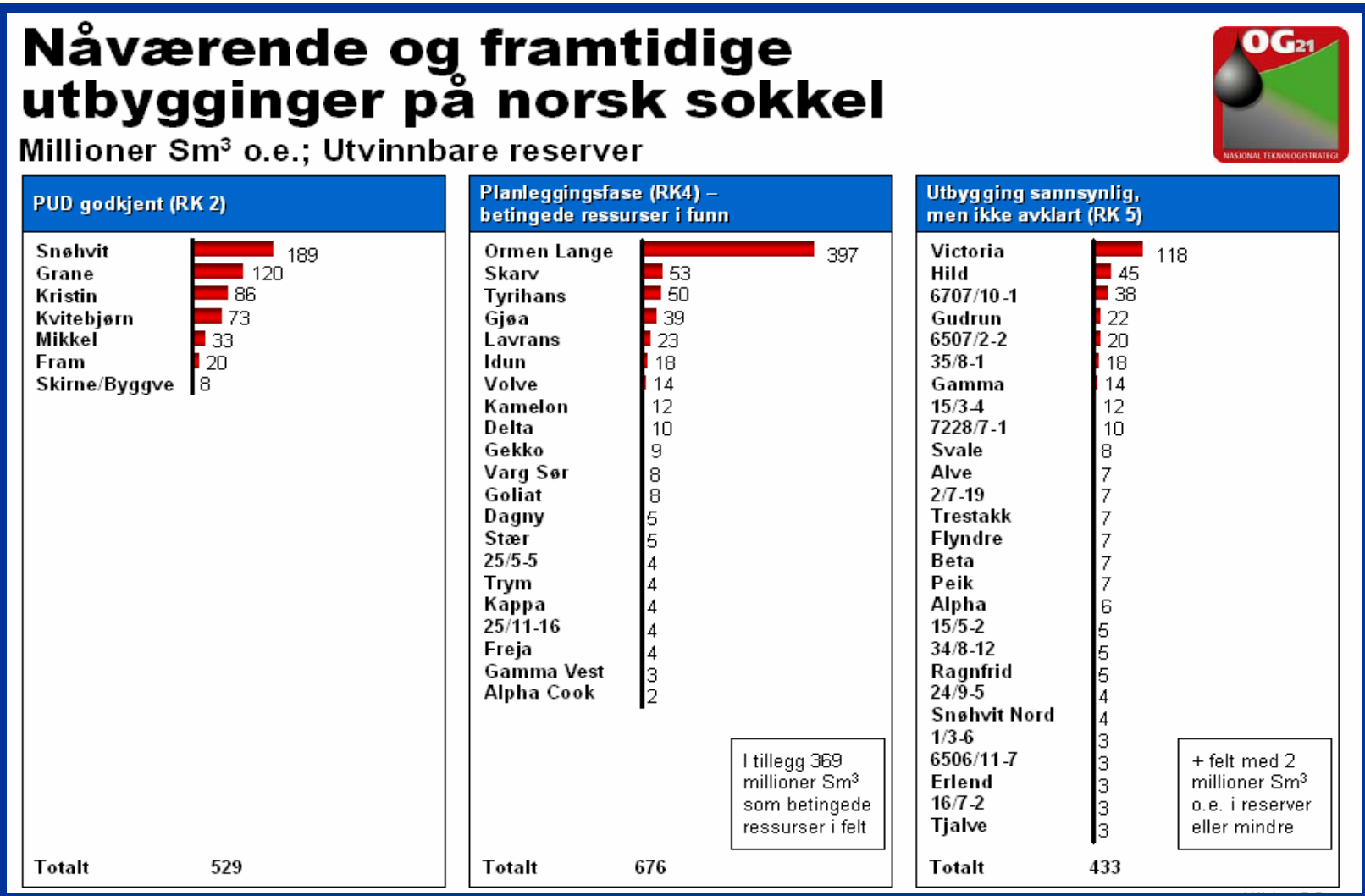
STN Discharge to Sea - Program outline

- Environmental Risk Management (DREAM/ERMS)
  - ✓ Risk is field specific and risk assessment provides tool for targeting optimal cost benefit efforts
  - ✓ Tool used by all NCS operators, application spreads internationally
- Produced Water Treatment
  - ✓ Specific technology to address continuous discharges
  - ✓ Increased volumes and stricter legislation
- Spills & Leak Detection
  - ✓ Enabler for subsea/remote operation
- Monitoring of oil in water
  - ✓ Enabler for subsea/remote operation, improved operation
- Discharge from drilling operations
  - ✓ Enabler for access to new areas

