CCS Field Development – Sensitivities and Recommendations

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GoMCarb Offshore Annual Meeting

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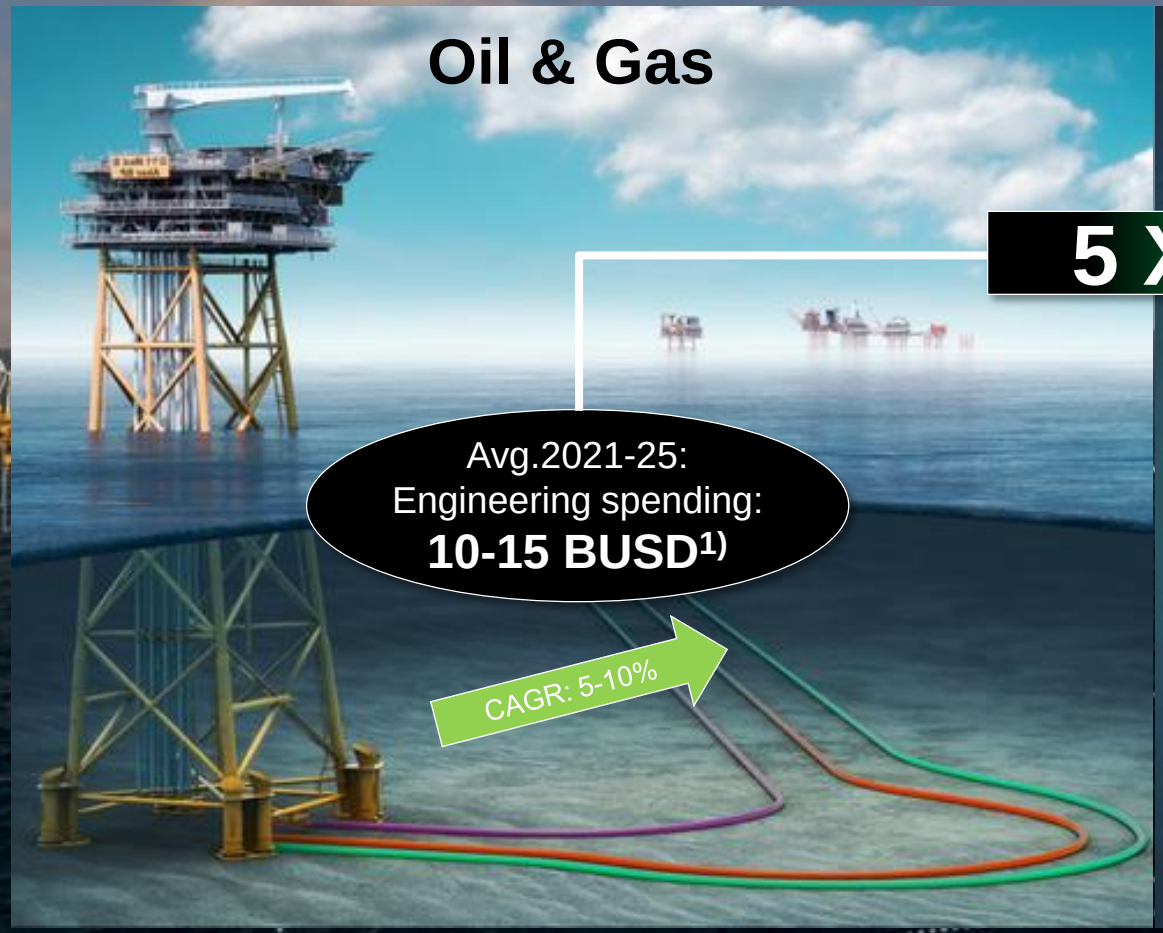
Energy transition unlocks large investments across multiple industries



