CCS Field Development – Sensitivities and Recommendations

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Energy transition unlocks large investments across multiple industries

Oil & Gas

Avg.2021-25:
Engineering spending:
10-15 BUSD
CAGR: 5-10%

Renewables & Green industries

Avg. 2021-25:
Engineering spending:
50-70 BUSD
CAGR: 15-20%

5X
We solve global energy challenges for future generations
CCS Value Chain and Our Current Effort in the Gulf Basin

CO2 Source to Sink Project Execution Capabilities

- **CO2 Capture**: Shipping Module, Compressor Integration, CO2 Purification, CO2 Dryer, Heat Integration

- **Compression & Liquefaction**: Shipping Module, Pipeline & Landfall, CO2 Pumping, Interim Storage, Metering

- **Transport Hub**: Subsea Injection Systems, Power and Signal Umbilical, Newly Build Platforms w/dry wells, Modification of existing assets

- **Storage Hub**: Pipeline & Landfall, Marine Loading, Engineering, Pipeline Installation, Marine Ops

- **Offshore Transport**: Marine Ops
Through the Life of a Field

**Exploration**
- Geological interpretation
- Drilling
- CO2 Injection site testing

**Development**
- Concept, FEEDs
- Detail design, EPC&I
- Hook-up, completion and commissioning

**CO2 Injection**
- Process optimization; De-bottle-necking; Expansion; Drilling; upgrades; Platform upgrades; CO2 metering?

**P&A and Plugged Well**
- Monitoring and Safe Decommission / Removal
Subsea and Topside Holistic Methodology

**SUBSEA + SURF + TOPSIDES MODIFICATIONS**
- Production case modelling
- Topsides modifications
- Risers & Umbilical’s
- Field architecture and flowlines
- Subsea Infrastructure
- System Integration
- Planning Coordination

**SYSTEM ENGINEERING**
- Overall field layout
- Overall functional requirements and limitations
- Barrier setup and requirements
- Interface handling
- RAMS & technical safety requirements
- System availability
- Expansion requirements

**FIELD DEVELOPMENT PROCESS: WHAT TO CONSIDER?**
- FIXED INPUT: Field specific parameters
- VARIABLE INPUT: Philosophies
- OUTPUT PROCESS: Analyses & optimization
System Integration: Understanding the drives, parameters, philosophies together can create optimized integrated CO2 storage solutions while adding value

**BUSINESS DRIVERS**
- Capex;
- Opex;
- Drillex;
- Abex;
- Injection profiles;
- Availability;
- Start-up date

**FIELD SPECIFIC PARAMETERS**
- CO2 flow/injection rate;
- Pressure;
- Temperature;
- Water Depth;
- Soil Conditions;
- CO2 Properties;
- Design Life;
- Met-ocean Data / Weather;
- Step-out Length (from CO2 capture hub & controls distribution);
- Existing Infrastructure

**HOST PARAMETERS**
- Topside capacity vs. Injection rates;
- Topside power (hydraulic/electrical power) capacity;
- Sizing of existing infrastructure;
- Riser capacity;
- Pressure regimes;
- Weight and space limitations;
- Fiscal metering;
- Utilities available

**PHILOSOPHIES**
- Barrier Philosophy;
- Installation Philosophy;
- RAM philosophy;
- Tooling Philosophy;
- Flow Assurance Philosophy;
- Expansion Philosophy;
- Standardization Philosophy;
- Material Selection Philosophy;
- Well Intervention Philosophy;
- CO2 Operational Philosophy;
- Abandonment Philosophy

**ANALYSES**
- Process Analyses: Main Field Layout; Well Layout (clustering);
- CO2 Distribution Optimization;
- Utilization of seabed space;
- Connection system optimization and selection;
- Specification regime optimization/spec breaks;
- Hydraulic System Design;
- Power & Signal System Design;
- Fatigue Analyses of vertical axis (Wellhead/Riser System)

**AUTHORITIES**

**RULES & REGULATIONS**

**CO2 SITE OPERATOR**
- PROJECT BASIS; FUNCTIONAL DESIGN REQ.; OPERATIONAL & MAINTENANCE REQ.

**STANDARDS AND GUIDELINES**
- REGIONAL AND NATIONAL
Reuse of Existing Assets

**IMPROVED UTILIZATION OF EXISTING ASSETS**
- Capacity upgrades
- Debottlenecking
- Surface Tree Upgrade for CO2 Injection
- Reduction of emissions
- Energy usage optimisation
- Electrification

**SUBSEA CO2 WELLS TIE BACKS**
- Cost efficient Field development
- Reuse of assets
- Maximizing utilization of existing assets

**FACILITY UPGRADES**
- Safety systems upgrades
- Life-Time extensions
- Jacket (Hull) upgrades
- Deck Capacity upgrades
- Electrification

**LATE LIFE & DECOMMISSIONING**
- Cost effective Tail extension
- Seamless transition to Decommissioning
- Disposal & Recycling
- Due Diligence
- Duty Holder

**BROWNFIELD VALUE OUTTAKE**

**Maintenance**
**Modifications**
**Asset Integrity Management**
**Decommissioning**
Technological Enablers: CO₂ Subsea Injection Systems

**TODAY**
Starting point and benchmark

Equinor: Northern Lights Subsea Systems
- Standard XT system configured for Gas Injection
- Northern Lights is a standard 7” VXT with FCM configured for Gas Injection
- ISO / API dictating product layout and complexity
- Not cost optimized for simple CCS Wells

**TRANSITION**
Simplified “available” solutions

What sort of cost reductions can we achieve with currently available technology?
- Ongoing conceptualization on HXT
  - All-electric building block

Add-Ons:
How to simplify VXT stack-up & layout
Potential to modularize into simplified and cheaper solutions?

**FUTURE**
Novel products and solutions
- Based on new governing standards optimized for CCS (simplified)
- Target on significantly reduced cost level
- Assumed significant reduced complexity
- Introduction of the term “injection head” in stead of XT
- Novel solutions and assumed need for new core technology / TQPs
- Electrification and other methods to continue CO₂ offset
Understanding the Market Business Challenges

**Development Drivers**
Understanding what critical values are driving the project
What are the critical success factors

**Injection CO2 Profile**
Fluid challenges
Long field/site life over 60 years

**Technical**
CO2 Injection route options; Long Lead Procurement;
Brownfield Modification; Functional Specification

**Commercial**
Delivery timelines often critical, is it a case w/ CO2 Storage sites? Financial commitment for long lead items to meet CO2 Injection rates; Total cost of ownership
Thank you!

Q&A

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