Water treatment moves upstream…



NCS development portfolio



Existing infrastructure

- Characteristics
  - Increased recovery & tail-end production
  - Tie-in of nearby fields
- Challenges
  - Increased water production & capacity constraints
  - Compatibility of fluids (water, HC, chemicals)
  - Complexity and old infrastructure
- Technology needs
  - De-bottlenecking ('cheap&dirty', constrained by revision stop practicalities and investment climate)
  - Remote operation (de-manning)
  - Monitoring (including condition monitoring, online OIW monitoring)

New areas

- Characteristics
  - Small fields
  - Subsea development to host
  - Deeper
- Challenges
  - Economy
  - Remote operation
  - Power, chemicals, control at long step-out
- Technology needs:
  - Subsea systems with PW discharge to sea meeting zero harmful discharge requirements
  - On-line monitoring, Control, Operability and Maintainability

Summary

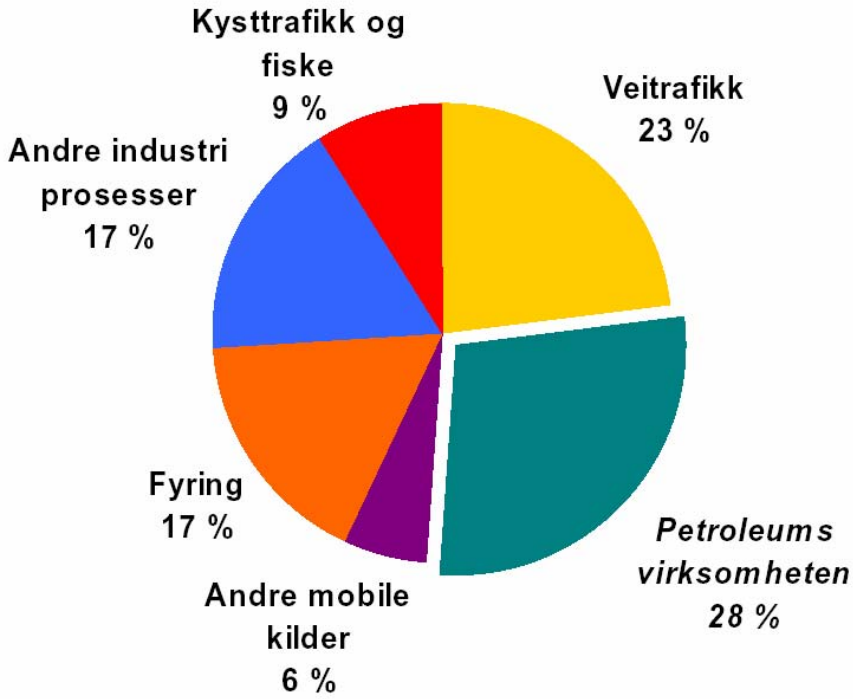
- Zero harmful discharge work will continue. Legislation will become stricter, but with individual assessment of each field development
- Bottlenecks in existing facilities – liquid capacity
- Small fields – limited investments - subsea tie-back to host
- Necessary to develop compact, robust and affordable solutions for economic water treatment

✓ Economic solutions for new and existing infrastructure requires:

- Online monitoring
- Compact equipment (subsea and de-bottlenecking)
- Enabling technologies for remote operation

