Environmental Topics as a Part of the Petroleum Engineering Course of Studies

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Education and Culture

Tempus

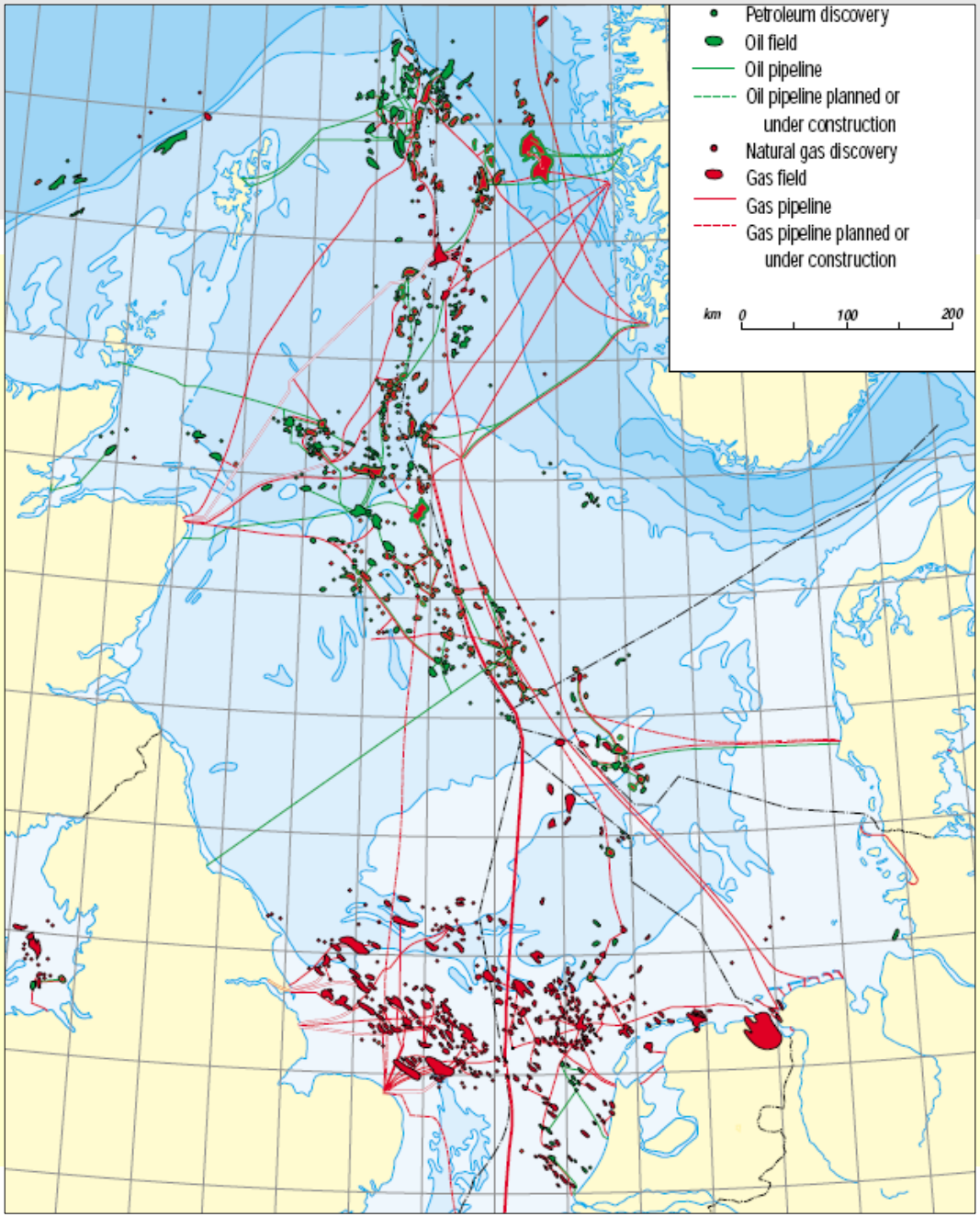
European-Turkmen Centre for Qualifications for continuing vocational Training in the oil and gas Industry

ETWZ

- Fachhochschule des Mittelstandes, Bielefeld
- Stiftung Bildung & Handwerk, Paderborn
- Rackow Schule gGmbH, Hamburg
- Uniwersytet Warminsko-Mazurski, Olsztyn, Polen
- Helsinki Business College, Helsinki, Finnland
- As an individual Expert: Prof.Dr. Karsten Runge, Hamburg

- Turkmen Polytechnic Institut in Ashgabad
- Turkmen Ministry of Education
- National Corporation „Turkmenneft“
- National Corporation „Turkmengas“
- Association of Entrepreneur „Turkmenneftgurluschik“
- Association of Entrepreneur „Turkmengasgurluschik“

