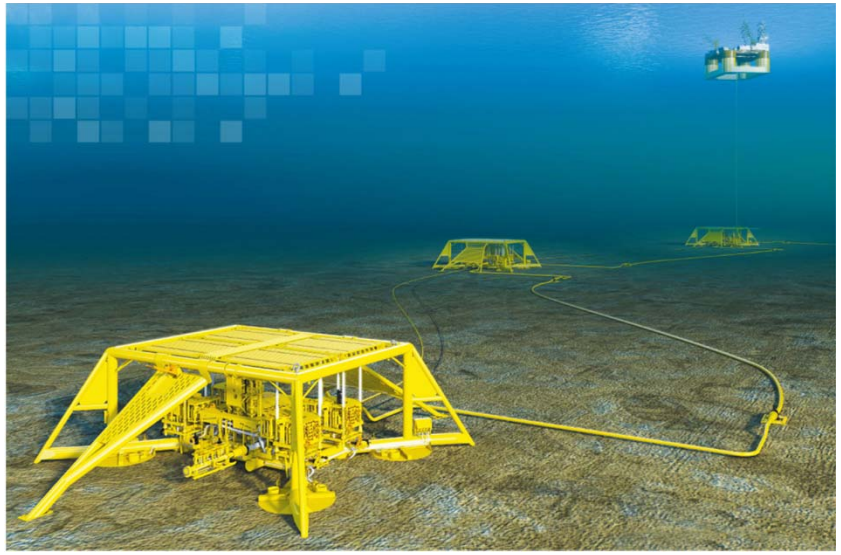
OG21 TTA4 REPORT
SUBSEA COST REDUCTION

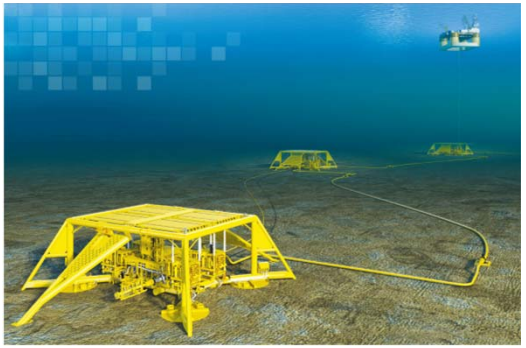
April 24th 2015

OUTLINE



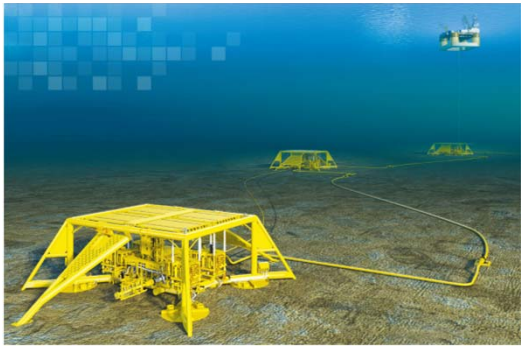
- Introduction
- Study task and scope
- Executive summary
- NCS cost data: general
- NCS cost data: development within Subsea segment
- Outside scope: Non-technical cost drivers
- Technology related measures with cost saving potential
- Expectations to key players
- Subsea cost reduction targets: 3-5 year perspective

INTRODUCTION



- Industry benchmarks show a tremendous increase in oil and gas field development cost over the last decade. Taking into account volatility in oil prices, this seriously challenges industry profitability short term. The consequence is that several new field development projects worldwide are not sanctioned according to plan, but rather put on hold or delayed with a need for revisit of development concepts and solutions requiring significant cost reductions
- Acknowledging the fact that the entire industry has to change, each party need to start with themselves. Simplification in how we work is a major part of this effort. How projects are specified, how operators and system suppliers relay technical requirements, and the extent of such requirements, is a part of the solution. So are ground-up field development and the way operators work and interact with suppliers. Standardization is another key element, mistaken by some as a reason for not implementing new technology. On the contrary, the present industry challenge cannot be met without new cost reducing technologies. Such technologies would need to have potential for widespread implementation throughout the industry, rather than being special solutions for single projects. Seeking to develop next generation standard technologies requires a holistic approach to technology development including qualification. At the same time, detailed knowledge and specialist competence is pivotal when simplifying technical solutions and creating smart new ones. Through future standard interfaces, it will become easier for new innovative solutions, also from smaller companies, to be integrated into larger system solutions.
- Previously, main focus of new technologies was to increase capabilities rather than reducing cost. The shift seen today is that we need to chase cost reduction first, or highlighting substantial cost reduction as a secondary effect of capability enhancing technologies. Innovation capability in academia, research institutes as well as supplier industry should be activated and focus on solutions on this industry challenge in close cooperation with operators.
- To realize the full potential of ongoing technology developments, it is vital to understand how the technology fits in the bigger picture and impact bottom line cost. The challenge is out there for all to innovate and understand how you can impact industry with cost reducing technology and competence.
- There has never been a better time for good ideas.

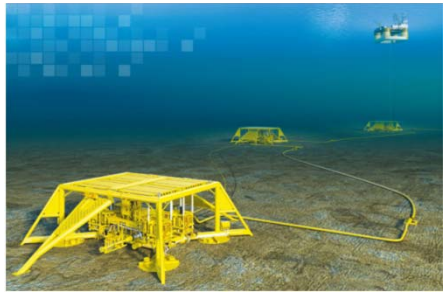
STUDY TASK AND SCOPE



- OG21 has its mandate from the Norwegian Ministry of Petroleum and Energy to develop and assist in implementing a national petroleum technology strategy for Norway
- The OG21 Board has challenged its technology group on Future technologies for production, processing and transportation (TTA4) to identify and evaluate technology related opportunities within the Subsea segment that could significantly reduce costs on the NCS over the next 3-5 years
- This report summarizes the work performed

- Scope:
  - OG21 Board scope question:
    - What technology related measures can be taken within the subsea segment to reduce cost with 50% during the next 3-5 years?
  - Both work processes and individual technologies with cost saving potential should be treated
  - Total system cost including split topside/subsea
- Outside scope:
  - Reduction of costs through reduction of activity level
  - Commercial models, terms and conditions in subsea contracts

EXECUTIVE SUMMARY (1:2)

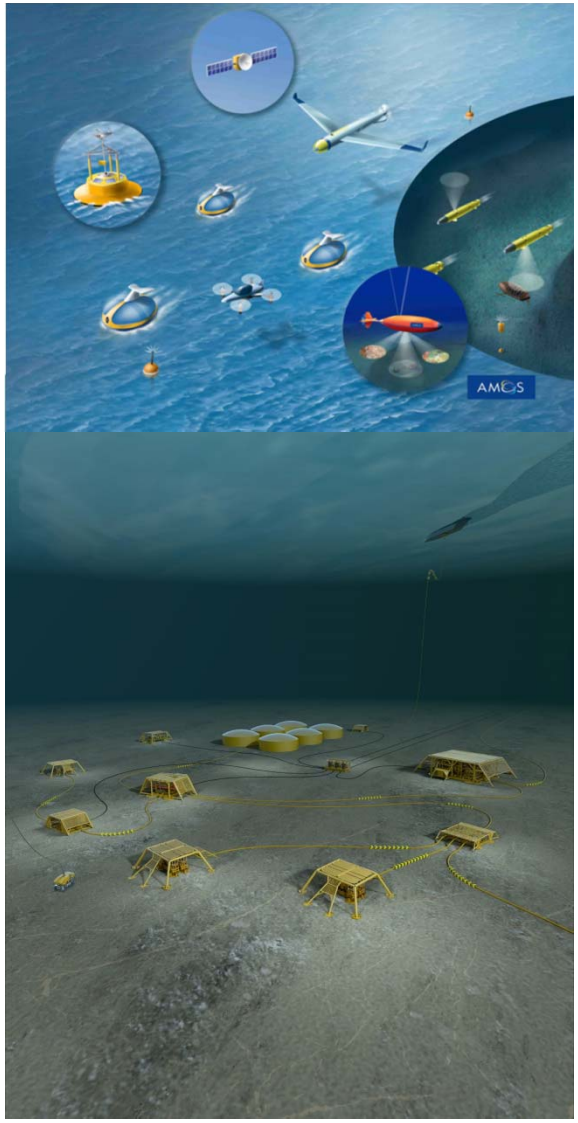


- This report provides data highlighting the cost challenge in the oil and gas industry in general and the subsea segment in particular. Trends and specific examples of inflation within the industry are shown. Comparing historical development of both activity level and cost within the subsea segment, a subsea index is constructed. In average, the subsea index grew 17.5% annually from 2005 to 2013. Hence, subsea cost have tripled in this period. Cost breakdown within the subsea segment is also presented.
- Solutions to meet the cost challenge are presented addressing key issues both in terms of work processes as well as new technology. All items presented are technology related, and focus is kept on relatively short-term effects.
- Some of the presented measures are oriented towards enabling suppliers to keep stock of core products to optimize own production. This save cost, but also enables suppliers to deliver products in a swift manner, reducing lead-times which could affect decision processes on system level.
- Some of the excessive cost within the subsea segment could be classified as “not value adding” to the product or service needed. A critical evaluation of such cost elements have been performed and recommendations given to some of the key elements within this category.
- Specific technologies with high potential for reducing subsea cost short-term are provided. For each, the rationale for the technologies chosen, key qualification elements, and responsibility for realizing the business potential is given. Importance of competence is highlighted though emphasis on ground-up field development, i.e. reservoir dictating well locations, drainage strategy etc., making subsea facilities a consequence of subsurface needs. Simplifying field developments starting with lean concepts require both a holistic view going across disciplines, as well as early involvement of specialist competence within each discipline.
- Subsea cost reduction targets of more than 50% is given in this report with an implementation perspective of 3-5 years. Only through collaboration would industry be able to fully meet this cost reduction target.
- Expectations to key players on how they should contribute are given: Authorities, Academia, Research institutes, Suppliers and Operators.

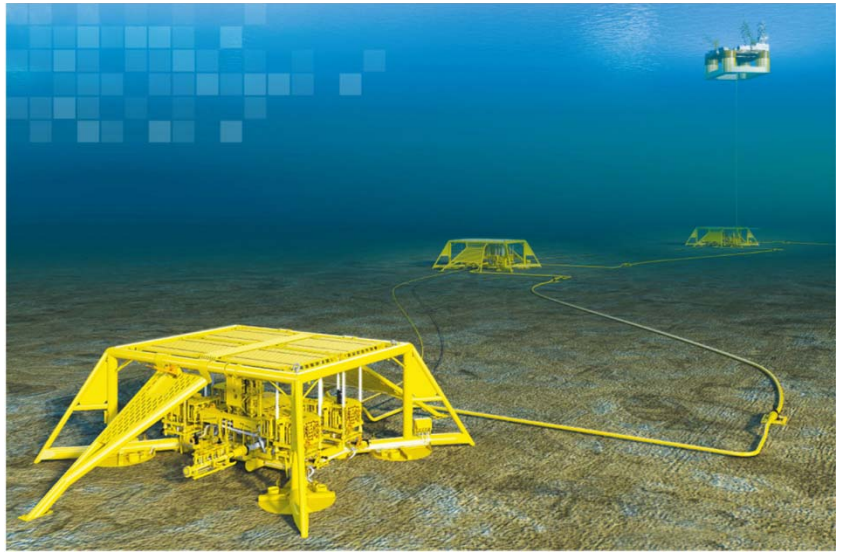
EXECUTIVE SUMMARY (2:2)

Solutions presented are the following

- Reduce complexity
- Simplify qualification
- Standardization and industrialization
  - Standard subsea modules and open interfaces
  - Simplify subsea documentation
  - Standard material specification
- Increase efficiency of marine operations
- Reduce cost of inspection, maintenance and repair
- Specific subsea technologies reducing cost:
  - Simplified satellite system: Single well solution
  - Simplified subsea power conversion and distribution
  - Simplified subsea communication and control power
  - Subsea storage
  - Simplified subsea boosting
  - All electric subsea system
  - Subsea processing system solutions
- Lean subsea concepts



OUTLINE



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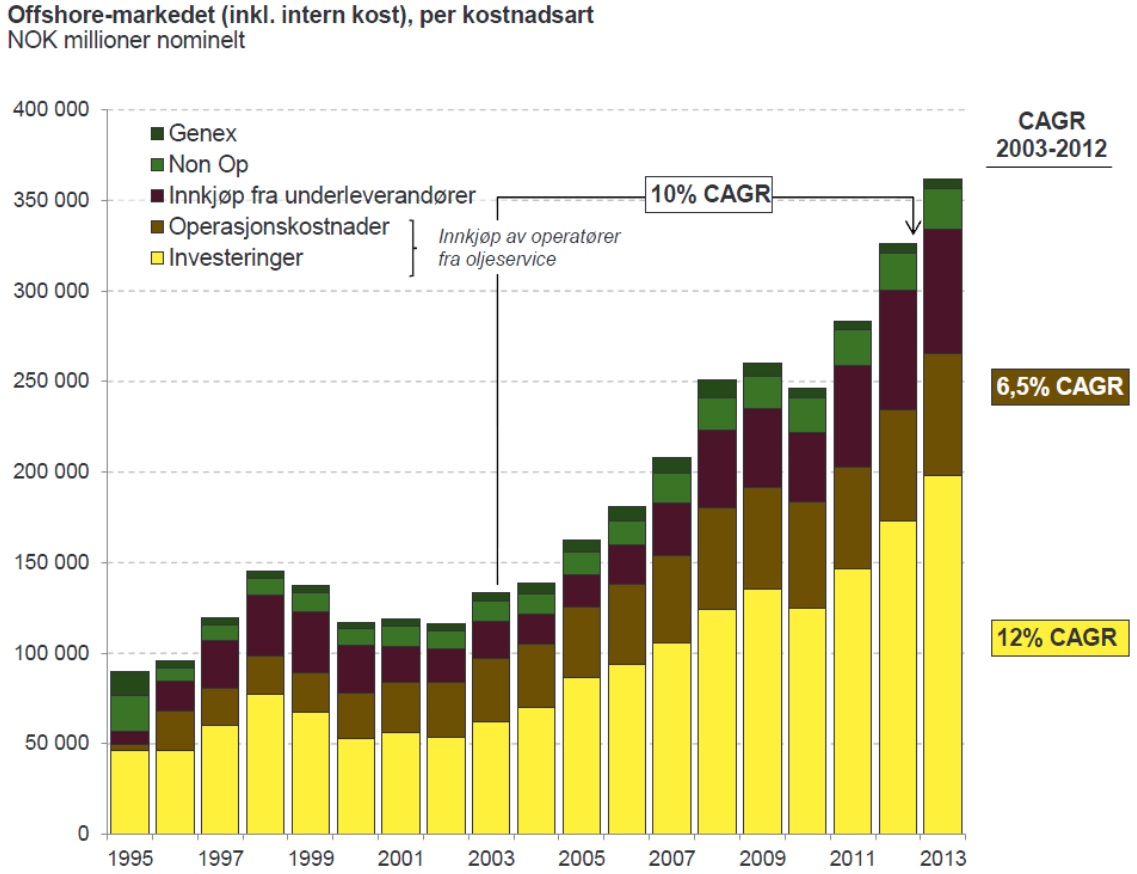
SIGNIFICANT INCREASE IN INVESTMENTS COMPARED TO ACTIVITY INCREASE