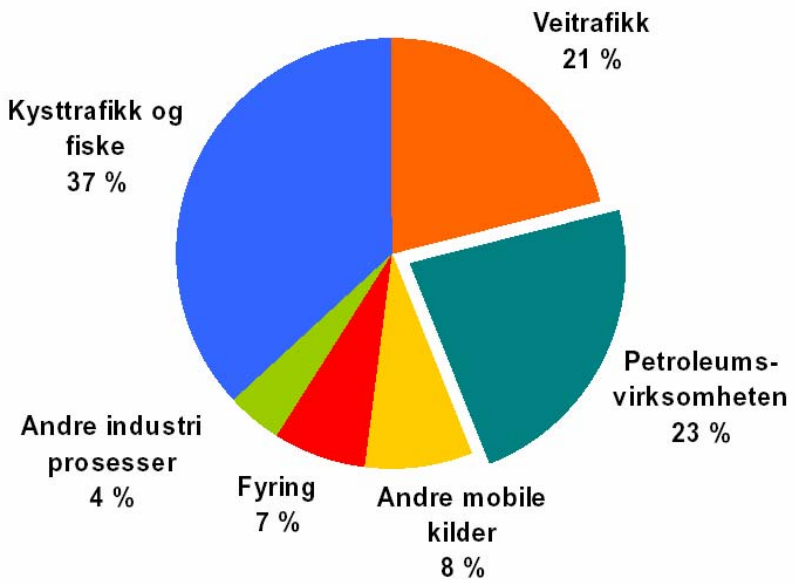
Emissions to Air

Kilder til norske utslipp av CO_2, 2002



Kilde: SSB/SFT

Kilder til NO_X-utslipp i Norge, 2002



Kilde: SSB

Emissions to air

- **Emissions to air:**
  - **Focus area in STN**
  - **Program establishment in progress**

- **Align with OG21 strategy, - reduce CO_2 and NO_x by:**
  - **Energy efficiency measures**
  - **CO_2 sequestration**
  - **Gas turbine with steam injection or SCR**
  - **Renewables offshore**

Global outlook

- **Legislation for discharge to sea increasingly stricter**
  - **Front-edge in Norway/Europe**
  - **Experience transfer from Norway to less “mature” areas**
- **Environmental risk assessment gaining support outside Norway (Used by Total, ENI, Petrobras, CP and Statoil outside NCS)**
- **Strong focus on leveraging and experience exchange (i.e. NSOM)**
- **Enabling technologies for new, vulnerable areas**

Shell in the world

With approximately 119,000 employees in more than 145 countries and territories around the world, the companies that comprise the Royal Dutch/Shell Group are engaged in Exploration and Production, Gas & Power, Oil Products, Chemicals, and Other industry segments including Renewables, Hydrogen and Trading.