Oil and Gas fields in the North Sea



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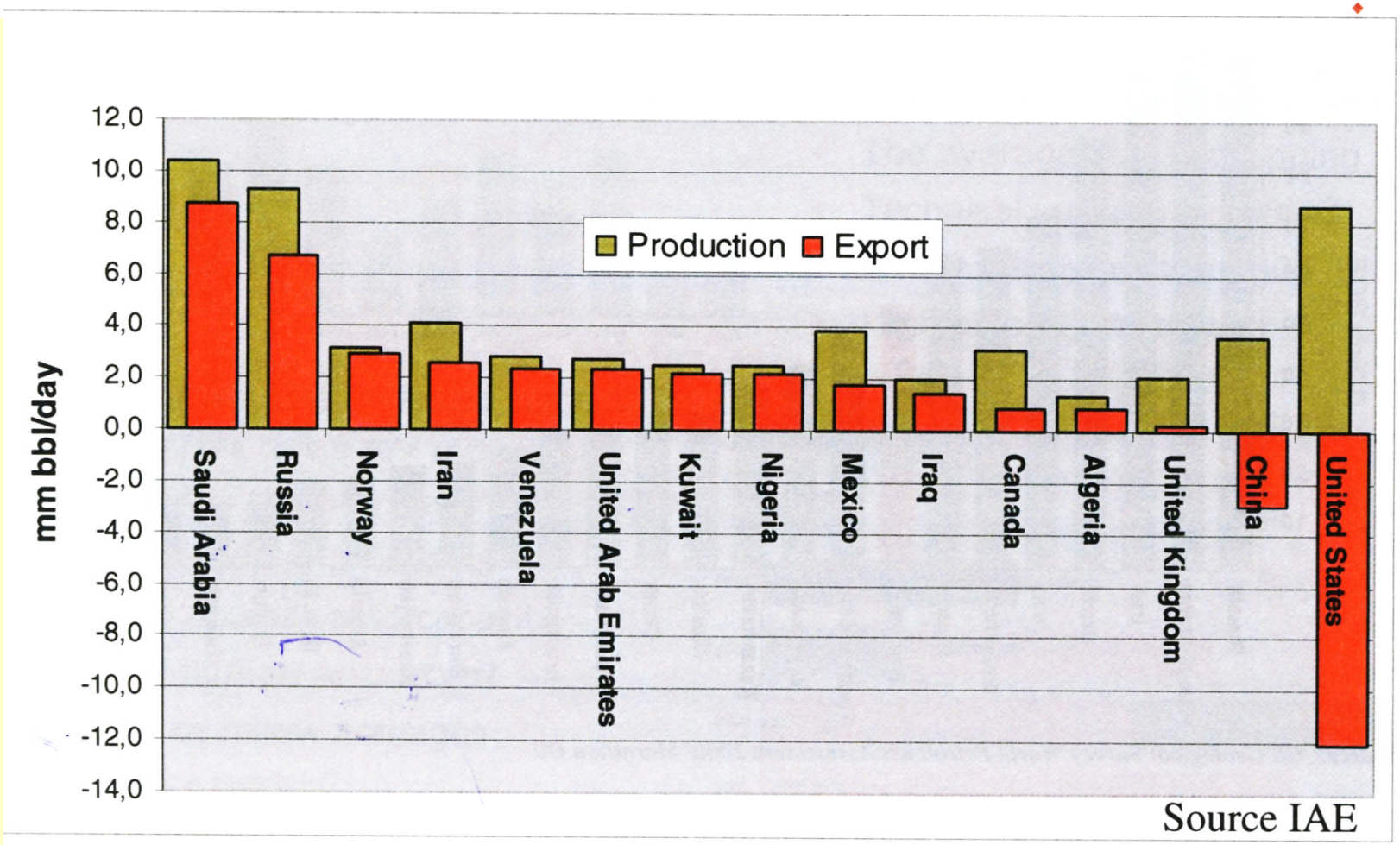
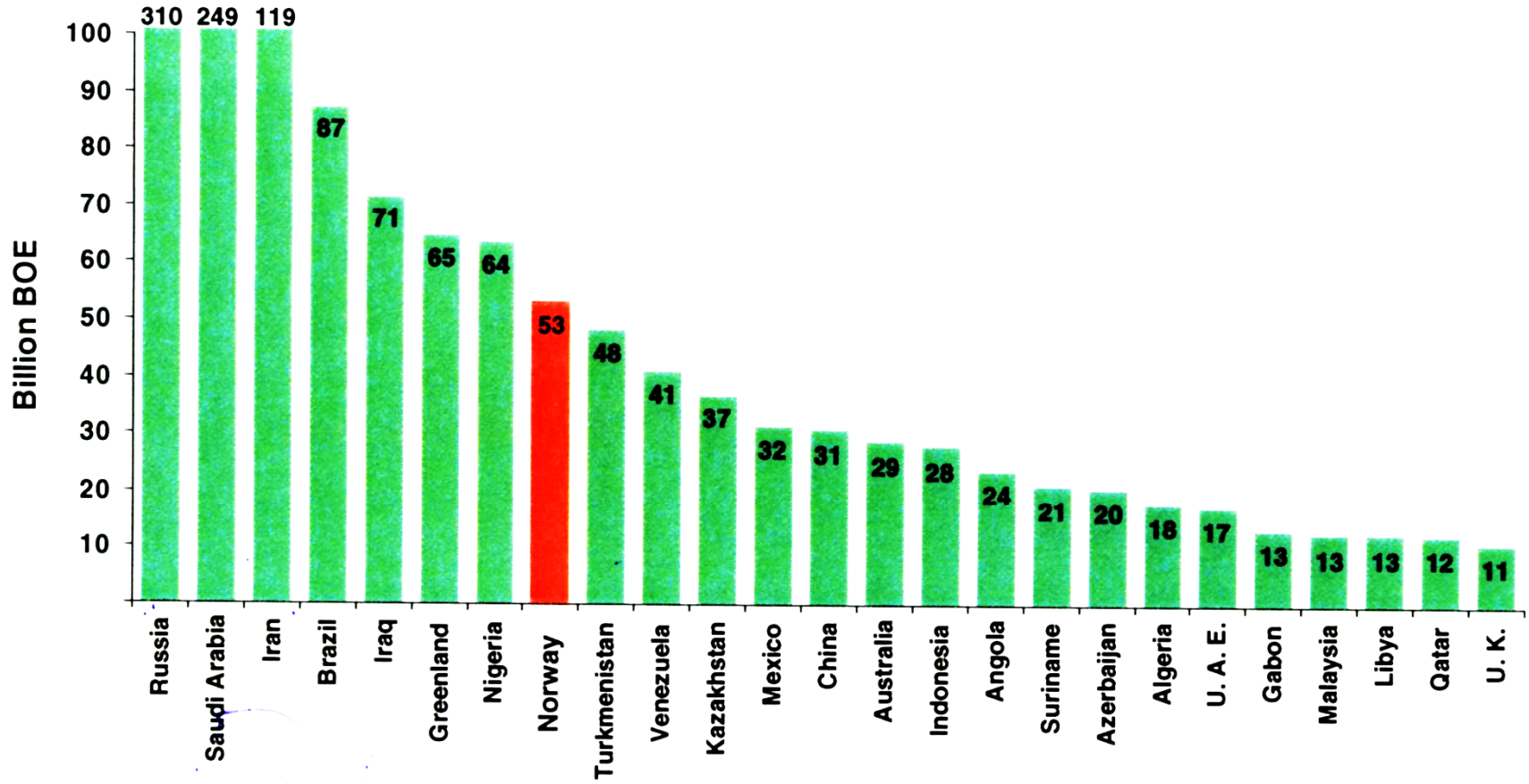
15 largest oil producers sorted by exported volume

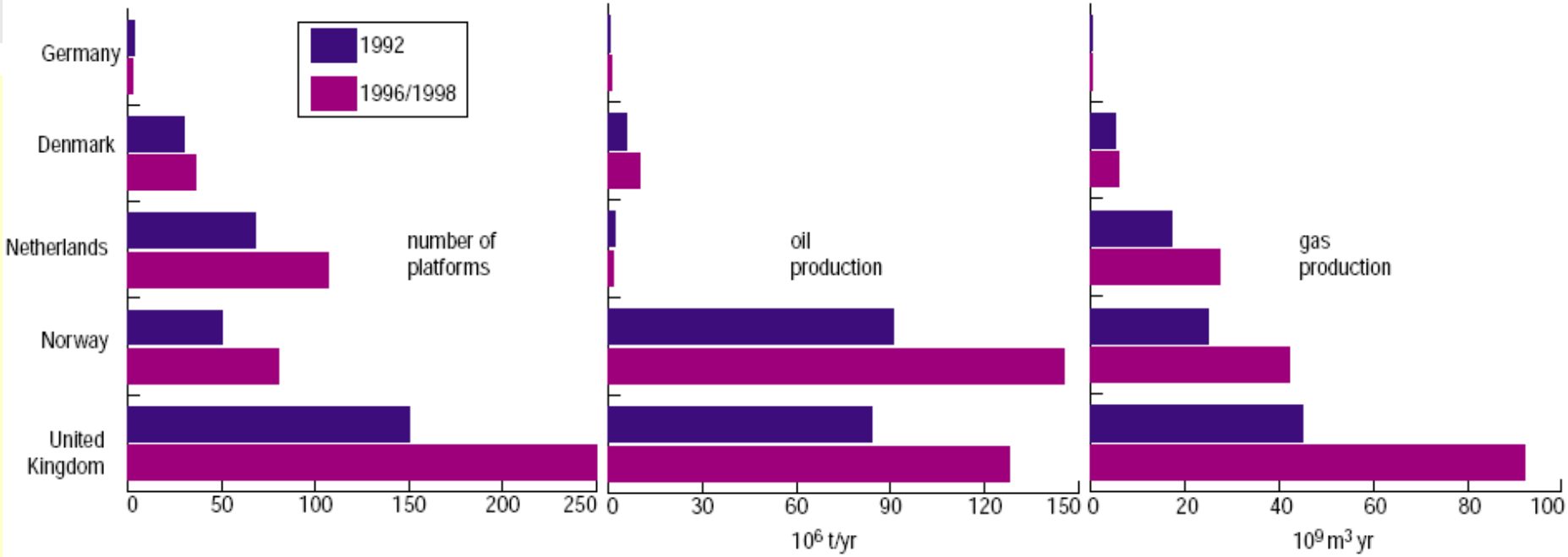


"Top 25 Areas" Undiscovered Resources



Source: US Geological Survey World Petroleum Assessment 2000/ Marathon Oil

3.12 **Comparison of offshore activities in 1990–92 (North Sea Task Force, 1993) with those in 1996–98.**



OECOS

OSPAR Commission

for the Protection of the Marine Environment of the North-East Atlantic

The 1992 OSPAR Convention is the main instrument for the protection of the marine environment of the North-East Atlantic.

It reaches back to the 1972 Oslo Convention on dumping waste at sea and the 1974 Paris Convention on land-based sources of marine pollution.

The OSPAR Commission represents the Governments of 15 contracting States and the European Commission.

One of its main objects is to set ecological standards for the Offshore Oil and Gas Industry.