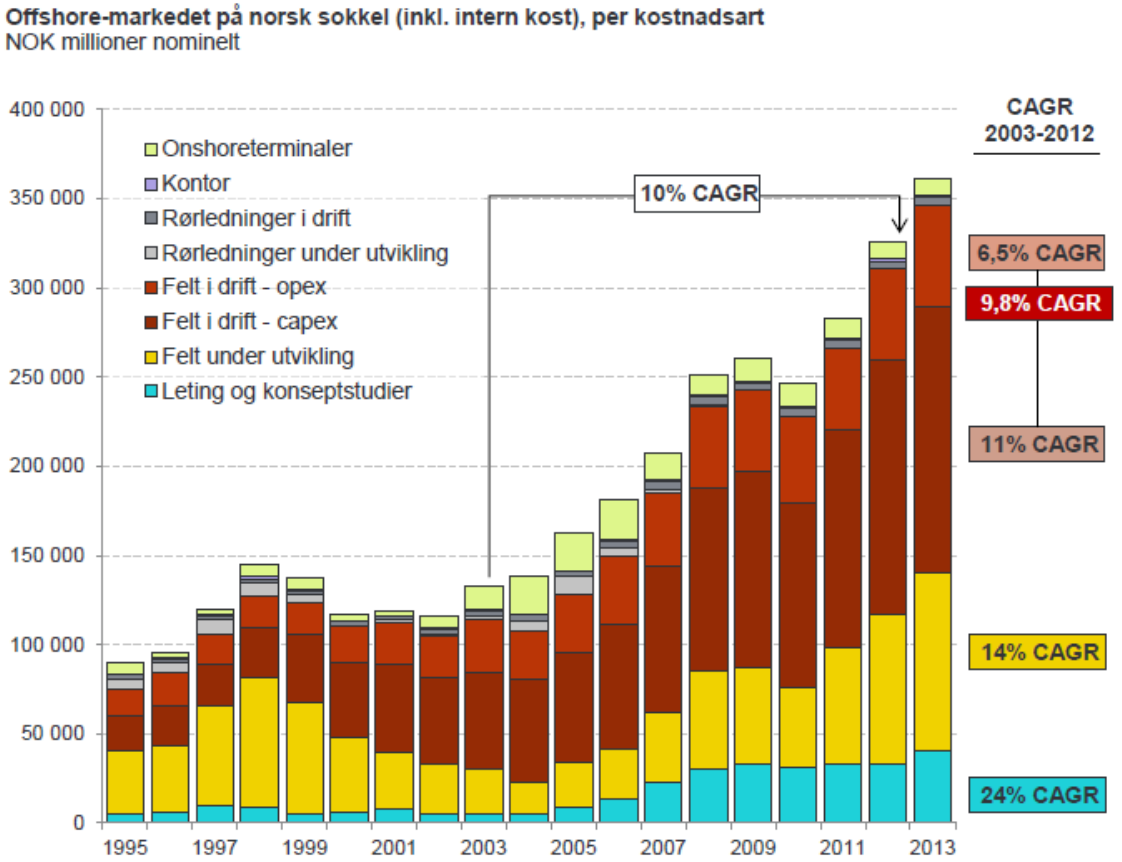


2003-2012:

- Investments : 12% annual increase
- Operational cost: 6.5% annual increase
- 10% annual increase in total, while activity increase is less (reflected in operational cost)

Source: OG21, Rystad Energy

COST EXCEED GENERAL ACTIVITY INCREASE IN ALL PHASES OF THE ASSET LIFECYCLE

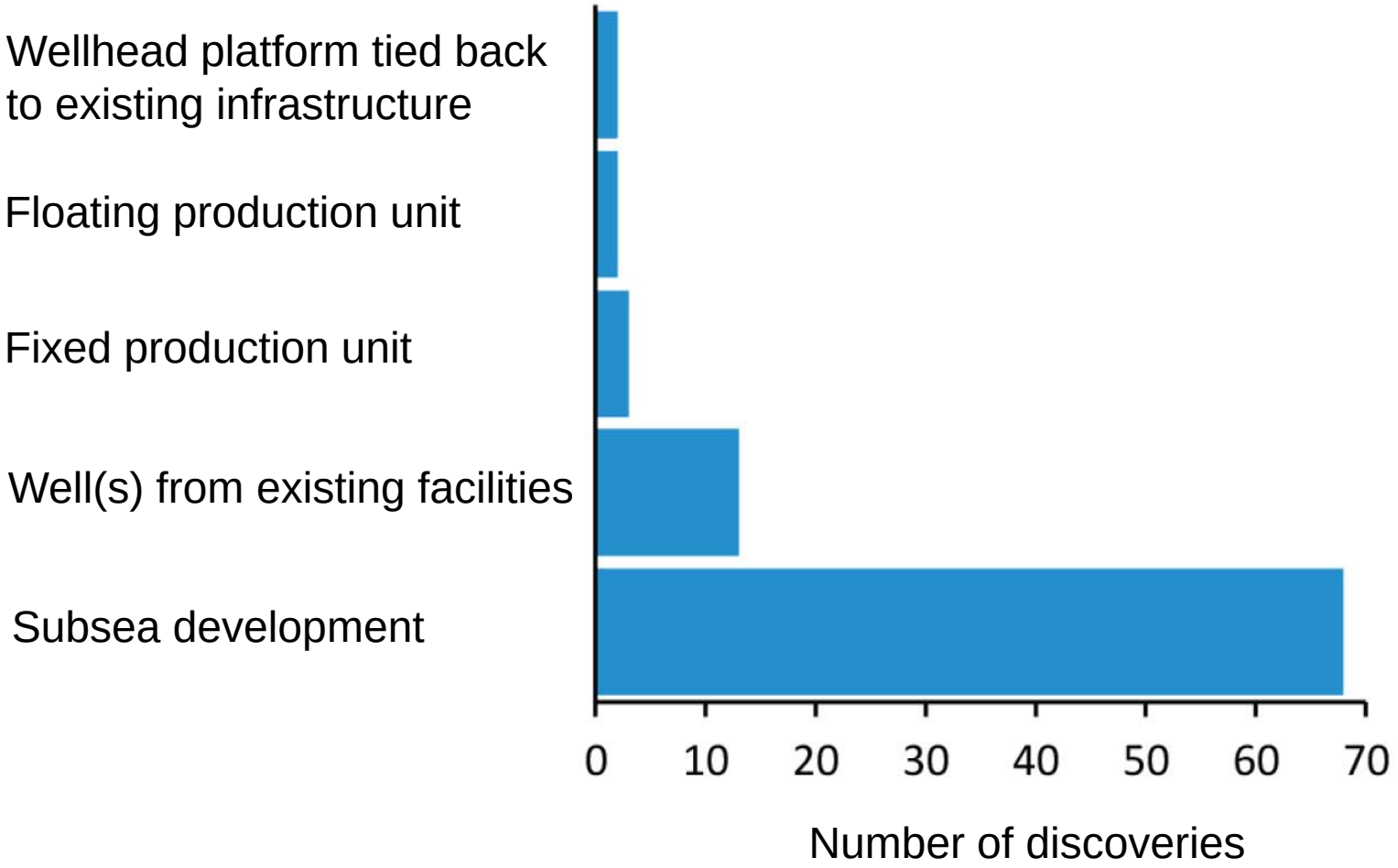


- Producing fields: 10% annual increase
- Fields under development: 14% annual increase
- Exploration and concept studies: 24% annual increase

Source: OG21, Rystad Energy

OD: Petroleumsressursene på norsk kontinentalsokkel 2014 - Felt og funn

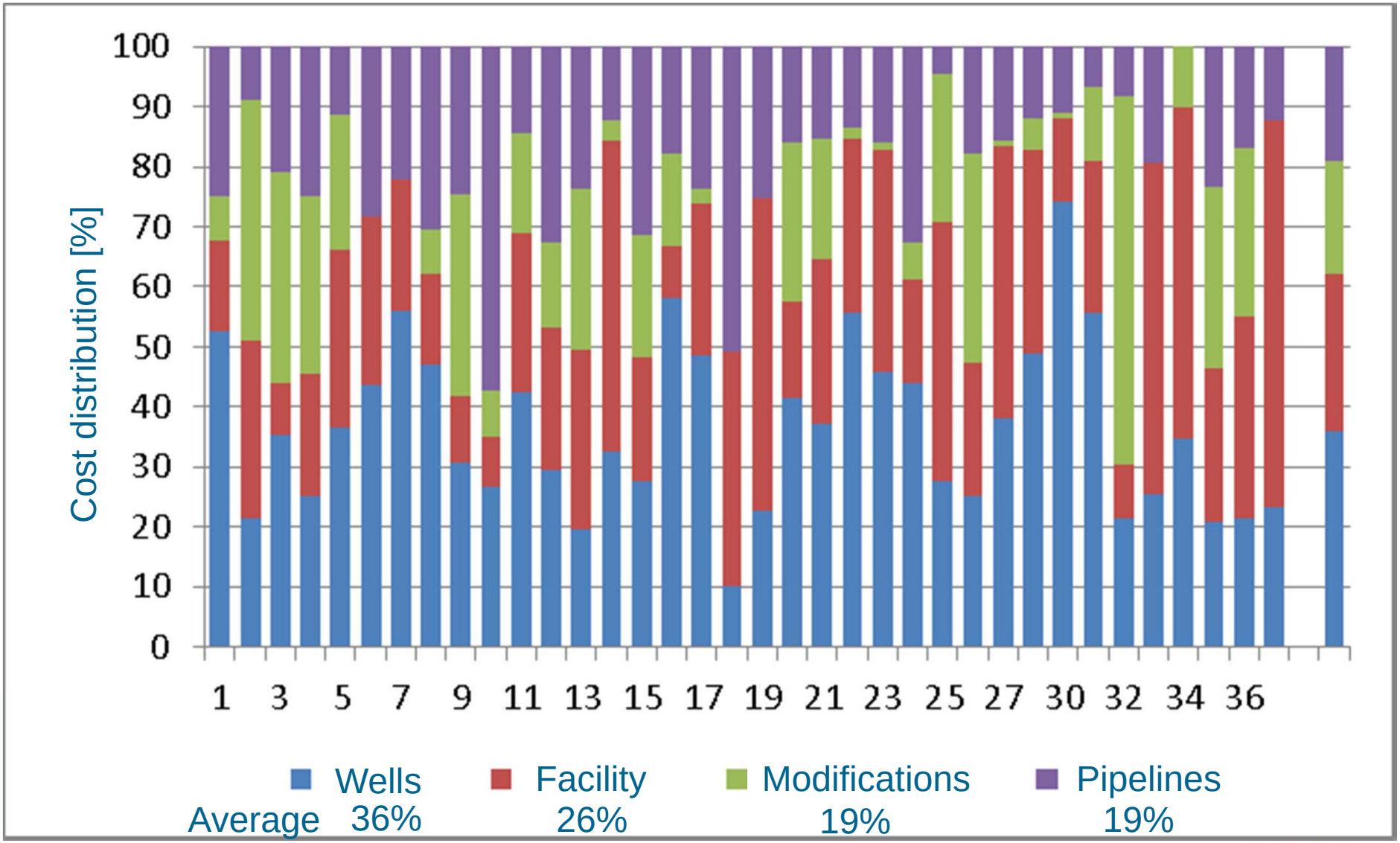
PRESUMED FIELD DEVELOPMENT SOLUTION FOR DISCOVERIES: 88 DISCOVERIES BY THE END OF 2013