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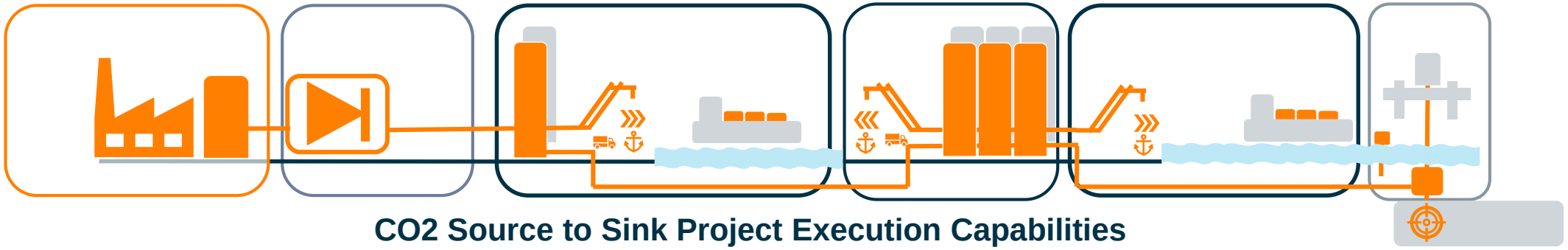
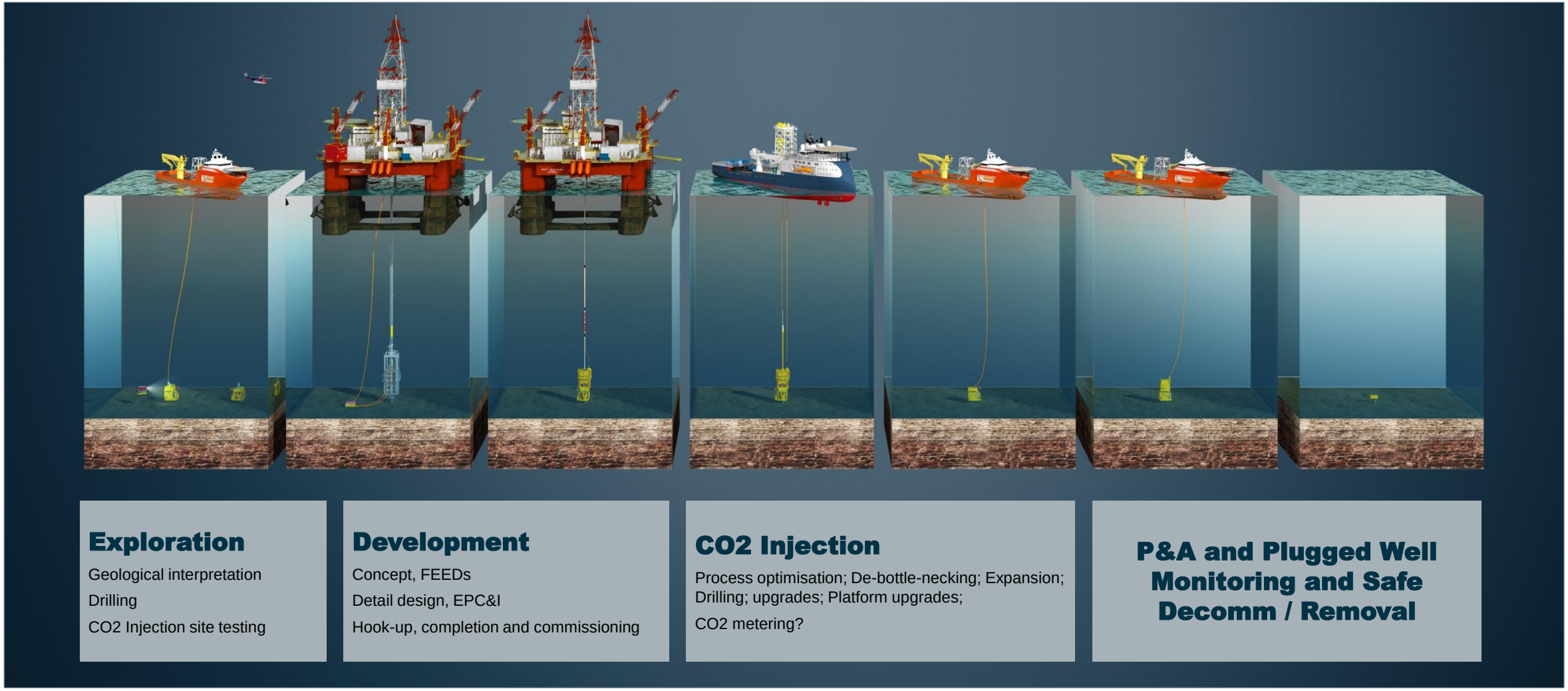
CCS Value Chain and Our Current Effort in the Gulf Basin