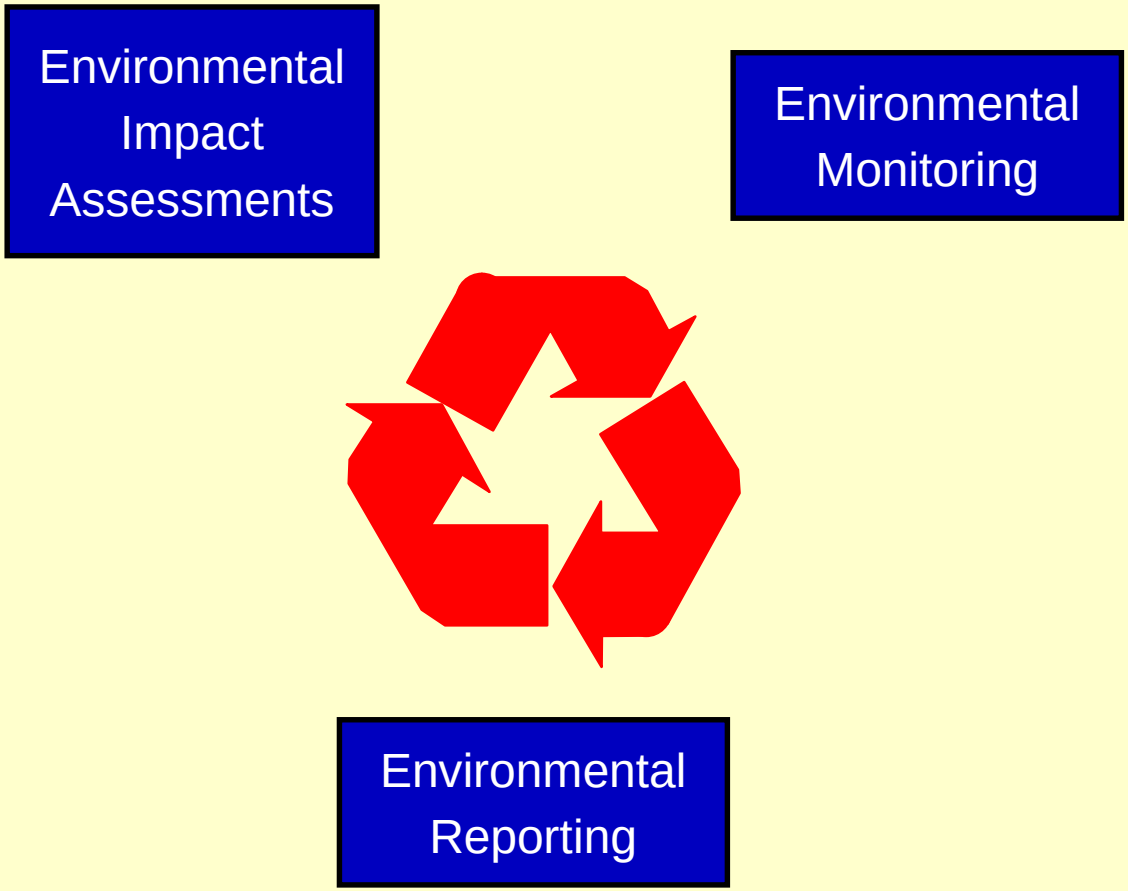
OSPAR-Decisions concerning oil and gas industries

- Obligation for complete disposal of disused offshore installations onshore (Decision 1998/3)
- Interdiction of oil-based drilling fluids (Decision 2000/3)
- Use of organic-phase drilling fluids only by permission (Decision 2000/3)
- Interdiction of offshore-disposal of organic-phase contaminated cuttings, when more than 1 % is contaminated (Decision 2000/3)
- Obligatory control system for the use and the reduction of drilling fluids and produced water. Best available treatment technologies and best environmental practice is mandatory (Decision 2000/3)
- Protection of marine environment, human health and other uses, when carbon dioxide is stored in geological formations (Decision 2007/2).

OSPAR-Recommendations

- Implementation of environmental management systems for offshore-industries, including elements for auditing and reporting, conducted by independent auditors (Recommendation 2003/5)
- Obligation for the contracting partner-states to reduce oil emissions of produced water by a minimum of 15% compared to the equivalent discharge in the year 2000 (Recommendation 2001/1)
- Continous reduction of oil content in produced water beginning from 2002 and, where the achievement of zero discharges of oil contaminated produced water into the sea by new offshore installations (Recommendation 2001/1)
- Interdiction of discharge of produced water into sea, if oil content adds up to 30 mg/l (Recommendation 2001/1)

Environmental assessments, environmental monitoring and reporting



Environmental Education
A part of Petroleum Engineering

Environmental Impact Assessments

Environmental Monitoring

Environmental Education

Environmental Reporting

Environmental Impact Assessments
A part of Petroleum Engineering

Environmental Impact Assessments

EIA is a method to:

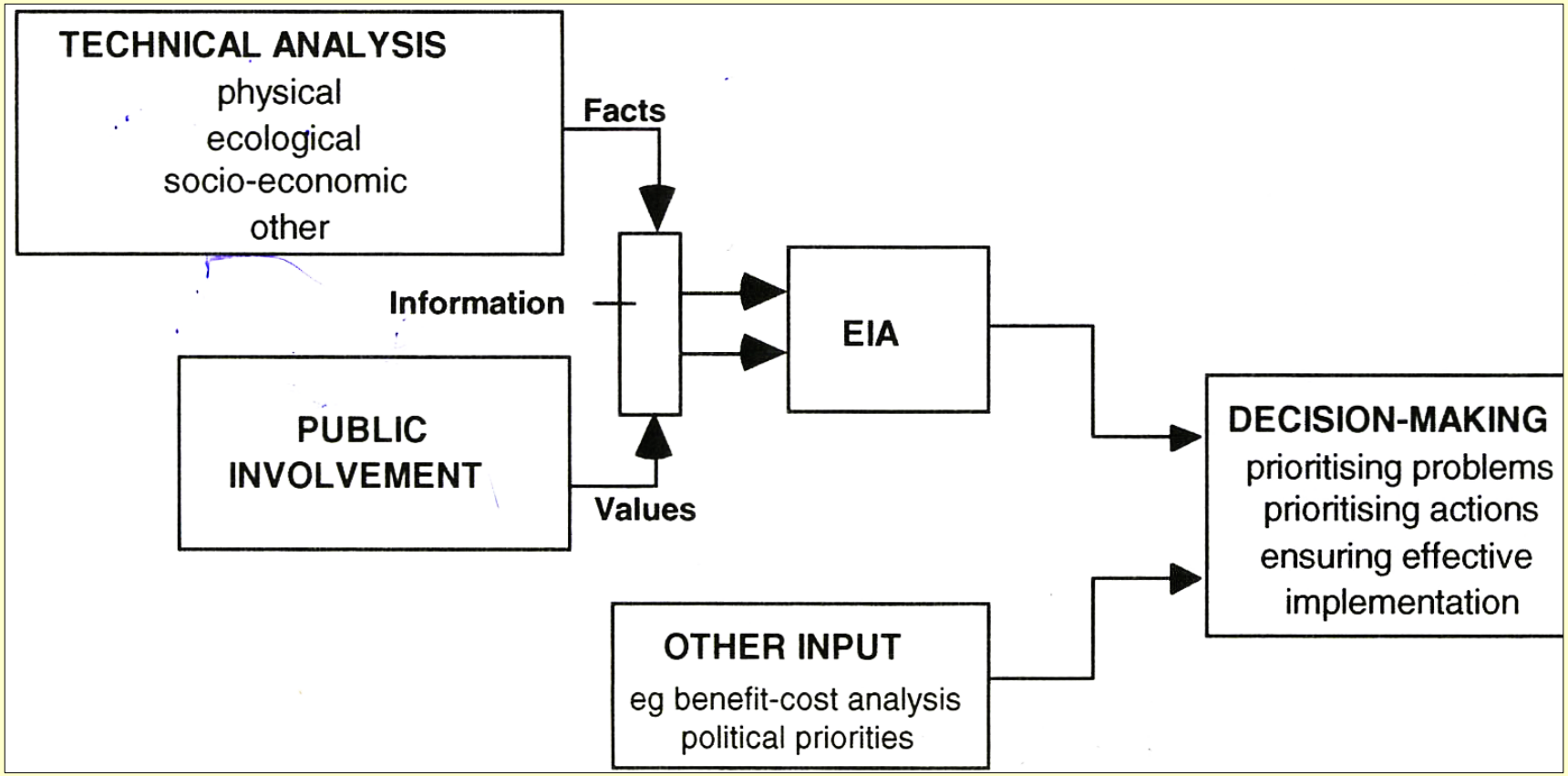
- Identify, predict impacts to the environment, health and the society of a proposed action

- Identify and implement mitigating measures to avoid, reduce or compensate for residual impacts and measures to enhance positive impacts