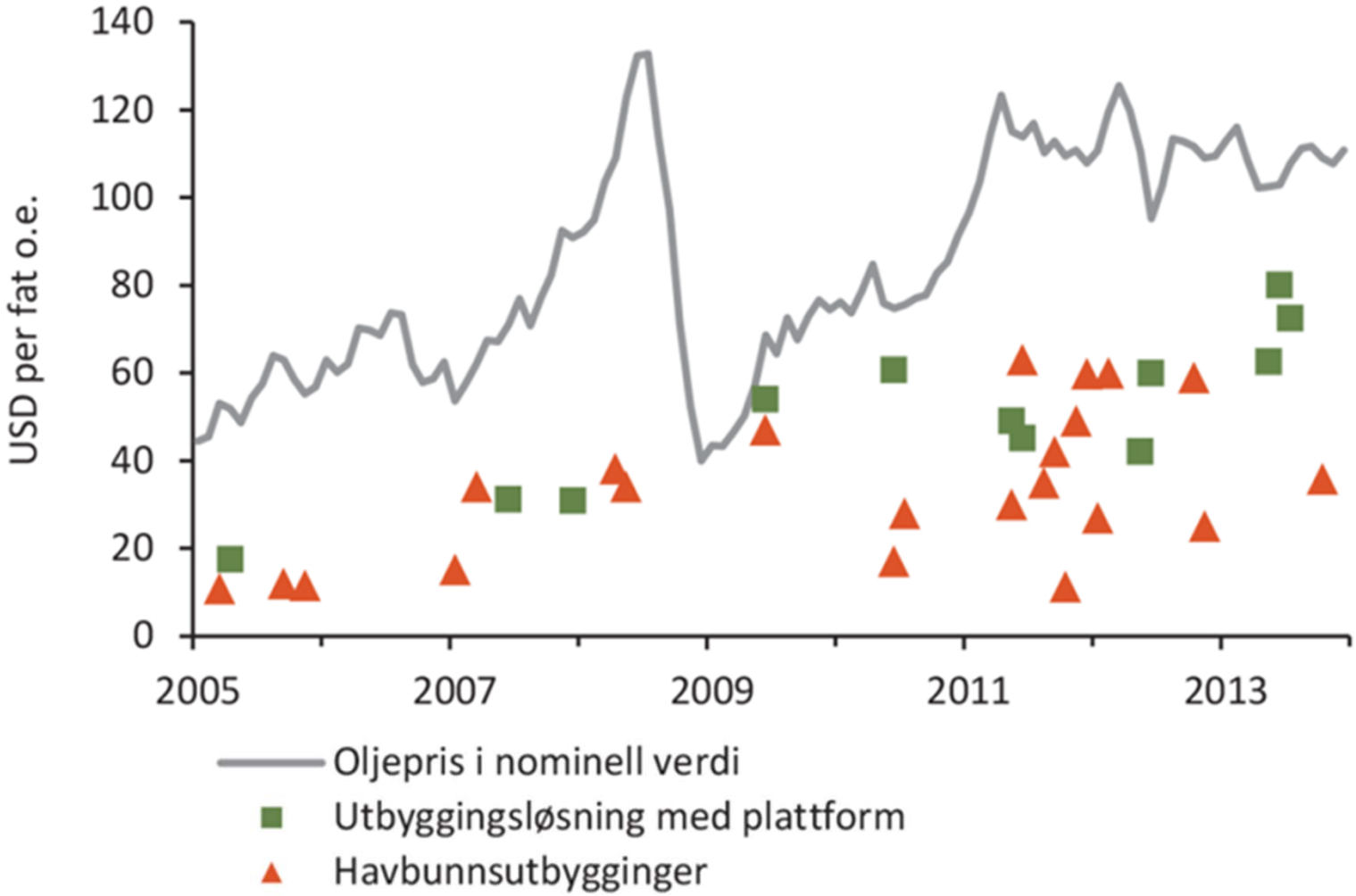
INVESTMENTS INCLUDING EXPLORATION COST

Data from NPD

COST SPLIT 37 FIELD DEVELOPMENT PROJECTS ON NCS



DEVELOPMENT BREAK-EVEN COST



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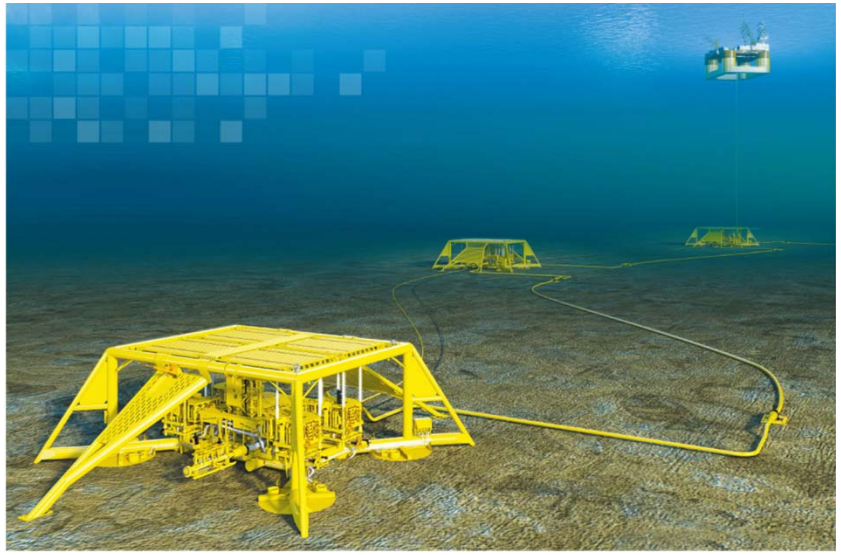

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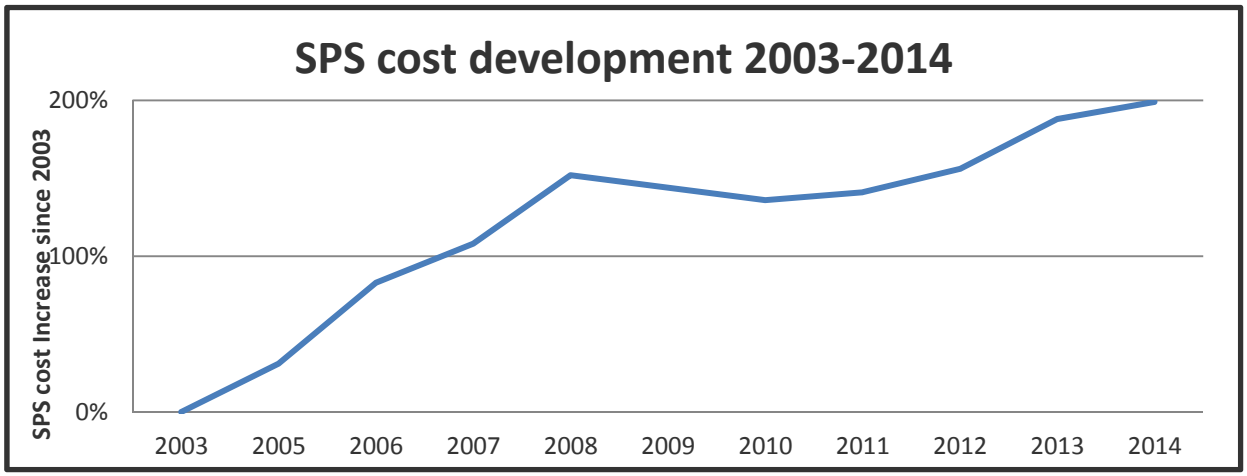
Data provided by Statoil ASA

WHAT HAPPENED THE LAST YEAR? *

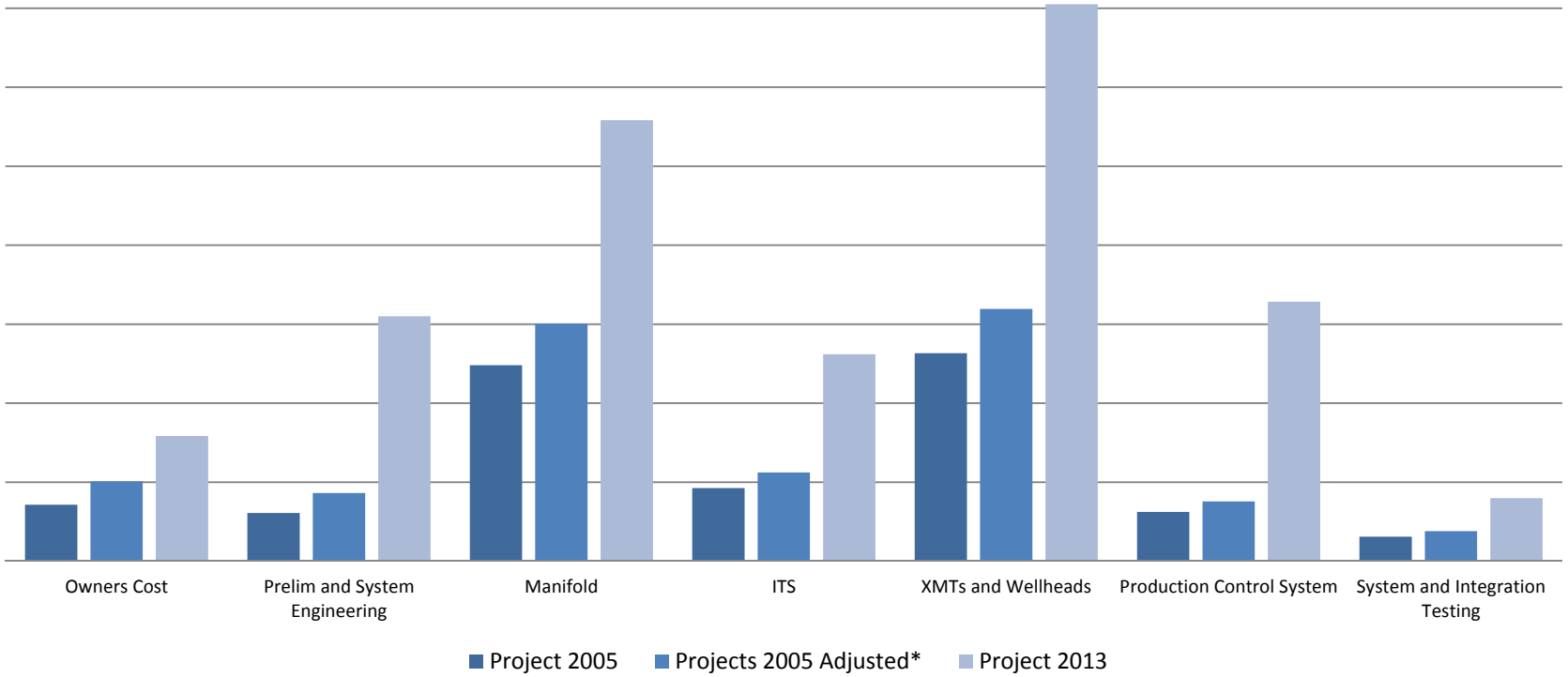
Castberg	DG2 postponed
Krafla	DG2 postponed
GRD	DG3 postponed
Alfa Sentral	DG2 postponed
Trestakk	DG2 postponed
Tanzania	DG1 postponed



** Subsea projects postponed due to high cost levels last 12+ months*

Data provided by Statoil ASA

SPS PROJECTS - COST COMPARISON



- Preliminaries and system engineering has increased by **408%**
- Total cost of hardware components (Manifold, ITS, x-mass-trees and production system) has increased by **178%**
- Testing has increased by **157%**

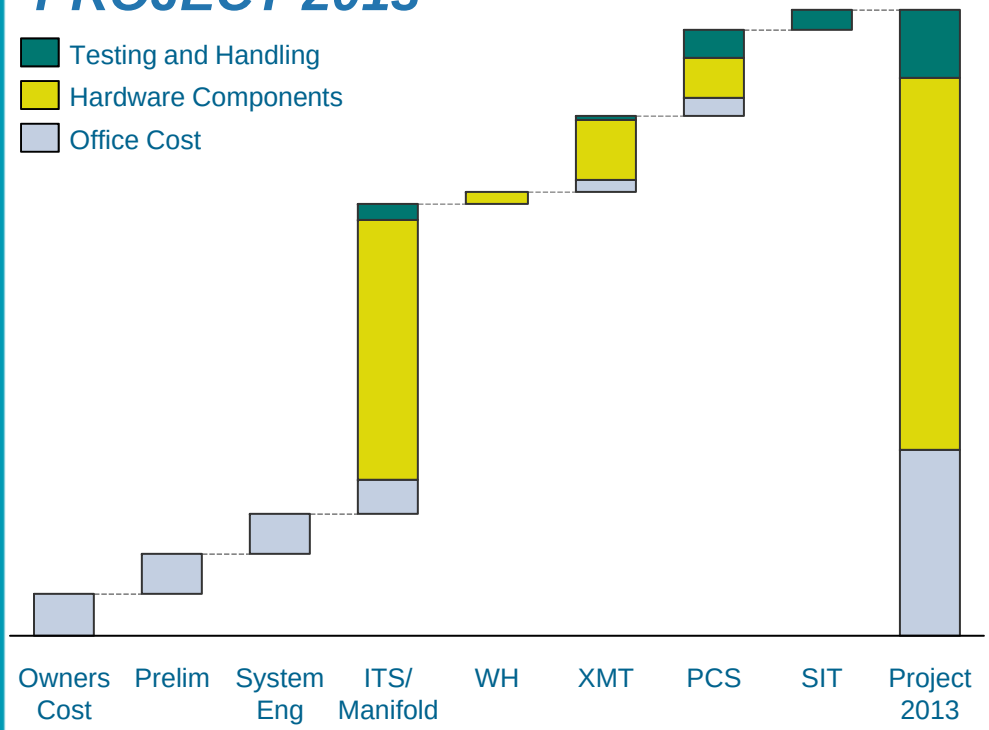
*To correlate for general cost trends between 2005 and 2013, "*Project 2005 Adjusted"* is adjusted as follows:

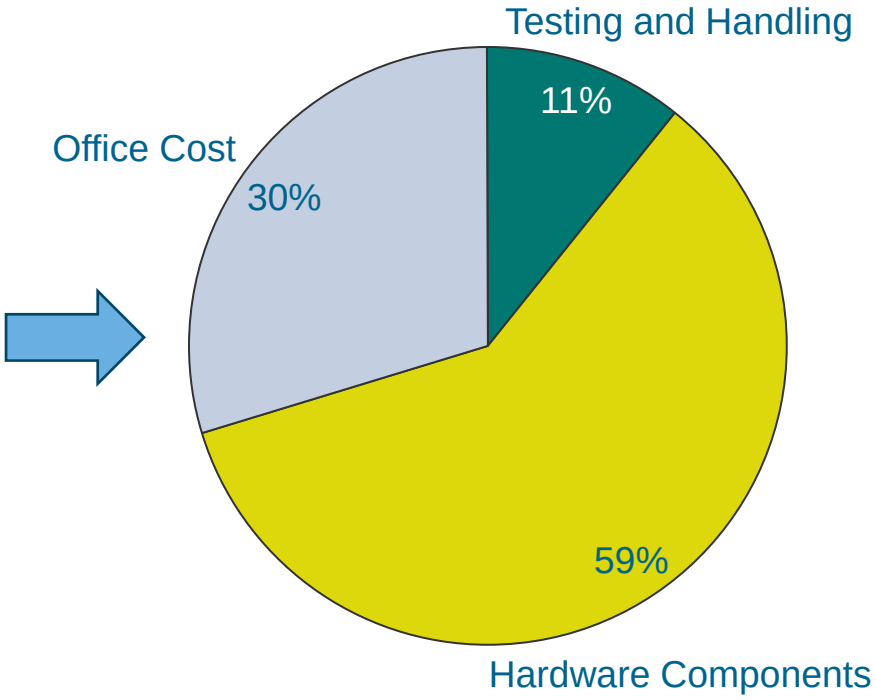
- Prelim and System Engineering adjusted for SSB labor cost index; Professional, scientific and technical activities
- The hardware components are adjusted 1/3 respectively for; SSB Labor Cost index, IHS Western Europe Machinery & Equipment, and Stainless steel prices for Northern Europe
- System and Integration Testing adjusted for EU15 labor cost, manufacturing

Data provided by Statoil ASA

SPS COST COMPONENTS

PROJECT 2013



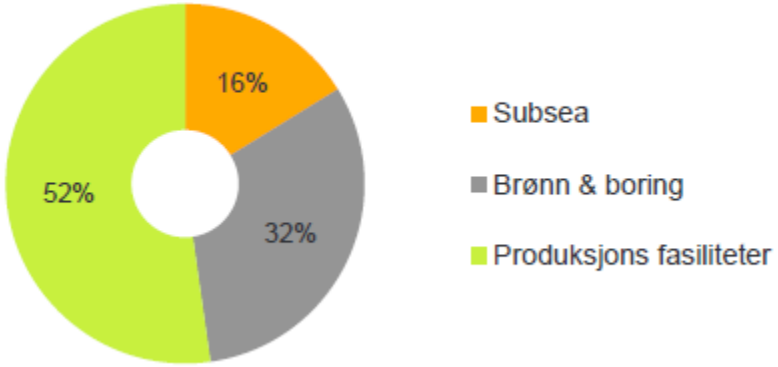


Comments:

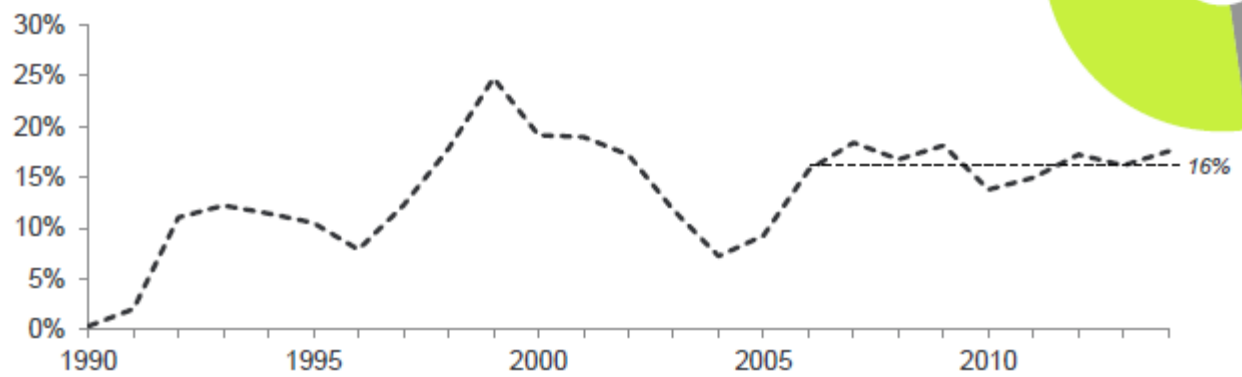
- The total value of Testing and handling comprises **11%** of the total cost
- The total value of Hardware Components comprise **59%** of the total cost
- The total value of Office Cost comprises **30%** of the total cost
- The total cost of Office Cost, and Test and Handling for *Project 2013* is **higher** than the total value of *Project 2005*

NCS CAPEX SPLIT

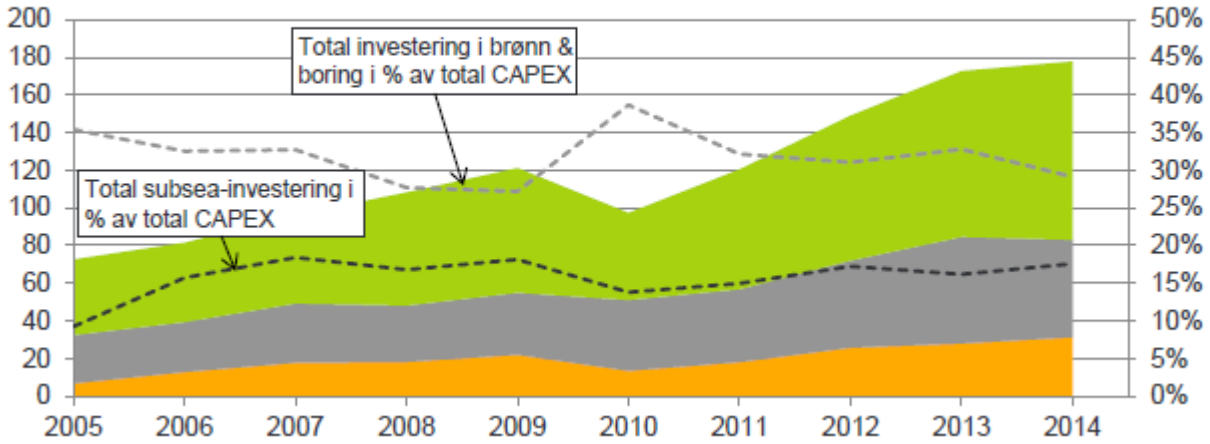
Average CAPEX distribution last 10 years



Share of subsea investments relative to total investments on NCS [%]

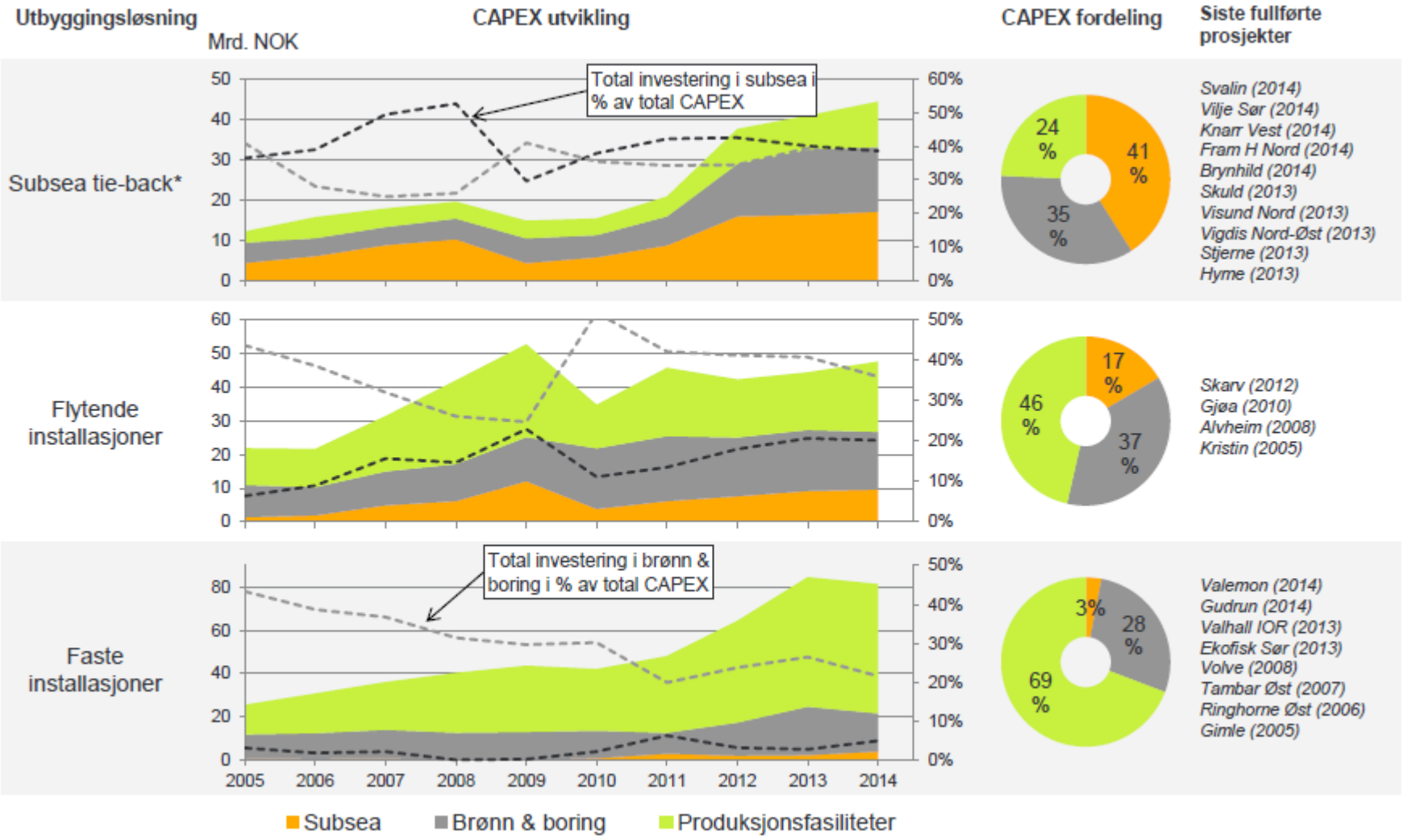


CAPEX fordelt på henholdsvis subsea, brønn & boring og installasjonen forøvrig
Mrd. NOK



Data from: «*Rapport OG21 TTA4, Kostnadsanalyse, subsea-teknologi*», Rystad Energy

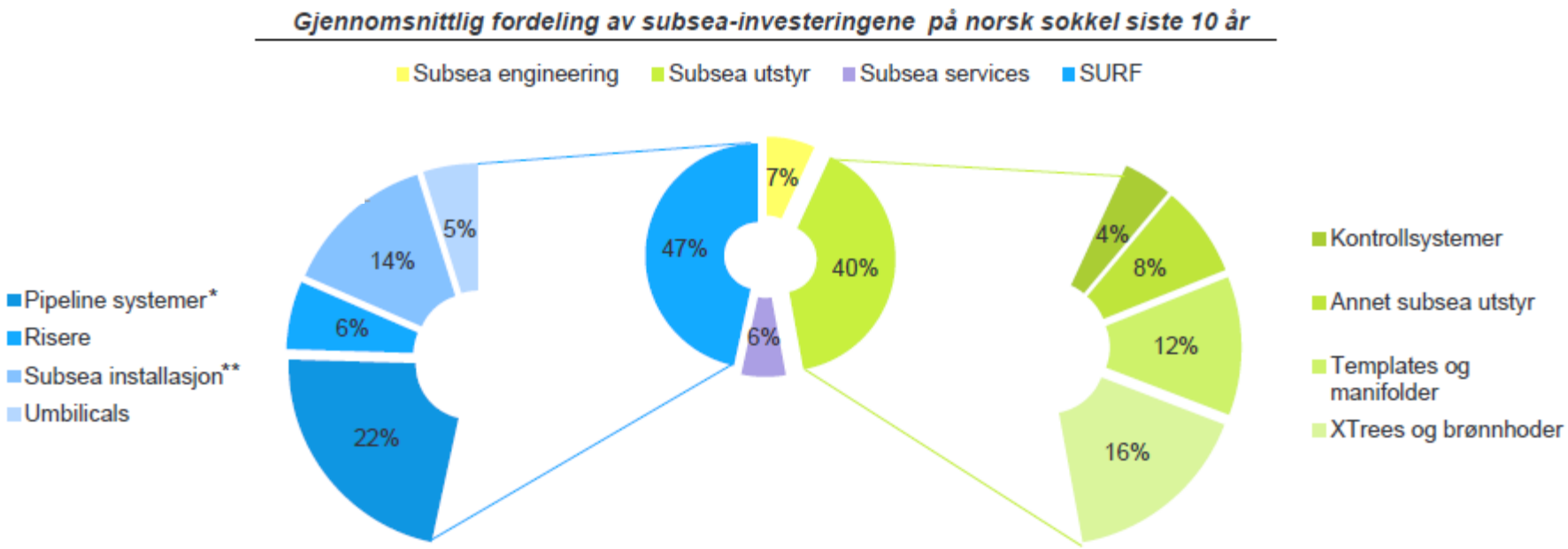
NCS COST SPLIT AND HISTORY



* Ormen Lange har blitt ekskludert i denne fremstillingen da installasjonen har en uforholdsmessig høy andel CAPEX knyttet til øvrige produksjonsfasiliteter

Data from: «*Rapport OG21 TTA4, Kostnadsanalyse, subsea-teknologi*», Rystad Energy

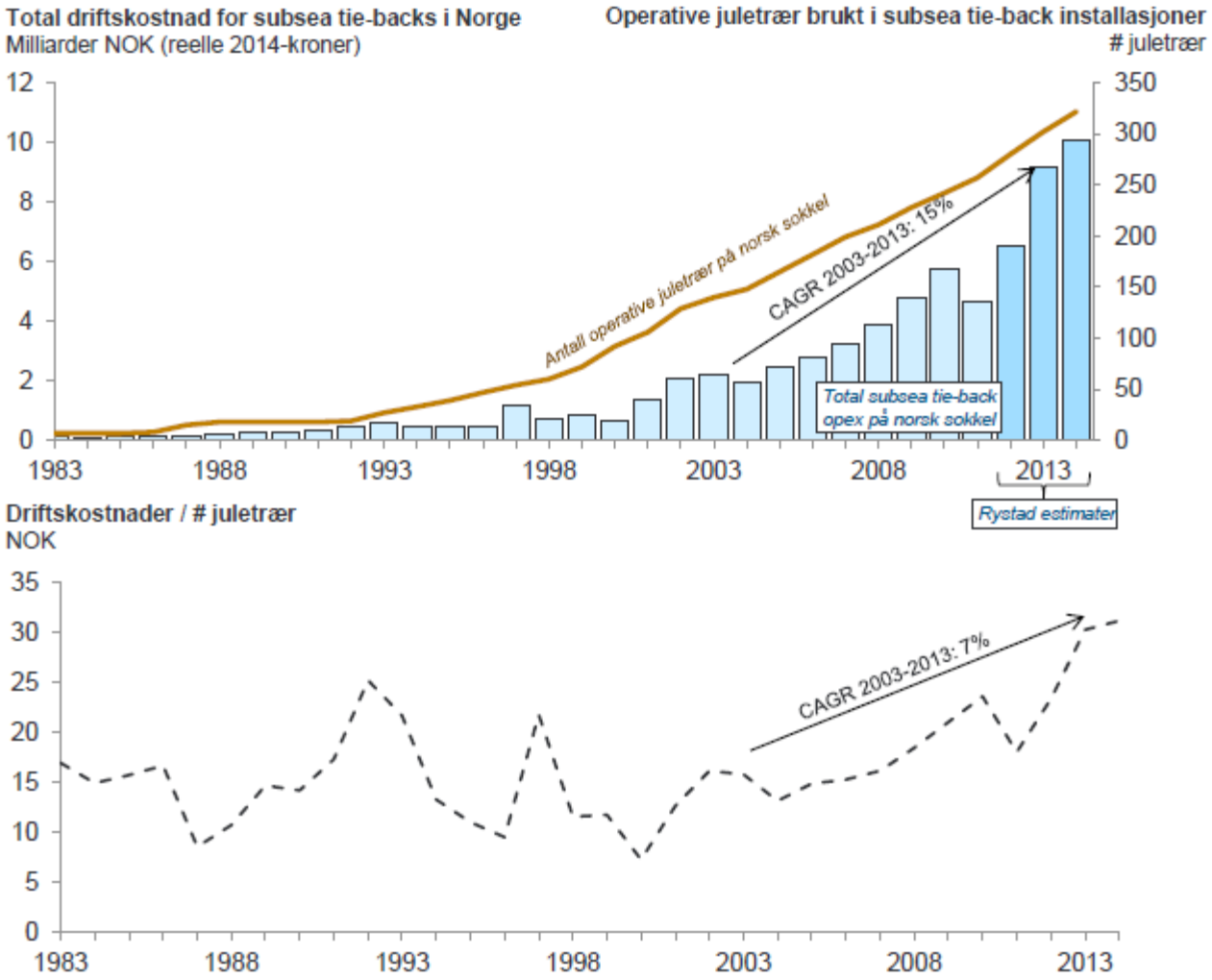
DISTRIBUTION OF SUBSEA COST



*Pipelinesystemer inkluderer tie-back delen til vertsplattform. **Subseainstallasjon inkluderer installasjon av juletrær, manifolder ++ (grønndel)
Kilde: Rystad Energy analyse