Exploration and Production

17,100 employees

$9.1 billion earnings

Gas & Power

2,100 employees

$2.3 billion earnings

Oil Products

81,600 employees

$2.9 billion earnings

Chemicals

8,600 employees

-$209 million earnings

Other industry segments

2,800 employees

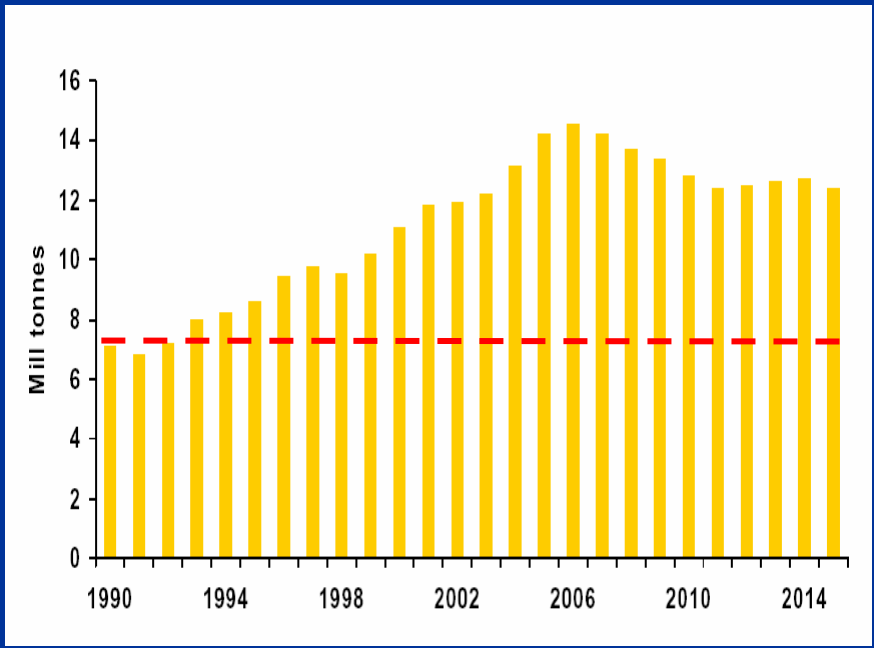
-$267 million earnings

Source: Annual Reports, May 2004

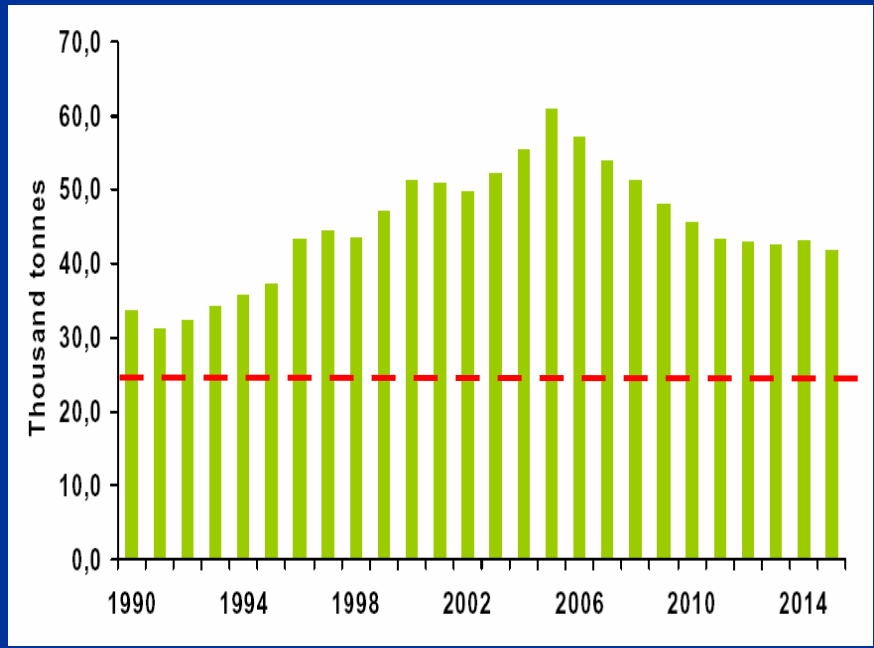
END

Emissions from the Norwegian Petroleum Sector

CO_2:



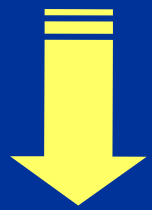
NO_x:



Source: MPE/NPD

Shell EP global challenge

- Maximise recovery from existing assets
- Expand into new assets, regions, markets
- Minimise unit costs



Timely identification, speedy deployment and wide scale application of the right technologies !!

30% Reduction of Harmful Emissions to Air

Objective:

- **Reduce the emissions of environmentally harmful gases to air. Focus on the gases for which a major part of the total national emissions are emitted by the oil and gas industry, and for which no roadmap to lower emissions is implemented.**

Specific Emission Targets for year 2010:

- **52 kg CO_2 equivalents per Sm^3 oil equivalents delivered**
  - ✓ The target is challenging, but within reach
- **0.12 kg NO_x per Sm^3 oil equivalents delivered**
  - ✓ Very difficult to reach. Current prognosis showing much higher emissions.

30% Reduction of Harmful Emissions to Air

Possibilities:

- **30% reduction of harmful emissions to air very ambitious.**
- **No quick fix solutions in the pipeline.**
- **A mix of short term and long term solutions needed:**
  - ✓ Energy efficiency measures
  - ✓ CO2 sequestration
  - ✓ Gas turbine with steam injection
  - ✓ Cooperate with sectors where cost of NO_x reduction measures are lower (e.g. convert ships to gas or install catalyst)
  - ✓ Renewables offshore

Challenges

- Difficult to start NO_x projects as long as the future Norwegian NO_x regime is unknown
- The main obstacle for CO_2 sequestration is economy. A stable, long term framework that makes CO_2 handling economical viable needed to get pilot projects off the ground.
- Uncertainties regarding geological storage of CO_2 vs. international protocols needs to be solved.