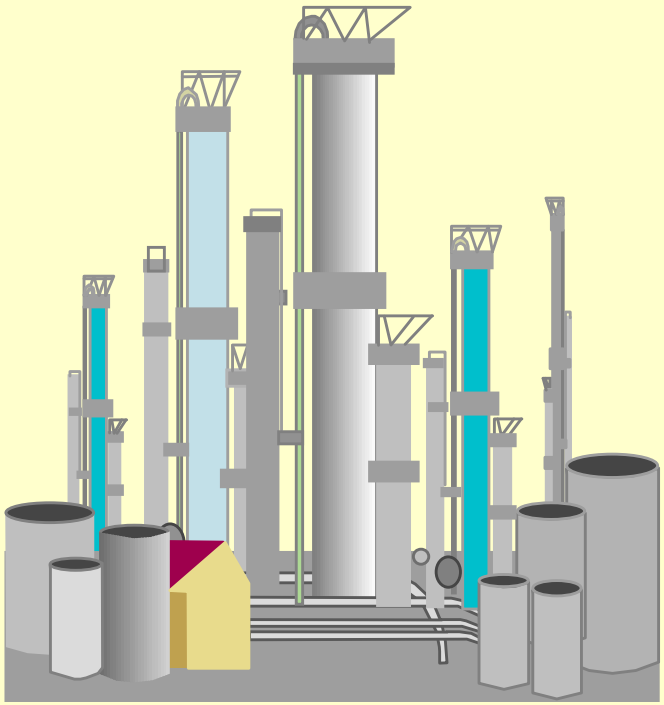
- Communicate this to the decision-makers (company, authorities), stakeholders, affected community and general public to ensure

  - o public participation
  - o good and well informed decisions
  - o risk reduction

Environmental Impact Assessments
A part of Petroleum Engineering



EIA-Procedure in the EC



Scoping process

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Collection of information („Environmental impact statement")

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Review process:
Consultation with other authorities
Participation of other states
Participation of other public

↓

Summary report of Environmental impacts

↓

Assessment of environmental impacts

↓

Consideration of the assessment in the decisionmaking process

EIA-Subjects

In general

- human beings, animals and plants,
- soil, water, air, climate and landscape,
- cultural heritage and other material assets,
- including the respective interactions.

Main aspects of oil and gas field development

- Other uses (f.ex. fishery)
- Air emissions (CO2, VOC, NOx, SOx),
- Produced water handling,
- Soil and groundwater pollution,
- Drilling fluids and cuttings,
- Hazardous waste,
- Accidental oil spills.

Other land- or sea-uses

- Impacts from pipelines and sub sea installations on bottom trawling
- All pipelines shall be overtrawlable and designed to resist any impact from fishing gears
- National programs for GPS-tracking of fishing boats are helpful for designing of protection structures for pipelines
- Meetings to discuss the pipeline routes with the fishery authorities and with the fishermen organisations

Air emissions

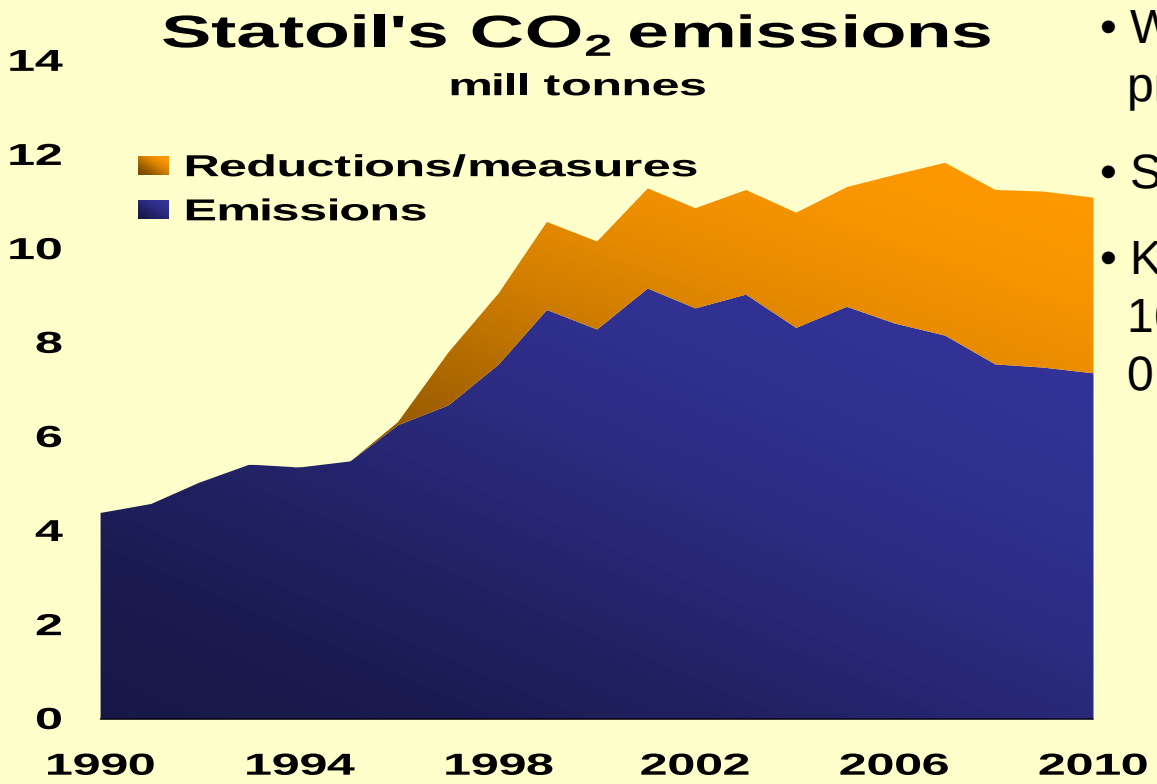
Main sources

- exhaust gas from turbines,
- flare gas (CO_2, NOx, SOx, VOC`s)
- fugitive emissions (CH4 and VOC`s from valves and flanges)

Potential mitigation measures

- Flare gas recovery systems,
- CO2 extraction from gas,
- Low NOx burners in gas turbines,
- Catalytic cleaning of exhaust gas,
- No open pit burning.

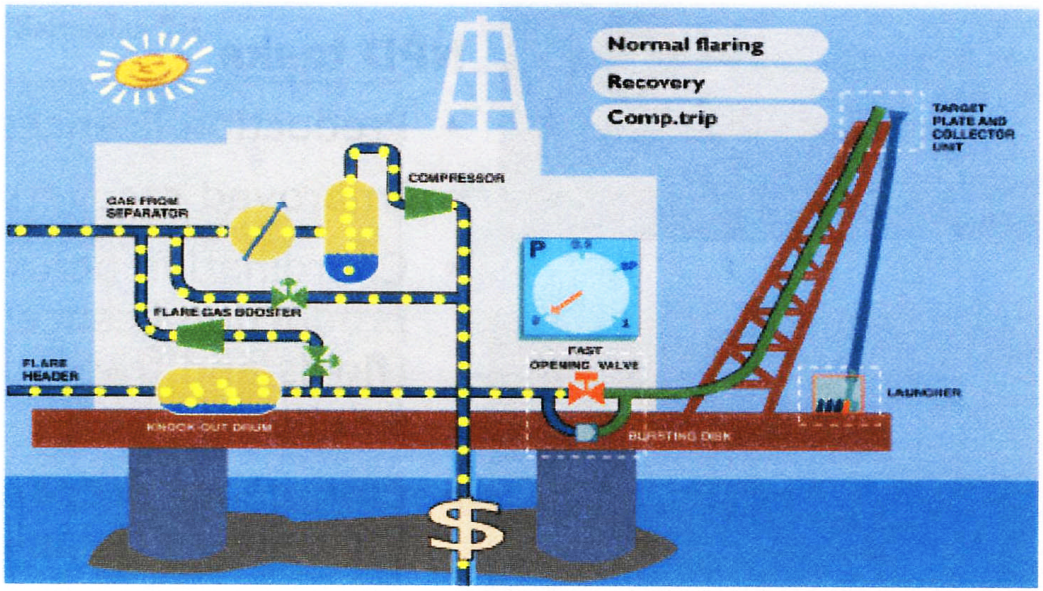
CO_2 emissions



- World average for oil and gas production: 115 kg CO_2 per Sm^3
- Statoil: 30-40 kg CO2 per Sm3
- Kvitebjörn Emissions to air:
  16 kg CO_2 eq./Sm^3
  0.02 kg NOx /Sm^3