Data from: «*Rapport OG21 TTA4, Kostnadsanalyse, subsea-teknologi*», Rystad Energy

OPEX HISTORY



Data from: «*Rapport OG21 TTA4, Kostnadsanalyse, subsea-teknologi*», Rystad Energy

COST ELEMENTS AND SUBSEA INDEX

Subsea-utstyr (~37%)

Viktigste innkjøpselementer

- Juletrær ~40%
- Template og manifolder ~30%
- Andre enheter ~30%

Valgt aktivitetsdriver:

- Installerte juletrær per år

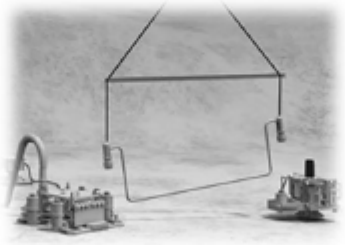
SURF (~45%)

Viktigste innkjøpselementer

- Installasjon ~30%
- Kontrollkabler ~10%
- Stigerør ~15%
- Rørledningssystemer ~45%

Valgt aktivitetsdriver:

- Installerte juletrær per år



Subsea-tjenester (~18%)

Viktigste innkjøpselementer

- IMR (Inspeksjon, vedlikehold og reparasjon) ~40%
- Testing og tool-pool ~55%
- Flow assurance tjenester ~5%

Valgt aktivitetsdriver:

- Antall produserende juletrær (installert base)

Subsea price index definition (formula):

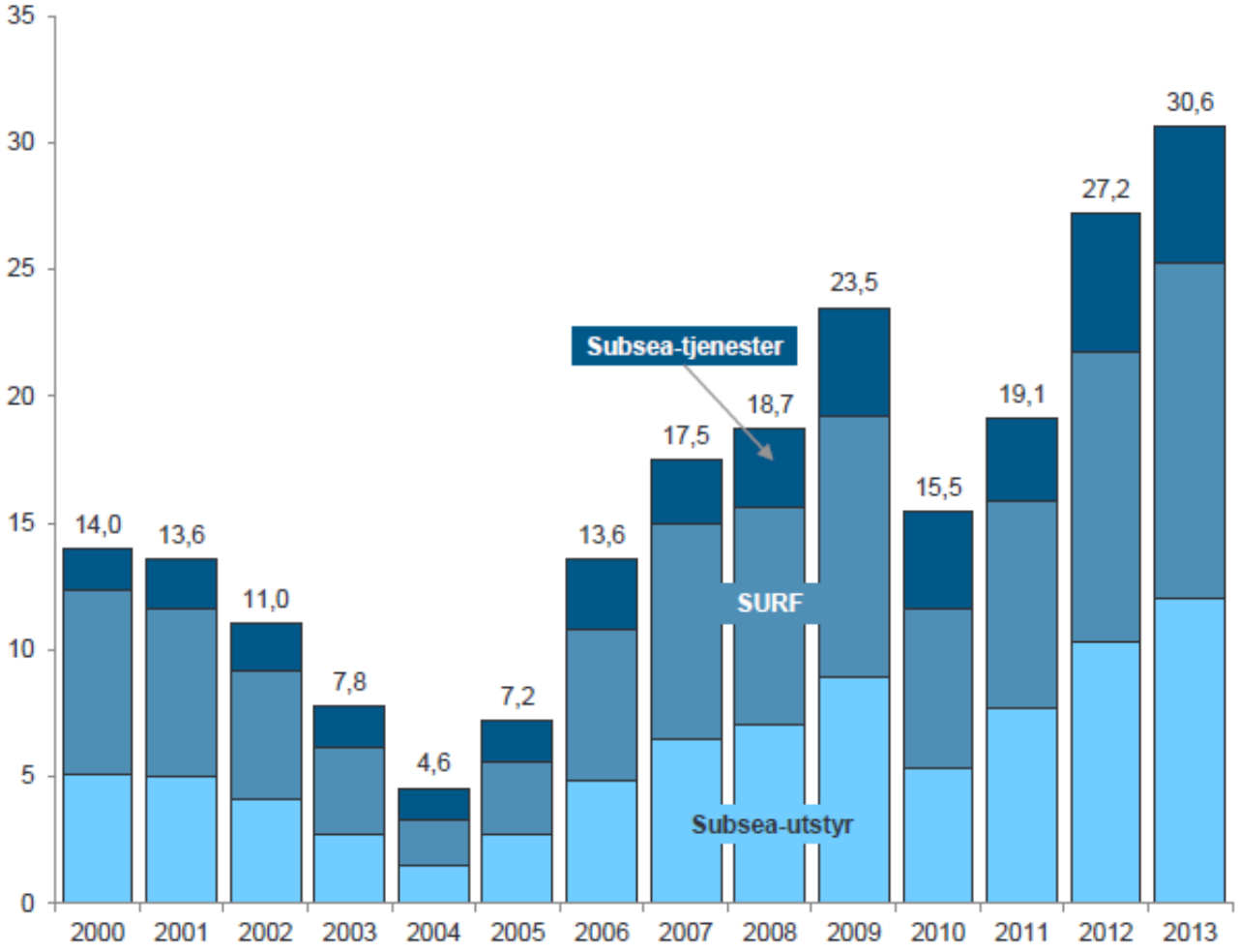
$$\frac{\text{INNKJØP}}{\text{AKTIVITET}} \times \%\text{ANDEL} + \frac{\text{INNKJØP}}{\text{AKTIVITET}} \times \%\text{ANDEL} + \frac{\text{INNKJØP}}{\text{AKTIVITET}} \times \%\text{ANDEL}$$

%-share: Share of operator spending in Norway 2000-2014 (nominal values) for each segment. Source: Rystad Energy DCube

Data from: «*Rapport OG21 TTA4, Kostnadsanalyse, subsea-teknologi*», Rystad Energy

SINCE 2004, PROCUREMENT OF SUBSEA EQUIPMENT AND SERVICES INCREASED FROM 5 TO 30 BNOK

Purchase of subsea-equipment and services by segment
[BNOK] (real 2014)



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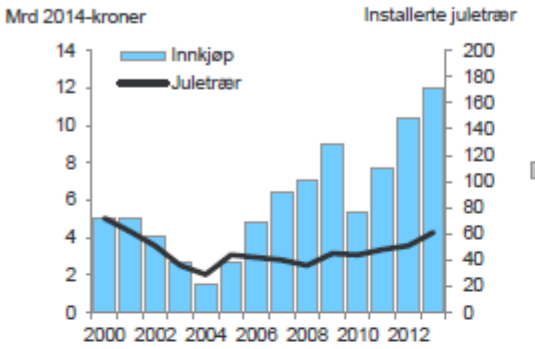
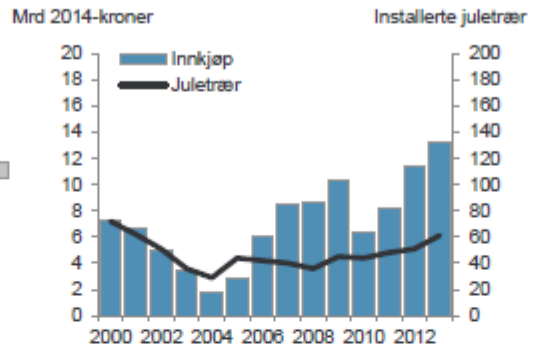
SUBSEA INDEX

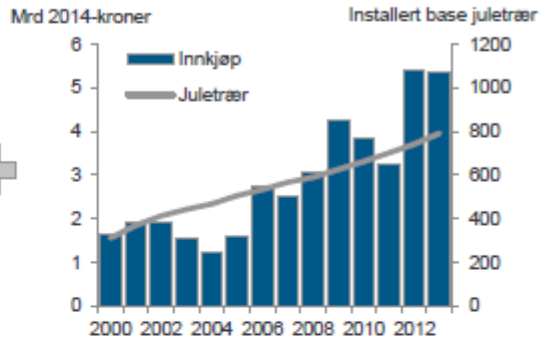
Subsea-utstyr (~37%)



SURF (~45%)

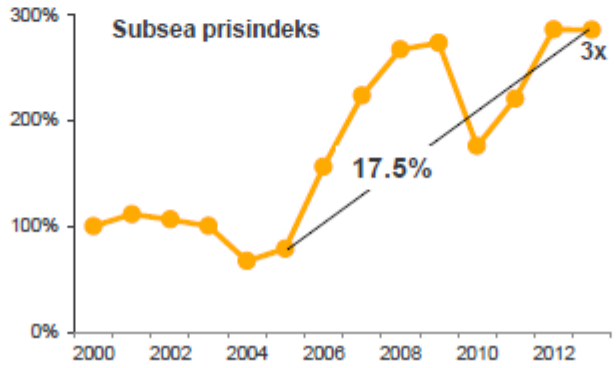


Subsea-tjenester (~18%)



Annual price increase since 2005

18% 18% 12%

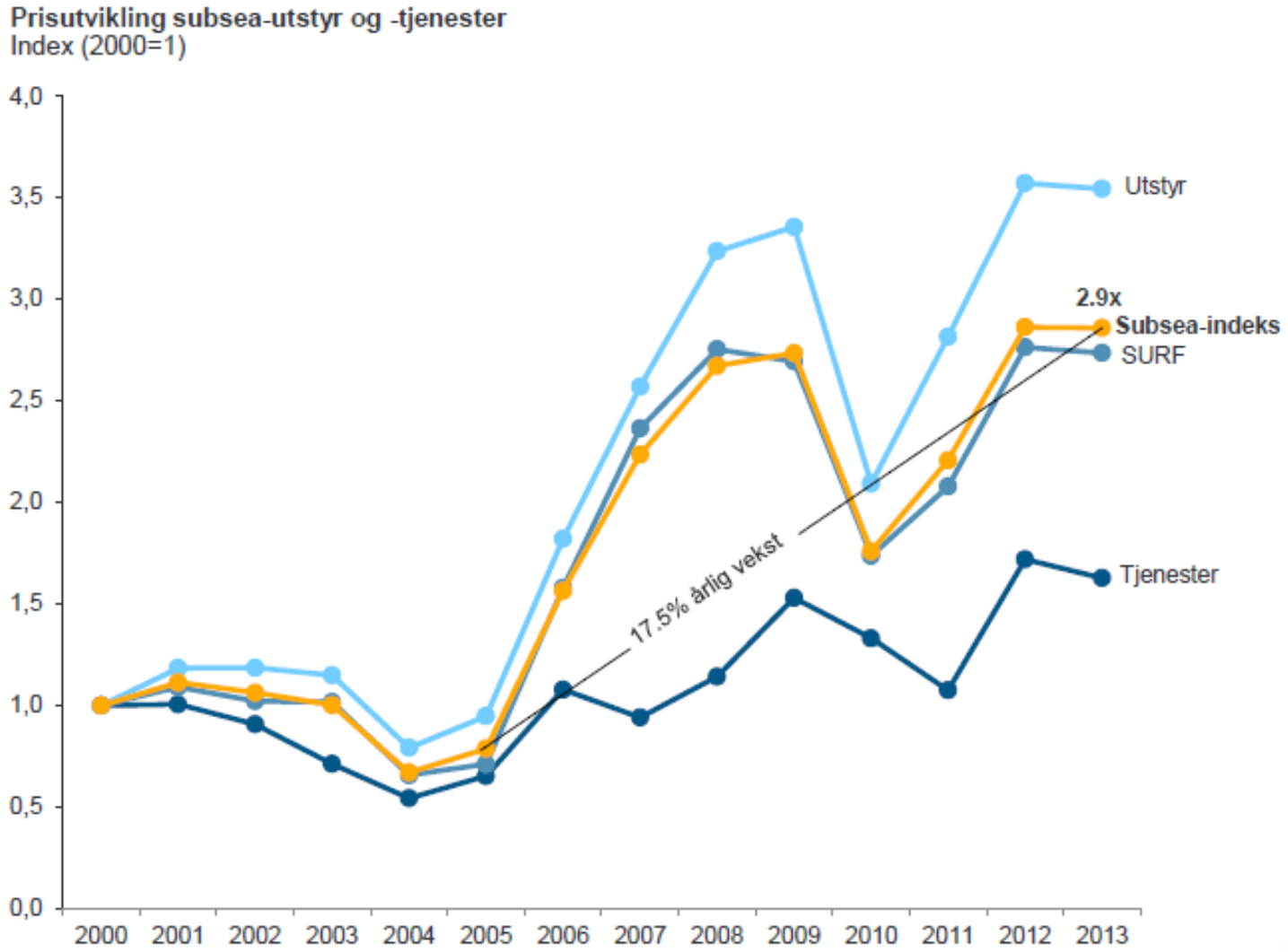


Subsea index explanation:

- Constructing the subsea index according to the formulae on a previous page, purchases are normalized by a quantity representative for the equipment/service provided.
- For subsea equipment and SURF normalization is done relative to number of installed X-mas trees, while subsea services are normalized by total number of X-mas trees in operation on NCS (see plots above).
- Individual contributions are multiplied by the percentage of operator spend towards each subsea segment (number on top of this page) and added together.