OG_{21} – Oil & Gas in the 21st Century

Main Objectives

Develop new knowledge and technology to ensure economic and environmentally sound development of the resources on the Norwegian Continental Shelf

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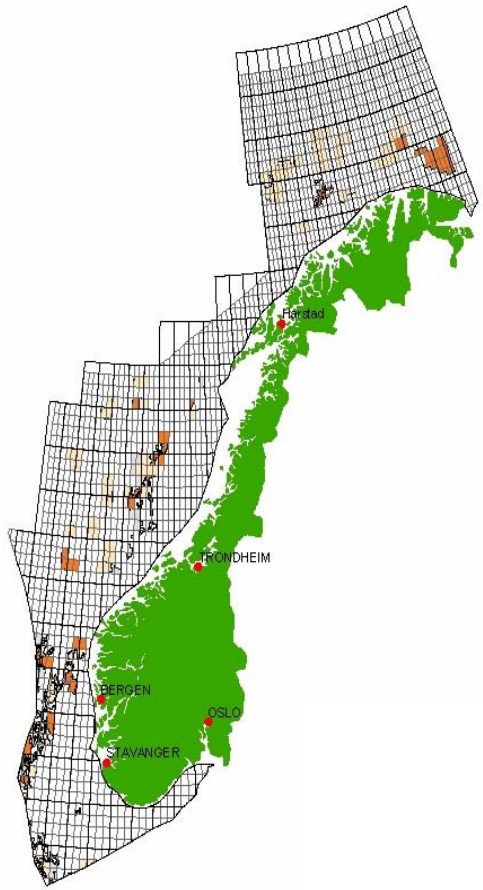
Strengthen the industry's competitive advantage in a global market by developing new and attractive technology products and systems



OG21 target figures

- **Faster, more cost-effective exploration**
  - Reduce the average lead time from licence award to discovery to 3 years.
- **Faster, more cost-effective development**
  - Reduce the average lead time from discovery to production to 4 years.
  - Reduce the average CAPEX for new fields on the NCS to US$ 3/boe.
- **Reduced operating expenses**
  - Reduce the average total OPEX on the NCS to US$ 3/boe.
- **The environment**
  - Reduce CO2 emissions on the NCS by 30 % compared with today's level
  - Zero harmful discharge to sea.
- **Gas value chain**
  - Enhance value creation by 50% through additional/new export capacity and more cost-effective technology
- **Exports**
  - Increase exports of Norwegian technology by NOK 50 billion, equivalent to sales of NOK 70 to 80 billion in 2010.
- **Enhanced recovery**
  - 60% for large oil fields
  - 80% for gas fields

Leverage, funding and cooperation

- OG21/OLF focus on discharge to sea and emissions to air
  - 1 of 9 Technology Target Areas (TTA) focus on souring, leak detection and water treatment technology
- Petromaks programme (NRC)
  - Water treatment to increase processing and transport capacity
- Demo 2000
  - RMR, SILD, OIW monitoring, DGRASS, Subsea separation, VIEC, Sand management, ResMan (Downhole water monitoring), ++
- Operators cooperation (NSOM, JIPs)
- Suppliers – Universities - Institutions
  - EPCON, C-Tour, KPS, CDS, AK, FMC, ABB (Vetco Aibel), ConSepT, …
  - NTNU, UiB, UiO, HiS, …
  - SINTEF, RF, CMR, …