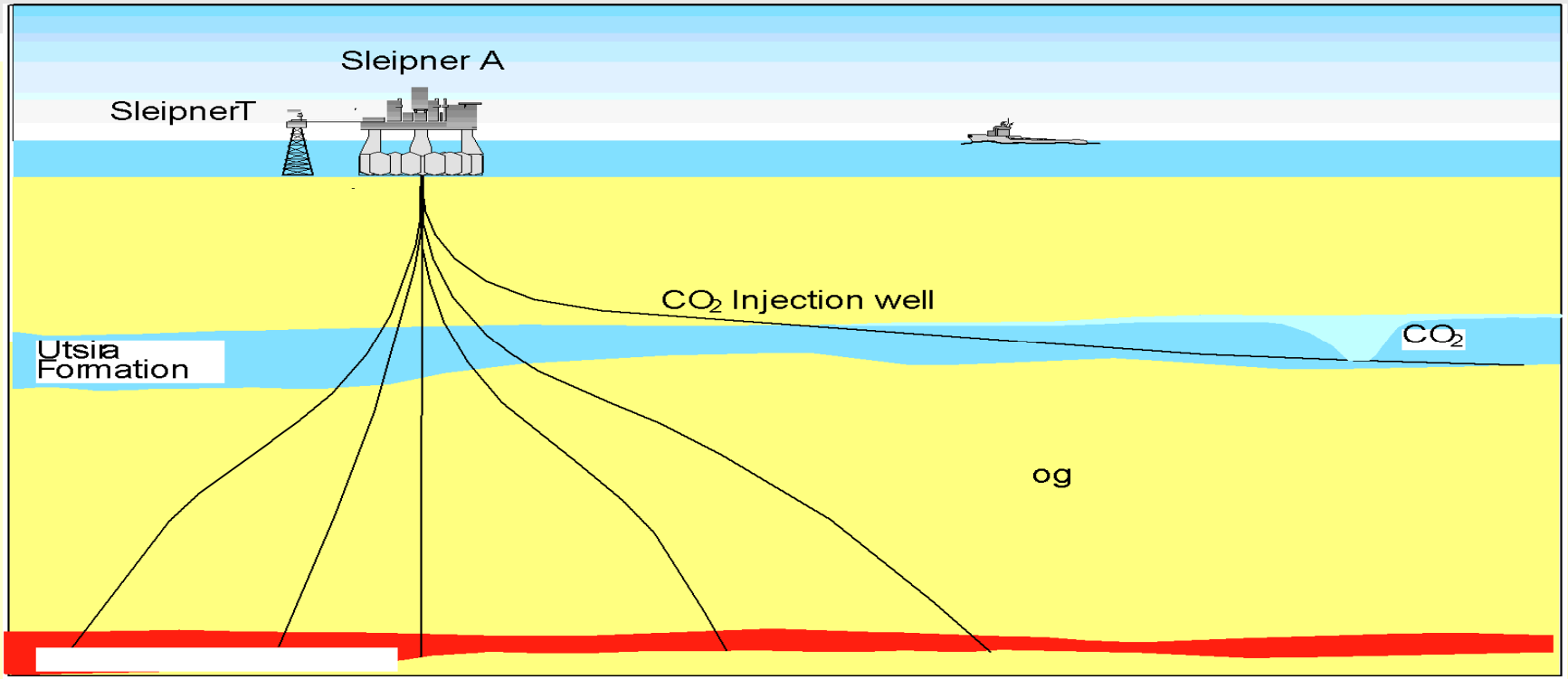
CO_2 and NO_x emissions

Flare Gas Recovery



- Substantial reduction CO_2- and NO_x-emissions.
- Developed on the NCS due to the CO_2-tax.
- Proven technology – installed on several platforms in the North

CO_2 Injection at Sleipner gasfield



- 1 mill. tonne CO_2 per year is separated from ***natural gas*** and injected in deep saline aquifer.
- Reduces CO_2 emission by 13% on the Norwegian Continental Shelf
- In operation since 1996

Produced Water

Potential environmental impacts

- groundwater pollution,
- soil pollution,
- river pollution or sea pollution.

Potential mitigation measures

- Isolation in reservoir or subsea separation,
- Reinjection into active reservoir for pressure support,
- Injection into non-active geological formation for disposal,
- Produced water cleaning and discharge to sea (offshore),
- Disposal into evaporation ponds

Drilling Fluids

Often hazardous

biocides, defoamers, scavengers, descalers, heavy metals and corrosion inhibitors, surfactants, solvents, emulsifiers, thinners and lubricants.

Potential mitigation measures

- Change of harzardous substances against less harmful ones like organic polymers, bentonites and other clays.
- Selection of drilling fluids based on an analysis of toxicity, biodegradation and bioaccumulation.

Accidental oil spills

- European Union requires risk assessment
- The concept is based on the ratio between environmental concentration and a defined tolerance level.
- Educational oil spill exercises are necessary for training purposes.

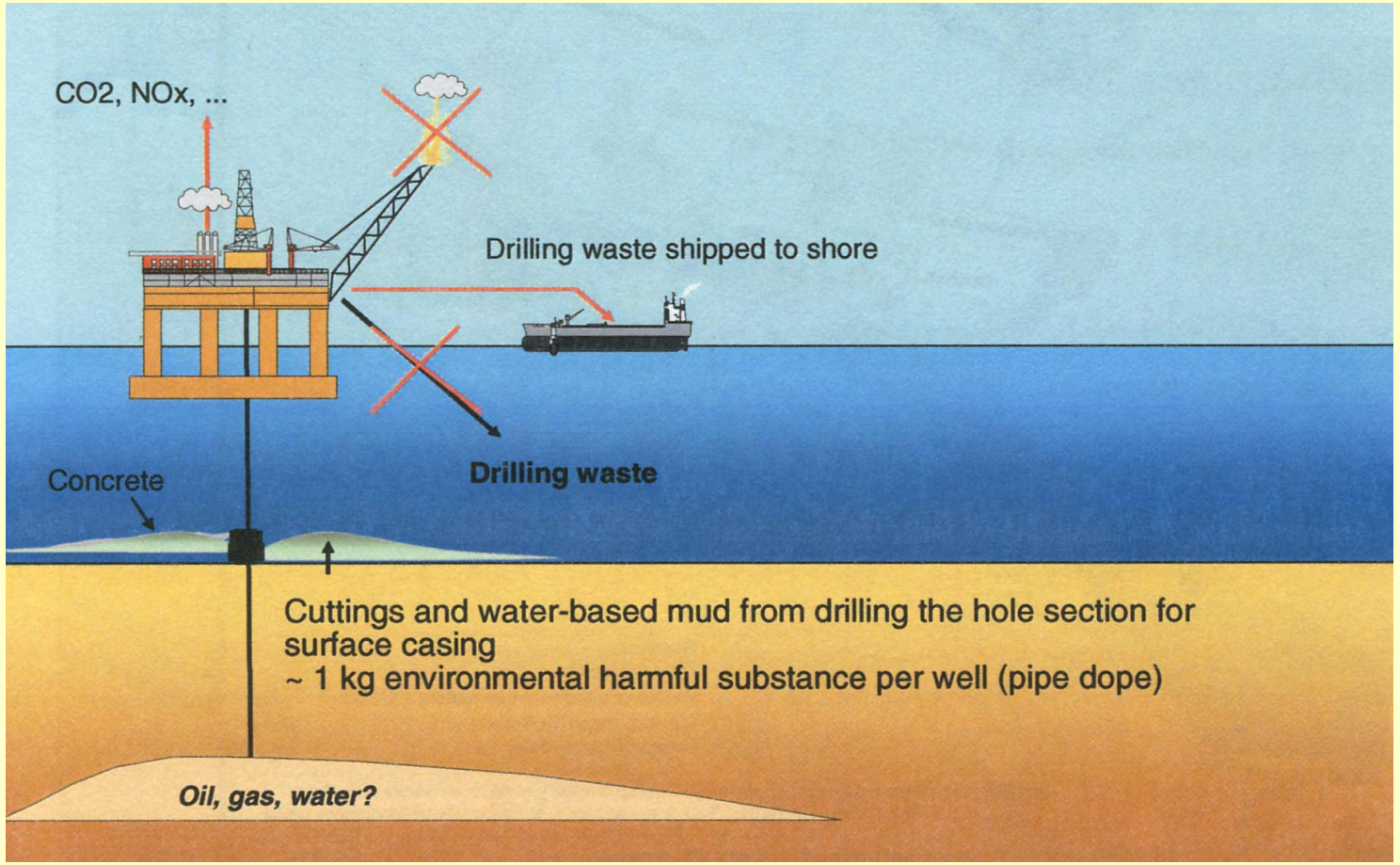
Measures to reduce oil spill risks

- **Continuous educational training to secure correct and quick reactions**
- **Regional contingency analysis and plans: oil spill response system established by state and municipalities, oil drift scenarios**
- **Selection of drilling rigg**
- **Continuous blow out preventer inspection**
- **Extra manning – environmental advisor**