Data from: «*Rapport OG21 TTA4, Kostnadsanalyse, subsea-teknologi*», Rystad Energy

HISTORICAL SUBSEA INDEX



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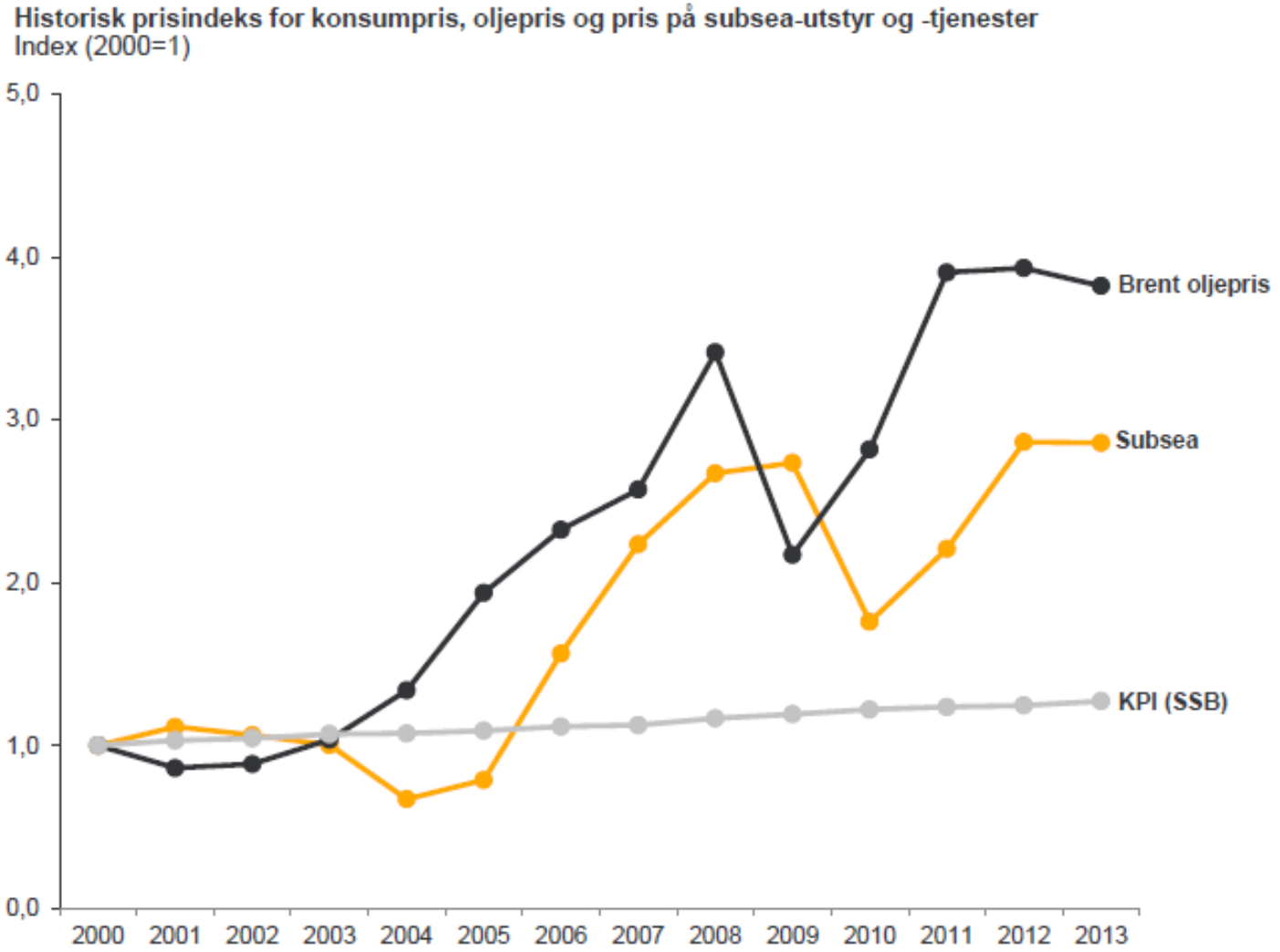

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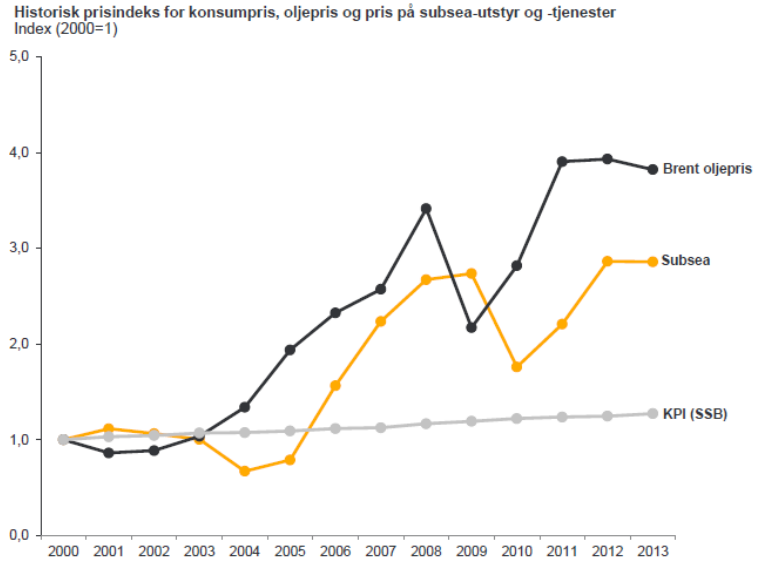
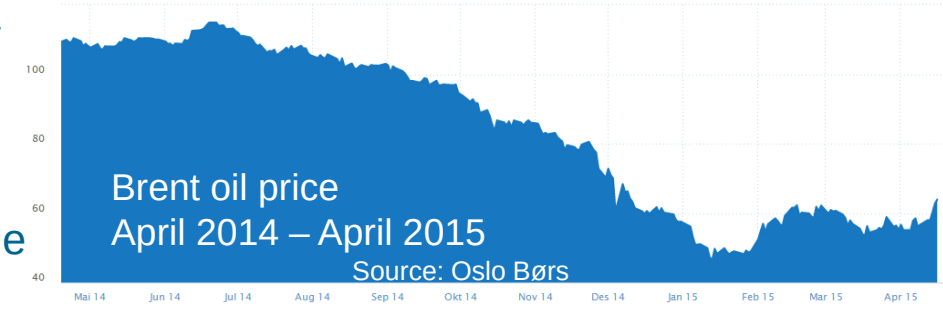
OUTSIDE SCOPE

NON-TECHNICAL COST DRIVERS

- Contracting models: Increased cost from coordination between different suppliers
- Previous rapid increase in manning with insufficient competence in industry increase cost
- Historical subsea index suggest that there could be a market effect of subsea cost linked to the oil price with a time delay of about 1 year
  - The present report does not reflect on this, but rather provide guidance and solutions for the underlying technology related cost elements
  - Oil price reduction is nonetheless adding to the sense of urgency for the entire industry to address the cost issue discussed.





Brent oil price
April 2014 – April 2015
Source: Oslo Børs

"We did not need to do anything, we earned money anyway. Oil prices were so high that all bought from us anyway. Now we need to sit down and think smarter and make things better"
Supplier senior official at Subsea Valley conference (ref. DN 15.04.2015)

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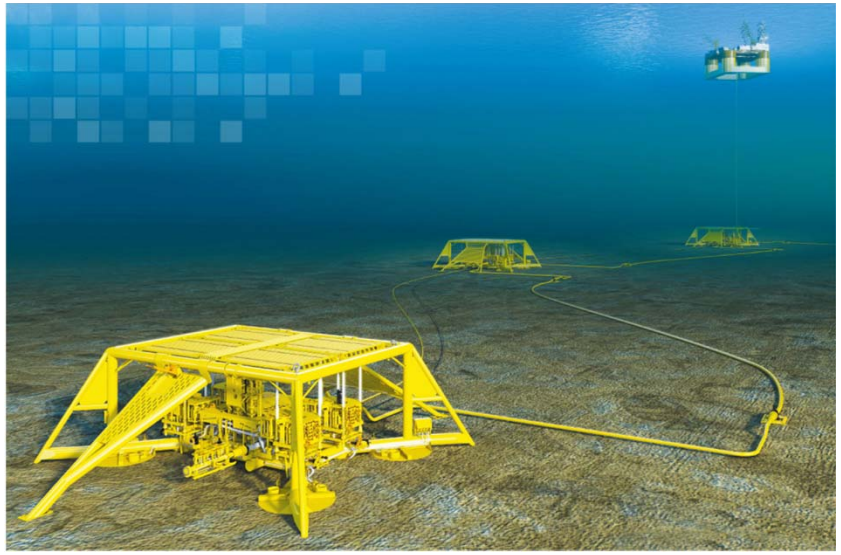

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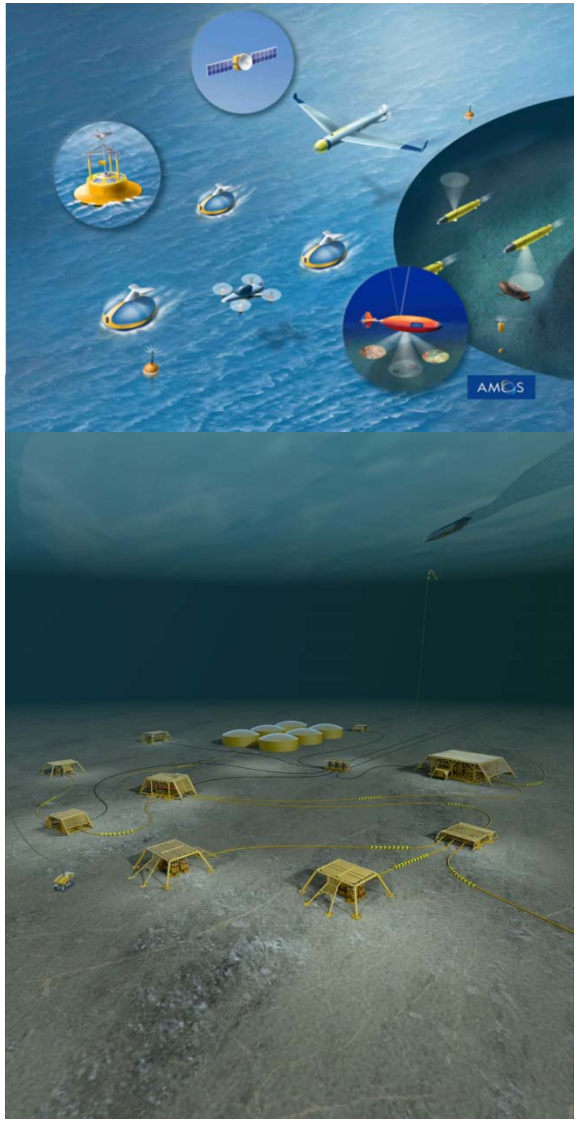
TECHNOLOGY RELATED MEASURES WITH COST SAVING POTENTIAL

Solutions presented are the following

- **Reduce complexity**
- **Simplify qualification**
- **Standardization and industrialization**
  - **Standard subsea modules and open interfaces**
  - **Simplify subsea documentation**
  - **Standard material specification**
- **Increase efficiency of marine operations**
- **Reduce cost of inspection, maintenance and repair**
- Specific subsea technologies reducing cost:
  - Simplified satellite system: Single well solution
  - Simplified subsea power conversion and distribution
  - Simplified subsea communication and control power
  - Subsea storage
  - Simplified subsea boosting
  - All electric subsea system
  - Subsea processing system solutions
- Lean subsea concepts



REDUCE COMPLEXITY

- Challenge definition:
  - Technical requirements from the operator is too complex, and is sometimes being put on top of system supplier specifications to which the sub-supplier has to comply
  - The result is excessive time spent on understanding requirements, using engineering hours on technical clarifications of potentially conflicting requirements
  - Another main consequence is that equipment will contain a higher degree of complexity than what is needed
- Solution:
  - Challenge the background for the specification or the requirement
  - Review the requirements together with suppliers and operators in order to understand the need and evaluate possible ways to meet the need
  - Reduce complexity of specifications
  - Reduce technical requirements
  - Only relevant requirements to spread out in supplier chain
- Effect:
  - Reduced cost
  - Fit for purpose equipment

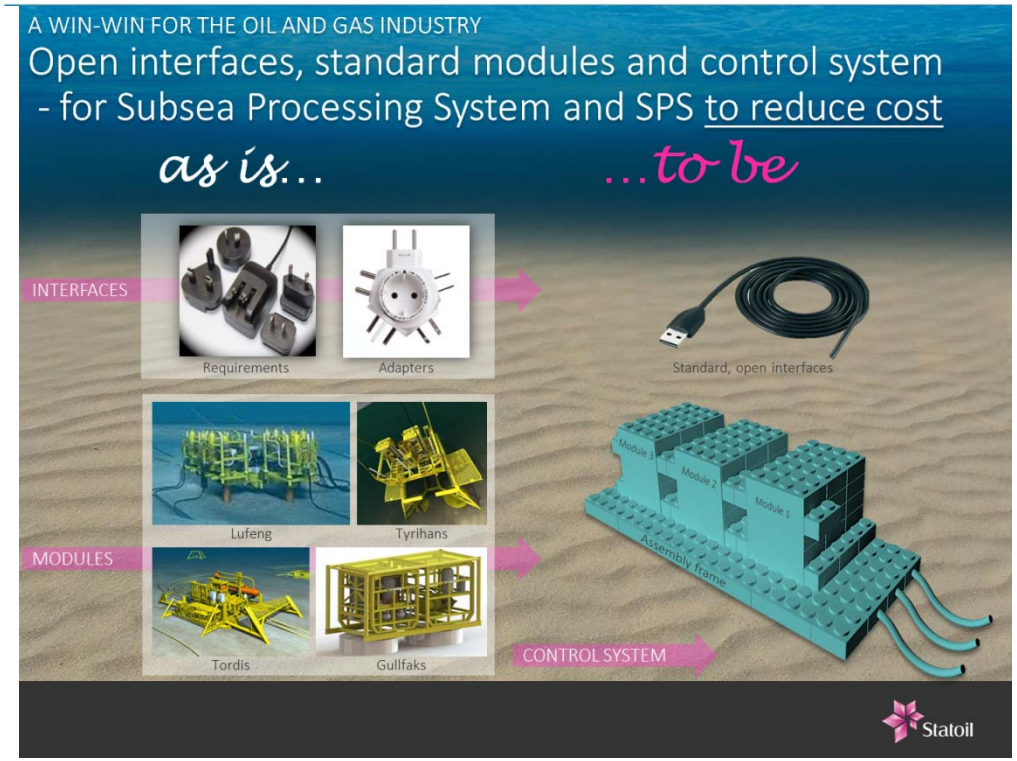
SIMPLIFY QUALIFICATION

- Challenge definition:
  - Technology qualification is costly
  - Cost increase with scale and complexity of qualification activities
    - High cost especially at TRL3-4 (TRL3: New technology tested, TRL4: Technology qualified for first use)
  - Each technology need may differ and cause operators to (re)qualify technology that other operators have tested extensively
  - Costly technology qualification completed, but equipment never piloted or implemented in the field
- Solutions:
  - Common understanding of technology qualification
    - Operators and suppliers all follow the same qualification principles (e.g. DNV RP A203)
  - Common qualification requirements for standard components
    - Alignment of requirements enable increased and rapid re-use of new technology by several operators
  - Qualify technology at right scale: Will reduce cost
  - Qualify technology with sufficiently wide operating range
    - Will not bring down initial cost, but enable multi-use and hence reduce total qualification cost by reducing need for re-qualification
  - Cooperation on technology qualification (JIPs)
  - Relationships between suppliers and customers: industry-wide standards is the main instrument to lower transaction costs