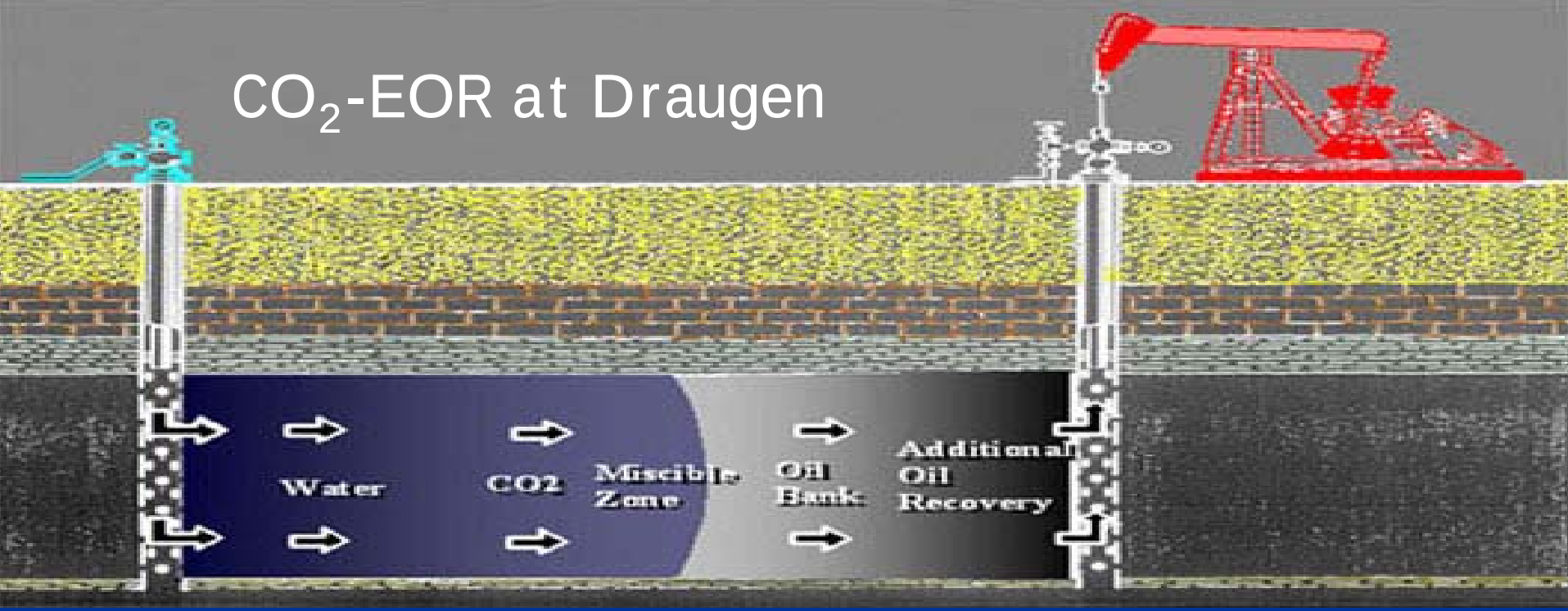
Leverage, funding and cooperation

- **OG21/OLF focus on reduced emissions to air**
  - **Technology Target Area focus on CO2 and NOx**
  - **power generation efficiency (steam injection, operational), energy management**
  - **alternative power sources (renewable, power transfer from onshore)**
  - **CO2 management & infrastructure**
  - **mapping emission reduction potentials**
- **Petromaks programme (NRC)**
  - **CO2-EOR**
- **Governmental Innovation Fund**
  - **2 billion nok fund for development of emission free gas power**
- **Bilateral agreement US/Norway and Carbon Sequestration Leadership Forum**
  - **Technology cooperation on CO2 capture and storage**
- **Operators cooperation (NSOM, JIPs)**
- **Suppliers – Universities - Institutions**

Utslippstype	Kilde	Viktigste bestanddeler
Produsert vann	Vann som kommer opp fra reservoaret sammen med oljen og gassen som produseres. På plattformen skilles det produserte vannet fra oljen og gassen. Deretter renses vannet før det slippes ut i sjøen.	• Vann • Mineraler fra formasjonen • Rester av olje • Organiske syrer • Salter • Tungmetaller • Naturlige lavradioaktive forbindelser • Rester av kjemikalier
Ballastvann	Sjøvann som er i lagercellene og som slippes ut fra plattformen etter hvert som lagercellene fylles opp med olje.	• Sjøvann • Kan inneholde små rester av olje
Drenasjevann	Regnvann	• Kan inneholde skitt fra dekk
Kjølevann	Sjøvann	• Sjøvann m/høyere temperatur
Hydraulikkvæske	Væske som brukes til å operere ventiler på havbunnen.	• Hydraulikkolje

Kilde: OLF

CO_2-EOR at Draugen



- **JIP with Statoil and 50% funding by the Norwegian Research Council (NRC). Awaiting funding approval from NRC.**
- **Study of CO_2-EOR on Draugen and Heidrun, transport of CO_2 and CO_2 capture from Statoil methanol plant at Tjeldbergodden**
- **Linked to Statoils plans of doubling methanol plant capacity and power plant construction at Tjeldbergodden.**
- **Learn from Statoil study of Gullfaks**
- **Combine with WAG study.**