Measures to recover oil on sea

Chemical dispersion by helicopter is not allowed in German waters

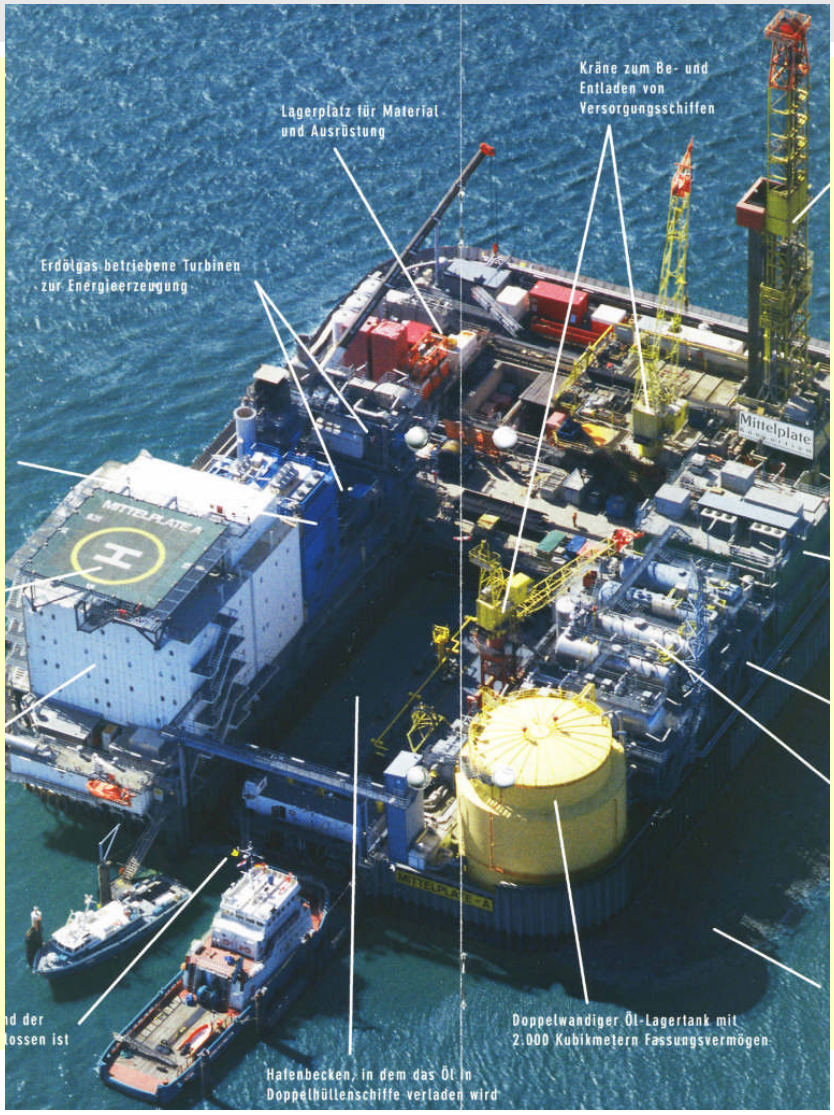
Zero Emission Concepts: Barents Sea



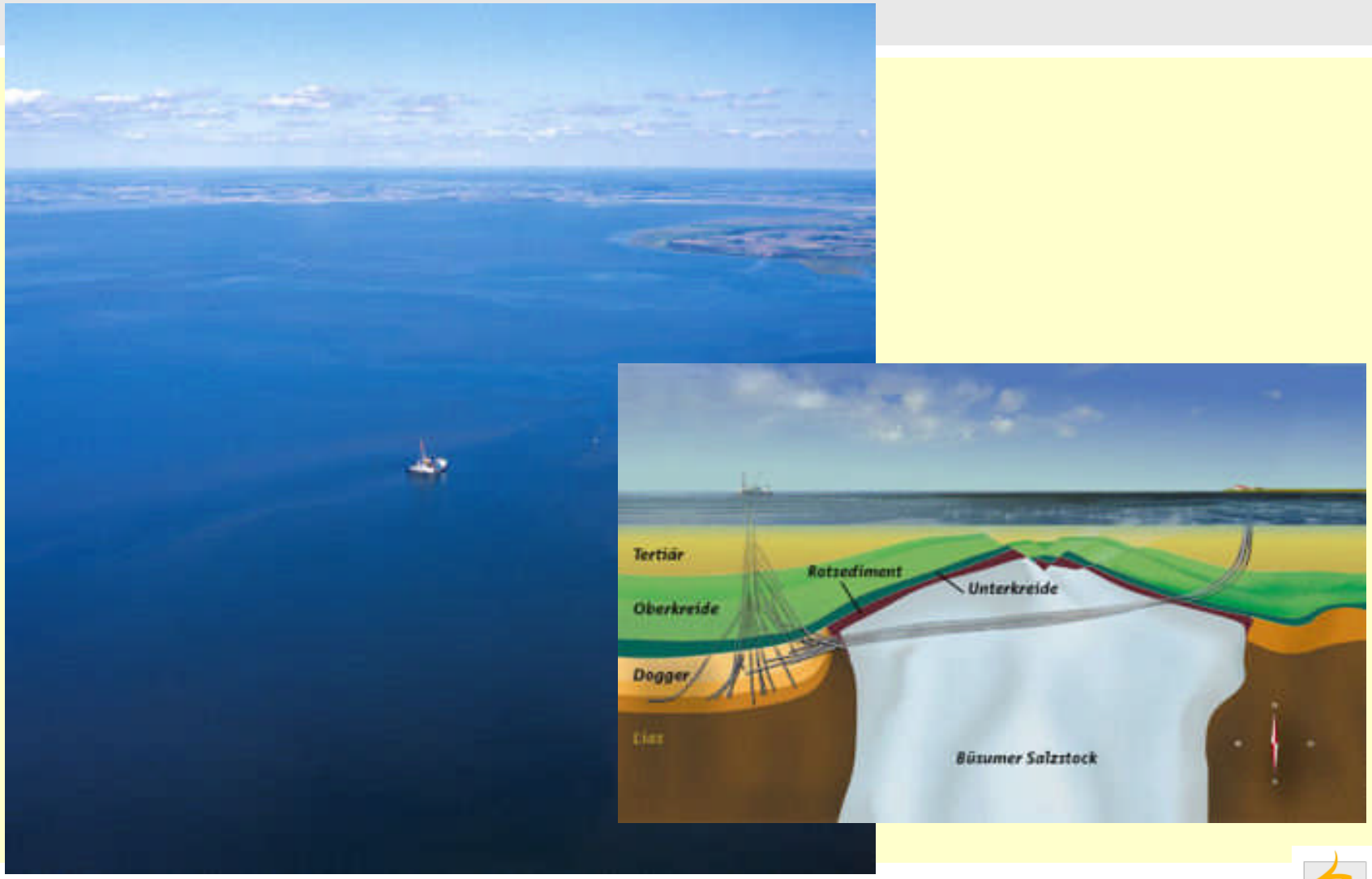
Zero Emission Concepts: Mittelplate

Germanys Near Shore Oil-plattform, situated in a National Park

- Gas driven turbines
- Locked shipgate
- Double coated ships
- Double coated tank
- Oil extractors
- Water cleaner station
- Concrete drilling cellar
- et cetera.



Zero Emission Concepts: Mittelplate



Typical measurements and reporting system at Offshore installations (LEVANG 2006)

- Flare gas and fuel gas flow meter is installed (to calculate CO_2, NOx, VOCs). Fugitive emissions (CH4 and VOCs) are calculated on spot measurements.
- Diesel fuel consumption is measured (to calculate CO_2, NOx, VOC, SO2).
- Produced water flow meter is installed. Daily samples are taken for oil concentration. Heavy metals and aromatics are analysed each 6. month.
- Drain water volume is measured. Sampling for analysis of oil concentration when the drain holding tank is emptied.
- Daily logging of chemical consumption and monthly reporting.
- Accidental spills of oils or chemicals are logged and reported.
- Waste quantities sent ashore are reported monthly.