STANDARDIZATION AND INDUSTRIALIZATION

STANDARD SUBSEA MODULES AND OPEN INTERFACES

- Challenge definition:
  - Different suppliers have proprietary solutions and operators have individual specifications hindering interchangeability and standardization
  - Low volume of hardware components and systems increase cost
- Solution:
  - Development of standard interfaces to secure interchangeability and “plug and play” functionality based on open specifications
  - Items to standardize: open interfaces, control system, workover system, modules
  - Broad cooperation between suppliers and operators
- Effect:
  - Increase volume and reduce cost
  - Enhance stock keeping/planning
  - Standardization creates predictability throughout the supply chain
  - Standardization enables flexibility to custom making by optimizing configurations



STANDARDIZATION AND INDUSTRIALIZATION

STANDARD SUBSEA DOCUMENTATION AND MATERIAL SPECIFICATION

Subsea documentation

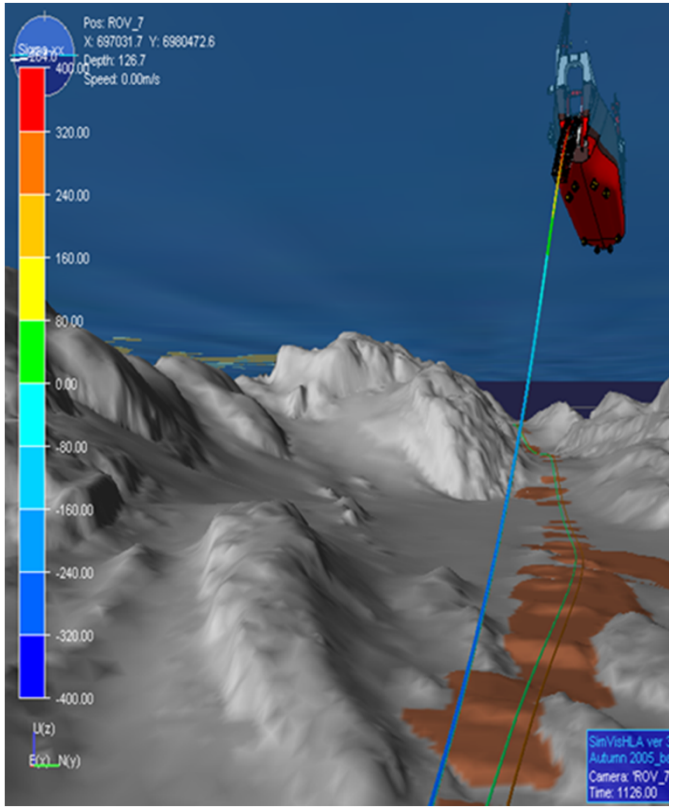
- Challenge definition:
  - Documentation content, format and detailing differs between operators: Not easy for supplier
  - Significant cost of documentation in projects
- Solution:
  - Enable suppliers to document deliveries in a unified manner
  - Operators and suppliers to agree on a typical set of subsea systems and functions, and its required minimum set of documentation
- Effect:
  - Reduce time spent for documentation in projects
  - Sufficient documentation that can be maintained and managed
  - Increased transparency and improved quality
  - Reduced cost

Material specification

- Challenge definition:
  - Operators and system suppliers specify steel components with company-specific requirements
  - Operators requires pre-approval of material specification prior to purchase
  - Stocking of prefabricated forgings, and thereby shorter lead times, becomes difficult: high cost
- Solution:
  - Standardize specification of materials for subsea applications
  - Standard requirements for qualification, manufacturing and testing of carbon and low alloy steel forgings
- Effect:
  - Unified products that can be produced in larger quantities
  - Reduced lead times, enhanced stock keeping, interchangeability of forgings
  - Help improve and maintain consistent quality
  - Reduced cost

INCREASE EFFICIENCY OF MARINE OPERATIONS

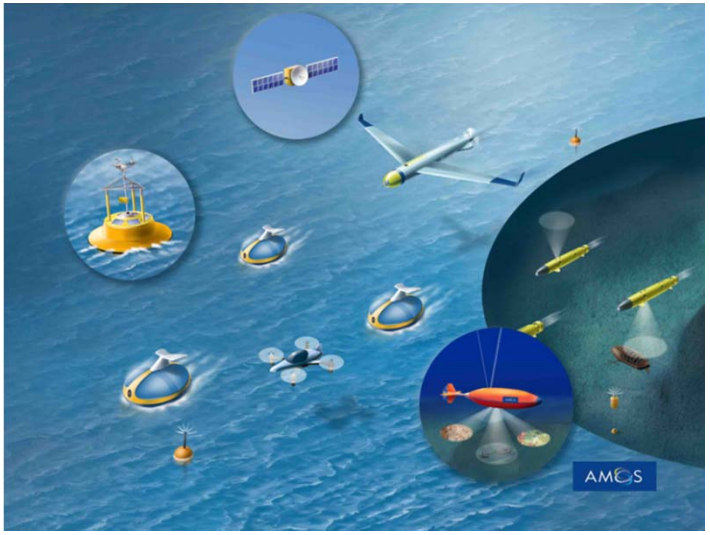
- Advantages/cost saving feature:
  - Reduce non-productive time waiting on weather: Save cost
  - Simulation of marine operations prior to execution to simplify and guide operation: set operation-specific weather-windows
  - Training of personnel preparing for challenging operational scenarios «what if..»: Save time and cost offshore
  - Simulations to assist in crew familiarization, securing execution according to plan and increasing the probability of cost-efficient operation
  - Real-time simulations during operation to provide fact-based decision support
    - Further improve efficiency in the operation, e.g. guide vessel headings
    - Contribute to situation awareness by visualizing the operation real time
- Components to qualify and pilot
  - Expand use of existing software tools
  - Further develop simulation software



- Responsibility:
  - Suppliers: Actively use simulation software prior to and during operations as an integrated decision support tool
  - Operators: Use existing simulation tools and support further software improvements
  - Academia/Institutes: Develop competence and improve software
  - Authorities: Continued support to Centers of Excellence (CoE) and Centers for Research-based Innovation (SFI) within this area

REDUCE COST OF INSPECTION/MAINTENANCE/REPAIR

USING AUTONOMOUS UNDERWATER VEHICLES & UNMANNED AREAL VEHICLES (AUV & UAV)



«Academia and industry should collaborate on developing and introducing robotics and autonomous systems with appropriate levels of autonomy and supervision including ROV, AUV and UAV technology to reduce surface vessel usage by 70-80% supporting subsea installations during operation»

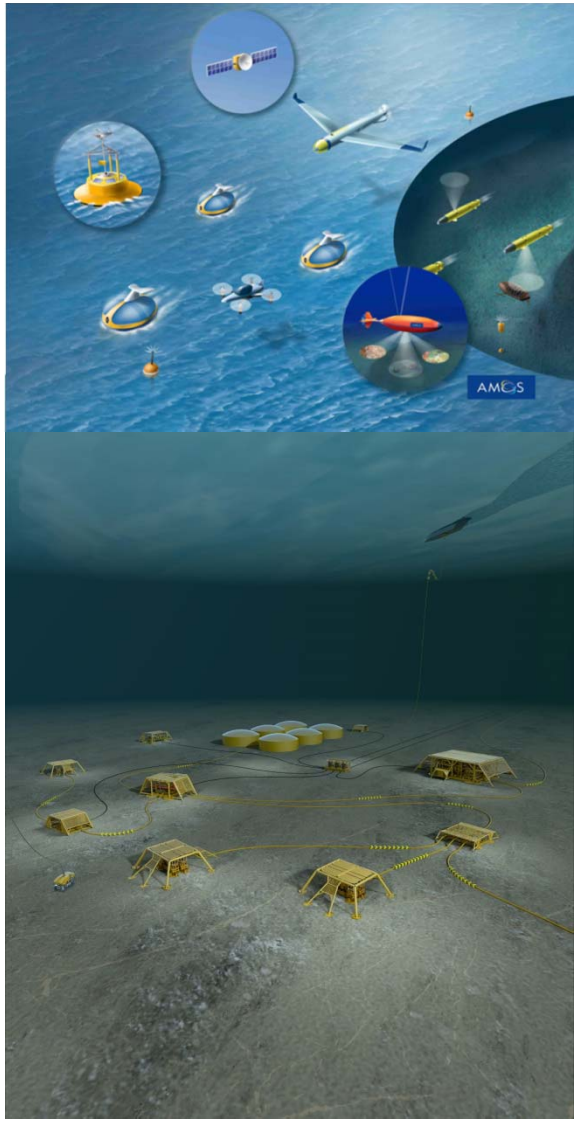
Prof. Asgeir Sørensen, Director Centre for Autonomous Marine Operations and Systems (AMOS)

- Advantages/cost saving feature:
  - Reduce IMR vessel cost by using AUV
  - Reduce waiting on weather: Save time and cost
  - Reduce response time and increase access subsea
  - Enable low-cost situation awareness for operations
  - Mobile environmental monitoring in sensitive areas
- Components to qualify and pilot
  - Launch and recovery systems that could expand range of vessels used, e.g. smaller vessels of opportunity
  - Tools for AUV functionality: intelligence/sensors and manipulator functionality
  - AUV hardware integrated with subsea system, e.g. docking stations, standard interfaces, increased reliability of AUV to be permanently residing subsea, easy sensor interchangeability
  - UAV systems for surveillance and situation awareness, e.g. Barents Sea
- Responsibility:
  - Suppliers: Innovate, develop and qualify new hardware and software
  - Operators: Pilot AUV and UAV technology in operations. Prepare new subsea installations with AUV docking capabilities
  - Academia/Institutes: Provide competence and groundbreaking new technologies
  - Authorities: Support piloting of key technologies. UAV regulation review to enable offshore use.

TECHNOLOGY RELATED MEASURES WITH COST SAVING POTENTIAL

Solutions presented are the following

- Reduce complexity
- Simplify qualification
- Standardization and industrialization
  - Standard subsea modules and open interfaces
  - Simplify subsea documentation
  - Standard material specification
- Increase efficiency of marine operations
- Reduce cost of inspection, maintenance and repair
- **Specific subsea technologies reducing cost:**
  - **Simplified satellite system: Single well solution**
  - **Simplified subsea power conversion and distribution**
  - **Simplified subsea communication and control power**
  - **Subsea storage**
  - **Simplified subsea boosting**
  - **All electric subsea system**
  - **Subsea processing system solutions**
- **Lean subsea concepts**



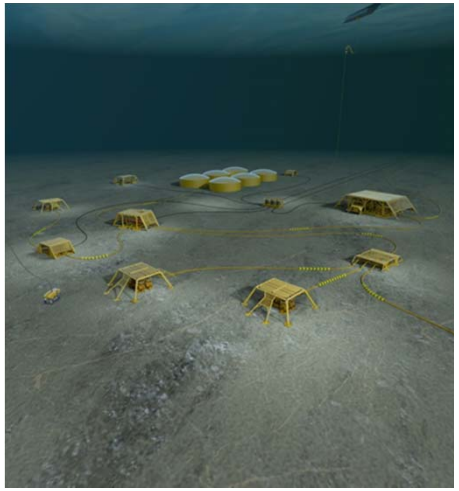
SIMPLIFIED SATELLITE SYSTEM: SINGLE WELL SOLUTION

- Advantages/cost saving feature:
  - Single well solutions could reduce weight and cost of subsea equipment when compared to traditional 4-slot templates
  - Single well solutions could simplify well placement and need for deviation drilling, i.e. less compromise between multiple wells
  - Cost saving potential is field specific, but would be most beneficial for shallow reservoirs and reservoirs covering large areas, e.g. Barents Sea
  - Could be optimized to enable phased development to save cost
- Components to qualify and pilot
  - Cost effective satellite system for both producing wells and injectors including manifolding
- Responsibility:
  - Suppliers: Develop and qualify hardware
  - Operators: Develop and select simplified satellite systems

SIMPLIFIED SUBSEA POWER CONVERSION AND DISTRIBUTION

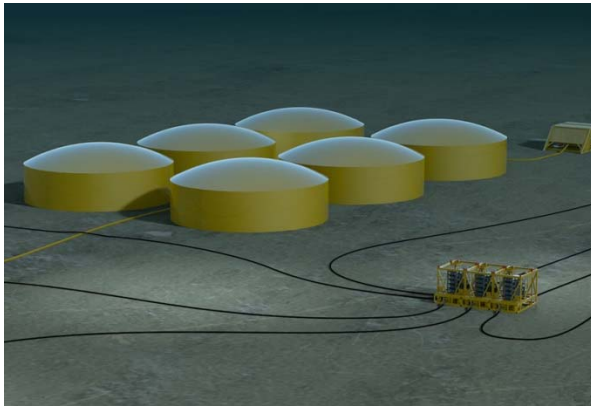
- Advantages/cost saving feature:
  - Reduce number of risers on host installation to provide power to major subsea power consumer such as pumps, compressors, DEH systems etc.
  - Reduce need for topside weight and space on host installation
  - Enable a system where only one power cable is needed
  - Convert and distribute the power to consumers subsea in a way that is configurable/expandable to allow future tie-ins or IOR measures to be taken at a low cost, and which enables a long step-out distance
  - Enable lightweight system for ease of installation and cost reduction
  - Cost efficient power distribution and potential for subsea development of fields further away from existing infrastructure
- Components to qualify and pilot
  - Qualify system with subsea variable speed drive, switchgear, connectors, penetrators etc.
- Responsibility:
  - Suppliers: Develop and bring into market
  - Operators: Support development, pilot and put into use
  - Academia/institutes: Provide competence to support simplification
  - Authorities: Support technology demonstration/piloting

SIMPLIFIED SUBSEA COMMUNICATION AND CONTROL POWER



- Advantages/cost saving feature:
  - Remove bottlenecks in subsea control power, e.g. power supply capacity length limitations
  - Enable increased instrumentation subsea and in subsea wells, e.g. multiphase meters and downhole instrumentation
  - Reduce number of risers used for communication and control
  - Simplify future tie-ins due to subsea distribution functionality
  - Reduce number of wet connectors: Increase control system availability
  - Reduce control and umbilical cost
- Components to qualify and pilot
  - Qualify system with increased control power supply capacity and long-range capabilities
- Responsibility:
  - Suppliers: Develop and bring into market
  - Operators: Support development, pilot and put into use
  - Academia/institutes: Provide competence to support simplification
  - Authorities: Support technology demonstration/piloting

SUBSEA STORAGE

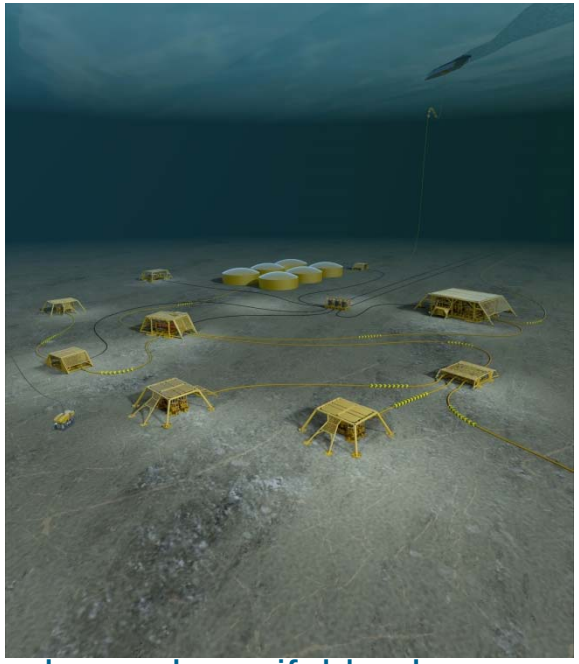


- Advantages/cost saving feature:
  - Reduce cost by reducing dependency on host installation
  - Reduce cost by potentially eliminating need for a host installation
  - Storage of consumables: MEG, corrosion inhibitor etc.
  - Storage of produced liquid hydrocarbon products
  - Potential added synergies if used as bulk separation unit
- Components to qualify and pilot
  - Subsea storage units
  - Subsea injection pumps for MEG, corrosion inhibitor etc.
  - Simplified subsea (fiscal) metering
- Responsibility:
  - Suppliers: Develop and bring into market
  - Operators: Support development, pilot and put into use
  - Academia/institutes: Develop technology and bring into market
  - Authorities: Support technology demonstration/piloting

SIMPLIFIED SUBSEA BOOSTING

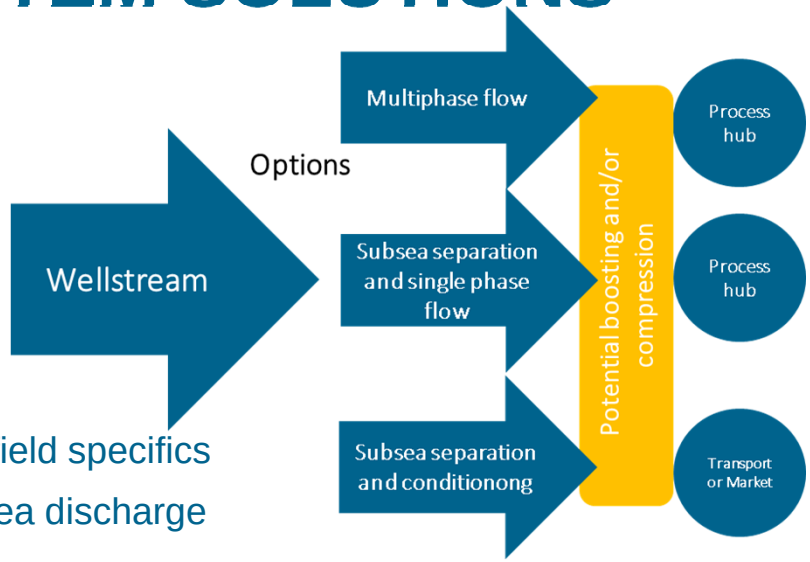
- Advantages/cost saving feature:
  - Increased use of boosting to enable accelerated production and increased hydrocarbon recovery
  - Cost-effective brownfield integration of subsea pumps
  - Reduce costly topside modification scope
  - Reduce weight and space reserve issues on host platform
  - Simplified umbilical: Only power and control umbilical needed to operate subsea pump
- Components to qualify and pilot
  - Subsea pump, subsea variable speed drive (VSD), subsea barrier fluid (or removal of barrier fluid need)
  - Complete subsea boosting system
- Responsibility:
  - Suppliers: Develop and bring into market
  - Operators: Support development, pilot and put into use
  - Authorities: Support technology demonstration/piloting

ALL ELECTRIC SUBSEA SYSTEM



- Advantages/cost saving feature:
  - Simplification by removing hydraulic distribution system
  - Reduce size and weight
  - Reduce cost
  - Increase step-out distance, e.g. Barents Sea
- Components to qualify and pilot:
  - Subsea electrically actuated X-mas tree, downhole safety valve and manifold valves
  - Expand use of electrical actuators to safety critical operations, i.e. fail-safe operations requiring local power back-up e.g. mechanical or subsea batteries
  - Simplified subsea communication and control power: Remove bottlenecks in subsea control power, e.g. power supply capacity limited reach
  - Added value: System could enable increased low-cost monitoring and control subsea and well
- Responsibility:
  - Subsea system suppliers and drilling & well service providers: Develop and bring into market
  - Operators: Support development, pilot and put into use
  - Academia/institutes: Provide competence and data to support all electric system
  - Authorities: Support technology demonstration/piloting

SUBSEA PROCESSING SYSTEM SOLUTIONS

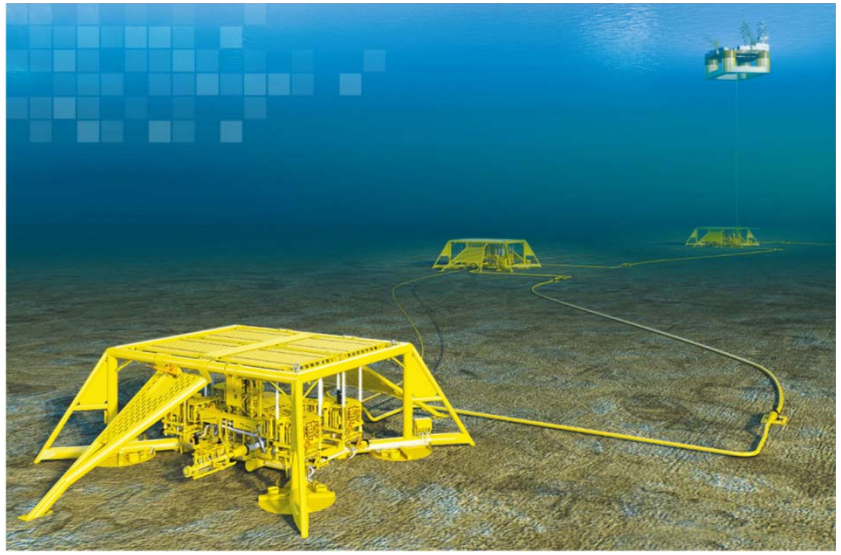


- Advantages/Cost saving feature
  - Subsea processing could increase efficiency due to higher pressure than topside processing
  - Multiphase flow will allow less equipment to be installed subsea, and could hence save cost
  - What is the most cost efficient solution depends on field specifics
  - Potential subsea produced water treatment for subsea discharge
- Components to qualify and pilot
  - Ability to choose between different field development concepts providing highest efficiency and lowest cost
  - Subsea processing hardware and software
  - Decision support software tool optimizing facilities and identifying bottlenecks
- Responsibility:
  - Suppliers: Provide hardware and software solutions to enable field development options, competence to challenge operators on system solution
  - Operators: Support and develop hardware and software, competence to reach optimum solution
  - Academia/institutes: Provide competence and data to support simplification
  - Authorities: Support piloting of technologies. Evaluate potential for produced water discharge subsea in cooperation with industry

LEAN SUBSEA CONCEPT

- Key features of process to arrive at a lean concept
  - Ground-up field development: facilities addressing reservoir needs
  - Brown-field: Identification of key cost-driving bottlenecks, eg. riser slots, turret limitations or topside processing capacity limitations
  - Holistic view of topside and subsea solutions to arrive at optimum field development concept
  - Early involvement of specialist competence and early evaluation of low cost field development solutions
  - Start with bare minimum of functionality and add from there
- A cost-efficient solution could potentially combine:
  - Simplified satellite system: Single well solution
  - Simplified subsea power conversion and distribution
  - Simplified subsea communication and control power
  - Subsea storage
  - Simplified subsea boosting
  - All electric subsea system
  - Optimum use of subsea processing: Subsea processing system solutions
  - Flexible spools
  - Improved integrity monitoring tools
- In addition: Lean execution of projects will reduce cost

OUTLINE



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- Study task and scope
- Executive summary
- NCS cost data: general
- NCS cost data: development within Subsea segment
- Outside scope: Non-technical cost drivers
- Technology related measures with cost saving potential
- Expectations to key players
- Subsea cost reduction targets: 3-5 year perspective

EXPECTATIONS TO KEY PLAYERS (1:3)

Operators:

- Adapt to changing business needs: radical innovation to reduce cost
- Cooperate with suppliers and other operators to develop new cost efficient solutions (standardization, industrialization, lean concepts etc.)
- Enable innovation by modifying/simplifying technical requirements and documentation requirements
- Support development, piloting and use of cost-saving technologies and solutions
- Sanction use of new cost-saving technologies and solutions
- Use period of reduced activity level to grow competence and make solutions to secure future growth

Suppliers:

- Adapt to changing business needs: radical innovation to reduce cost
- Cooperate with operators on standardization and industrialization, lean concepts etc.
- Develop new cost-efficient technologies and solutions: next generation standard solutions
- Strengthen competence to simplify and develop cost-efficient solutions
- Support and challenge operators on simplification: system solutions, technical requirements and documentation
- Use period of reduced activity level to grow competence and make solutions to secure future growth

EXPECTATIONS TO KEY PLAYERS (2:3)

Research institutes:

- Adapt to changing business needs: radical innovation to reduce cost
- Develop and maintain world leading infrastructure and competence to support present and future oil and gas business needs
- Pick up and further mature basic research from universities to become applied research and new business solutions needed for cost reduction

Academia:

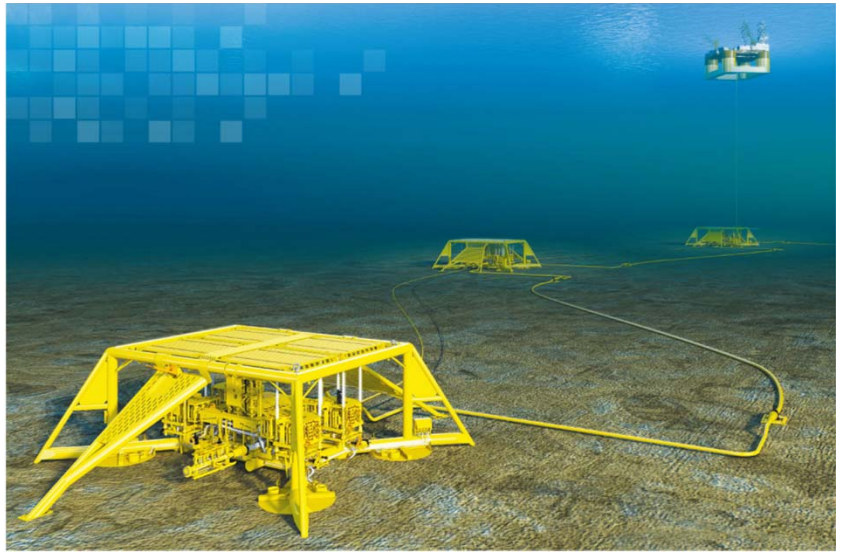
- Strengthen master programs, PhDs and Post Docs positions within core areas for petroleum industry
- Secure higher relevance and quality of eduction and reserch though close interaction with petroleum industry for strategic direction and context. Thereby securing relevant competence profiles of new students to reflect future industry needs
- Develop and maintain world leading infrastructure and competence to support present and future oil and gas business needs

EXPECTATIONS TO KEY PLAYERS (3:3)

Authorities:

- Piloting: Increase support to demonstration/piloting of new technology
- Increase national investments in Large-scale programs targeting the petroleum sector, i.e. Petromaks2
- Continue trend of establishing excellent competence centers with great impact for oil and gas industry, i.e. Centers of Excellence (CoE) and Centers for Research-based Innovation (SFI)
- Increase national investments on research and education infrastructure including laboratories to attract and secure world-leading education, research and development relevant for the oil and gas industry
- Innovation: Continue support to establishment of new businesses delivering products to the oil and gas industry. Continued support to innovation cooperation (GCE and NCE)
- Review regulations with potential for obstructing simplification and cost-effective solutions

OUTLINE



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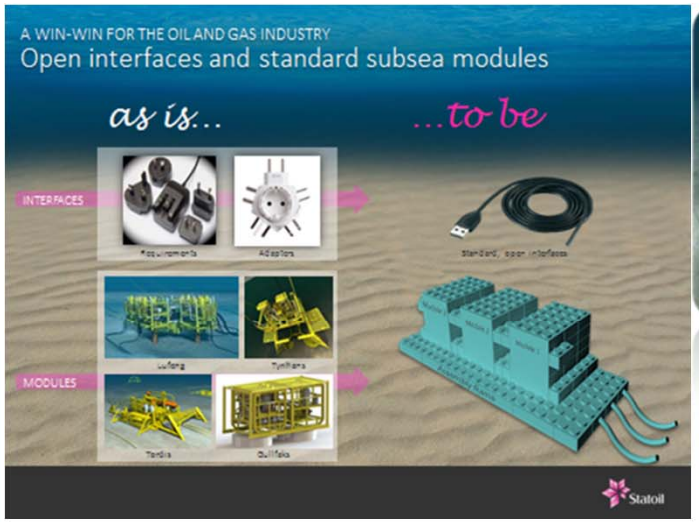
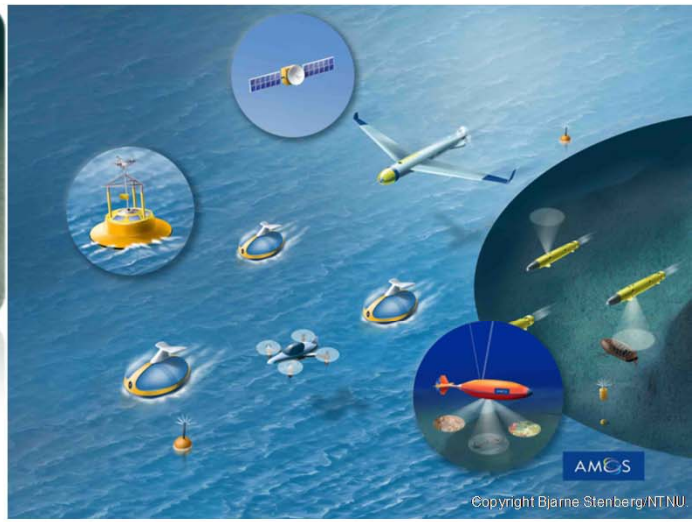
TECHNOLOGY MEASURES TO REDUCE COST: 3-5 YEAR PERSPECTIVE

SUBSEA COST REDUCTION TARGETS

- Standardization and simplification of technical requirements 20%
- Simplify qualification 10%
- Lean subsea concepts, New technology step-change, Competence 25%
- Efficient marine operations (25% improved efficiency) 4%
- OPEX: AUV for IMR 25-30% IMR cost reduction





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