World Bank Group emission levels Offshore

World Bank Group air emission levels Offshore Oil and Gas Production	**Maximum value** mg/Nm3 (milligrams per normal cubic meter)
Sulphur oxides (oil production)	400
Nitrogen oxides	1000

World Bank Group liquid effluent levels Offshore Oil and Gas Production	**Maximum value**
Oil and grease	42 mg/l (maximum daily average) 29 mg/l (maximum monthly average)
Discharge point for drilling fluids and cuttings	Discharge via a caisson at least 15 m below sea surface
Chloride concentration in water based drilling fluids and cuttings.	Max. chloride concentration less than 4 times ambient concentration of fresh/brackish receiving water.
Metals in barite	Barite used will meet Hg < 1 mg/kg and Cd < 3 mg/kg dry weight (total).
Cooling water temperature increase	< 3 degrees C at the edge of mixing zone (alternative 100 m from discharge point)

World Bank Group emission levels Onshore – Air emissions

World Bank Group air emission levels Onshore Oil and Gas Production	**Maximum value** mg/Nm3 (milligrams per normal cubic meter, unless other specified)
VOCs, including benzene	20
Hydrogen sulphide	30
Sulphur oxides (for oil production)	1000
Nitrogen oxides - Gas fired - Oil fired	 320 (or 86 nanograms per joule) 460 (or 130 nanograms per joule)

World Bank Group emission levels Onshore – Effluent levels

World Bank Group liquid effluent levels Onshore Oil and Gas Production	Maximum value
pH	6-9
BOD	50 mg/l
TSS	50 mg/l
Oil and grease	20 mg/l (up to 40 mg/l is acceptable for facilities producing less than 10 000 tons per day)
Phenol	1 mg/l
Sulphide	1 mg/l
Total toxic metals (toxic metals include antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, vanadium and zinc).	5 mg/l
Temperature increase	< 3 degrees C at the edge of the mixing zone (or 100 meters from the discharge point)

Monitoring Programmes and ISO 14001

- **Monitoring is at best integrated in an *environmental management system* according to the international standard ISO 14001.**
- **An environmental management system secures *continuous reporting* of the environmental state and *continuous improvement of precautional actions*.**
- **Following OSPAR Recommendation 2003/5 many oil- and gas companies establish an environmental management system on oil- and gasfields as a standard.**

Environmental Management System based on the International Standard ISO 14001

Policy

- Environmental policy is stated by top management and implemented at all organization levels.

Planning, implementation and operation

- Environmental aspects are identified
- Environmental targets are set up incl. activities to reach targets.
- Mitigation/control measures are taken
- Responsibilities, training and documentation are fixed.

Checking and corrective action

- Monitoring and measurement.
- Corrective and preventive action.
- Reporting system.

Management review

Inventory of resting birds and bird migration

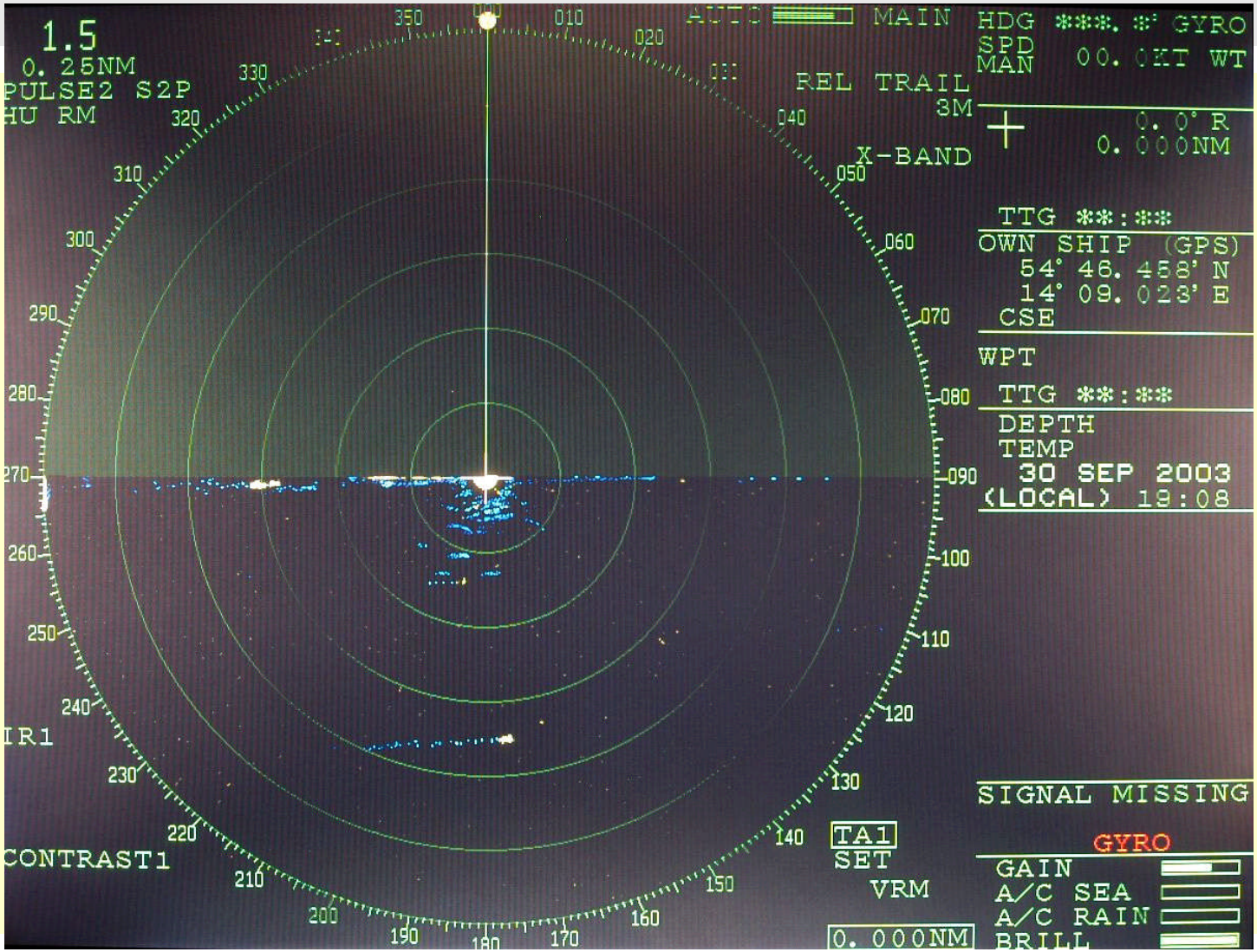
- Is the area a natural habitat for migratory and resting birds?
- How extensive is the disturbance effect on the birds?
- Will there be an attraction by signal lights?
- Is there a risk of collision?

- > survey the populations by watching (ship + aircraft), x-ray

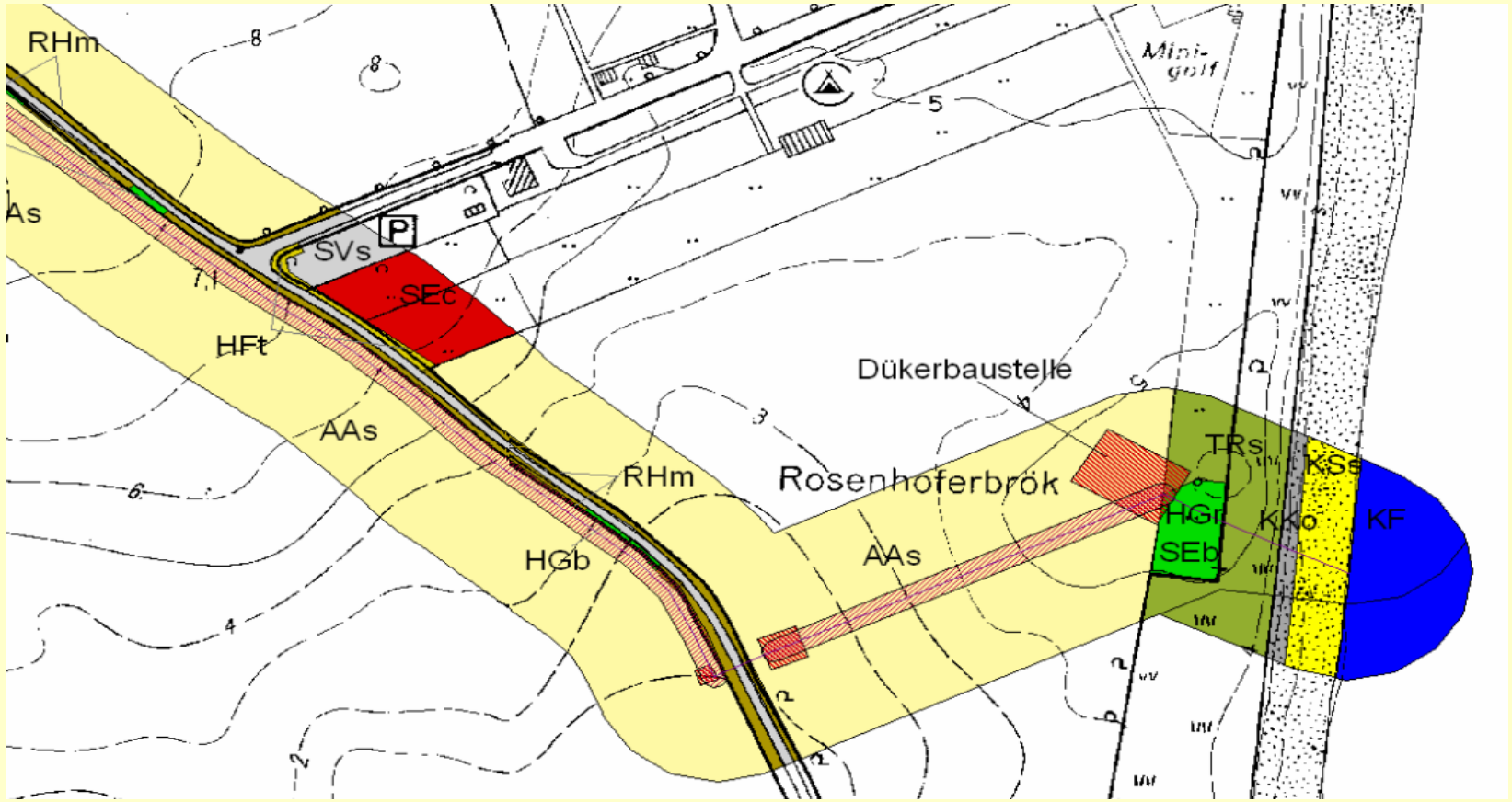
  > statistical analyses of the distribution in space and time

  > assessment of impacts of the construction

Inventory of bird migration



Power Grid and Pipelines



Inventory of sea mammals

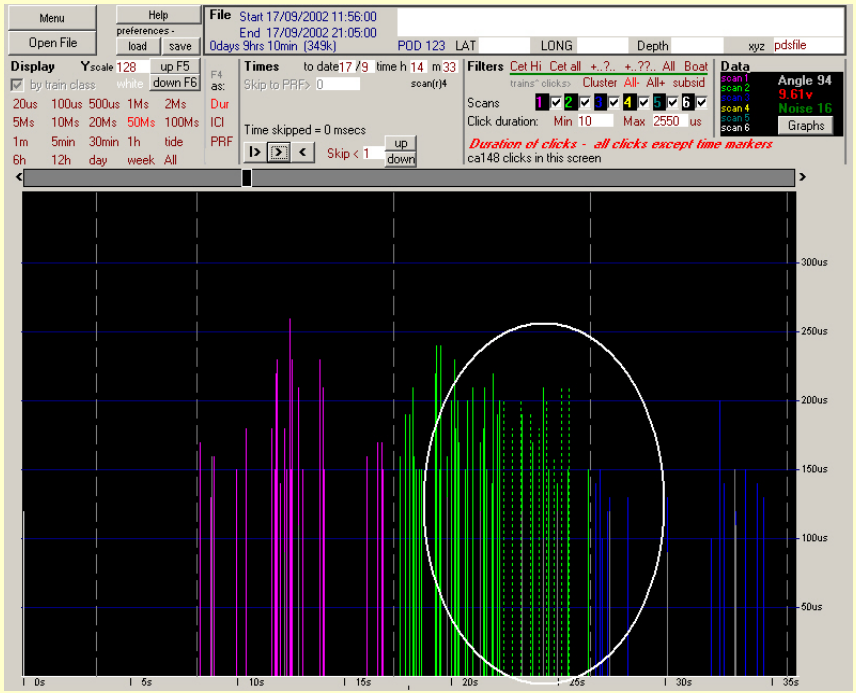
- Are there any porpoises or seals in the region?

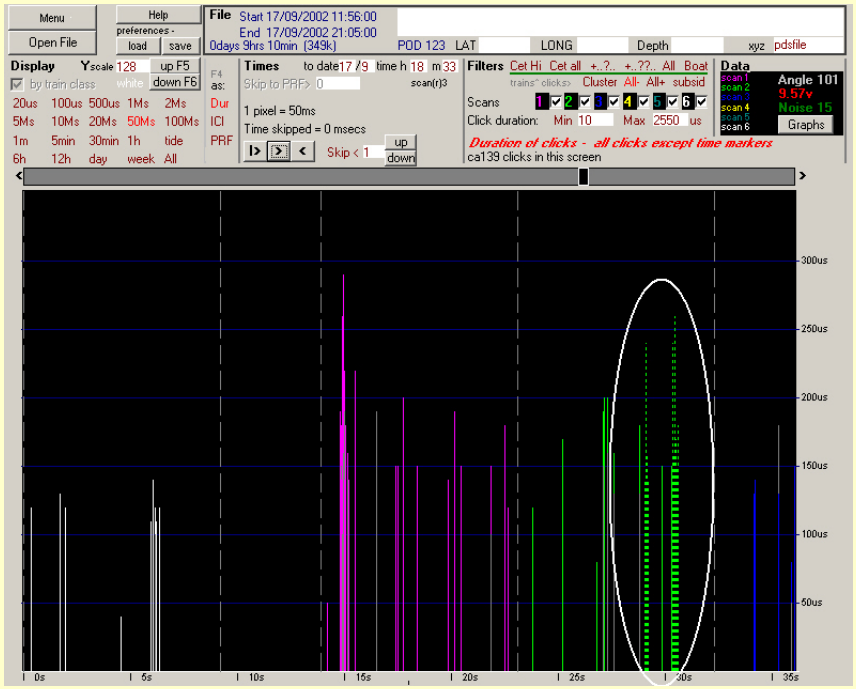
> survey the populations using today‘s technology (PODS)

> statistical analyses of the distribution in space and time

> assessment of impacts of the construction

Inventory of sea mammals





Inventory of fish habitats

- Will the turbine foundations attract fish?
- Will fishing in the area be attractive?
- Are there any tracks of migrating fish?

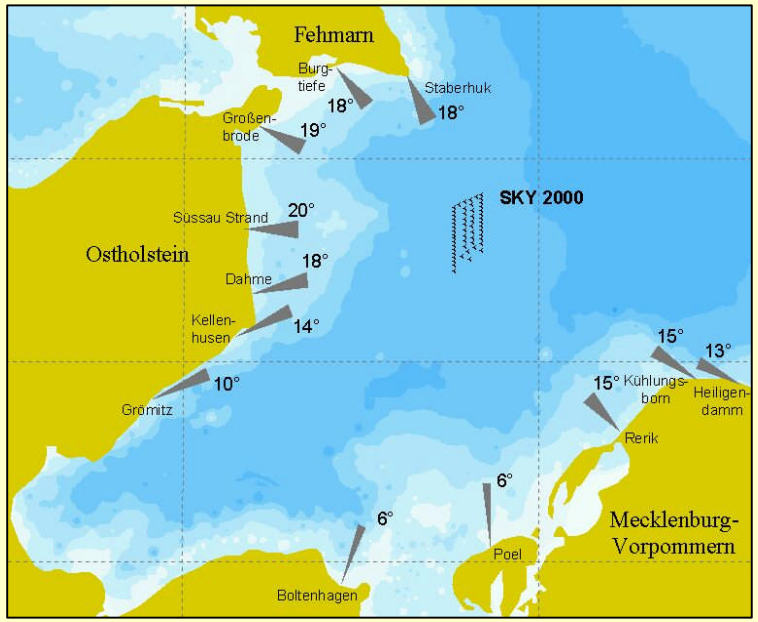
> survey with special equipment (net)

> statistical analyses of the distribution in space and time

> assessment of impacts of the construction

Criterias for visual impact identification

- important landscape areas, sensitivity of the landscape
- tourism at coastal areas
- height, width, colour, shape, pattern of buildings,
- distances,
- lights,
- typical weather conditions,
- visualisation of offshore buildings
- potential for compensation



Environmental Risk Analysis