CO2 Source to Sink Project Execution Capabilities

CO_2 CAPTURE	COMPRESSION & LIQUEFACTION	TRANSPORT HUB	STORAGE HUB	OFFSHORE TRANSPORT	SUBSEA INJECTION	SUBSURFACE STORAGE
CURRENT PARTNERS	KEY SUPPLIERS	AkerSolutions	AkerSolutions	AkerSolutions	AkerSolutions	CURRENT PARTNERS
AKER CARBON CAPTURE	SIEMENS energy MAN Energy Solutions	- Shipping Module - Compressor Integration - CO_2 Purification - CO_2 Dryer - Heat Integration	- Shipping Module - Pipeline & Landfall - CO2 Pumping - Interim Storage - Metering	- Pipeline & Landfall - Marine Loading - Engineering - Pipeline Installation - Marine Ops	- Subsea Injection Systems - Power and Signal Umbilical - Newly Build Platforms w/ dry wells - Modification of existing assets	agr

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

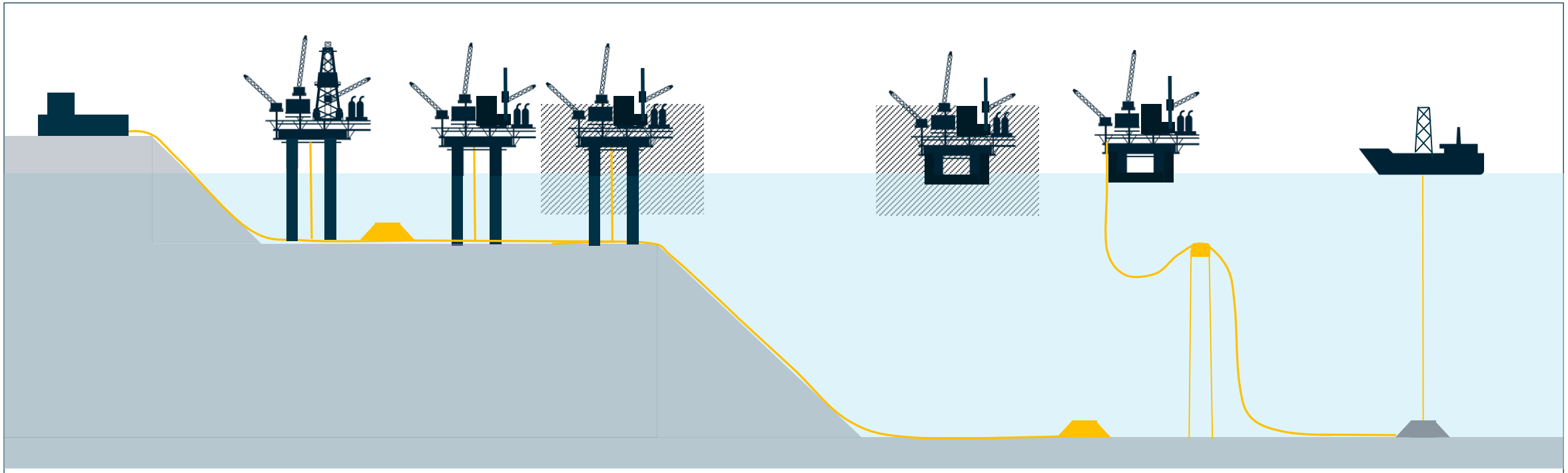
CO2 Injection

Process optimisation; De-bottle-necking; Expansion; Drilling; upgrades; Platform upgrades;

CO2 metering?

P&A and Plugged Well Monitoring and Safe Decomm / 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

- C02 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

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Reuse of Existing Assets

IMPROVED UTILIZATION OF EXISTING ASSETS	SUBSEA CO2 WELLS TIE BACKS	FACILITY UPGRADES	LATE LIFE & DECOMMISSIONING
Capacity upgrades Debottlenecking Surface Tree Upgrade for CO2 Injection Reduction of emissions Energy usage optimisation Electrification	Cost efficient Field development Reuse of assets Maximizing utilization of existing assets	Safety systems upgrades Life-Time extensions Jacket (Hull) upgrades Deck Capacity upgrades Electrification	Cost effective Tail extension Seamless transition to Decom Decommissioning Disposal & Recycling Due Diligence Duty Holder

BROWNFIELD VALUE OUTTAKE

Maintenance

Modifications

Asset Integrity Management

Decommissioning

Technological Enablers: CO_2 Subsea Injection Systems

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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

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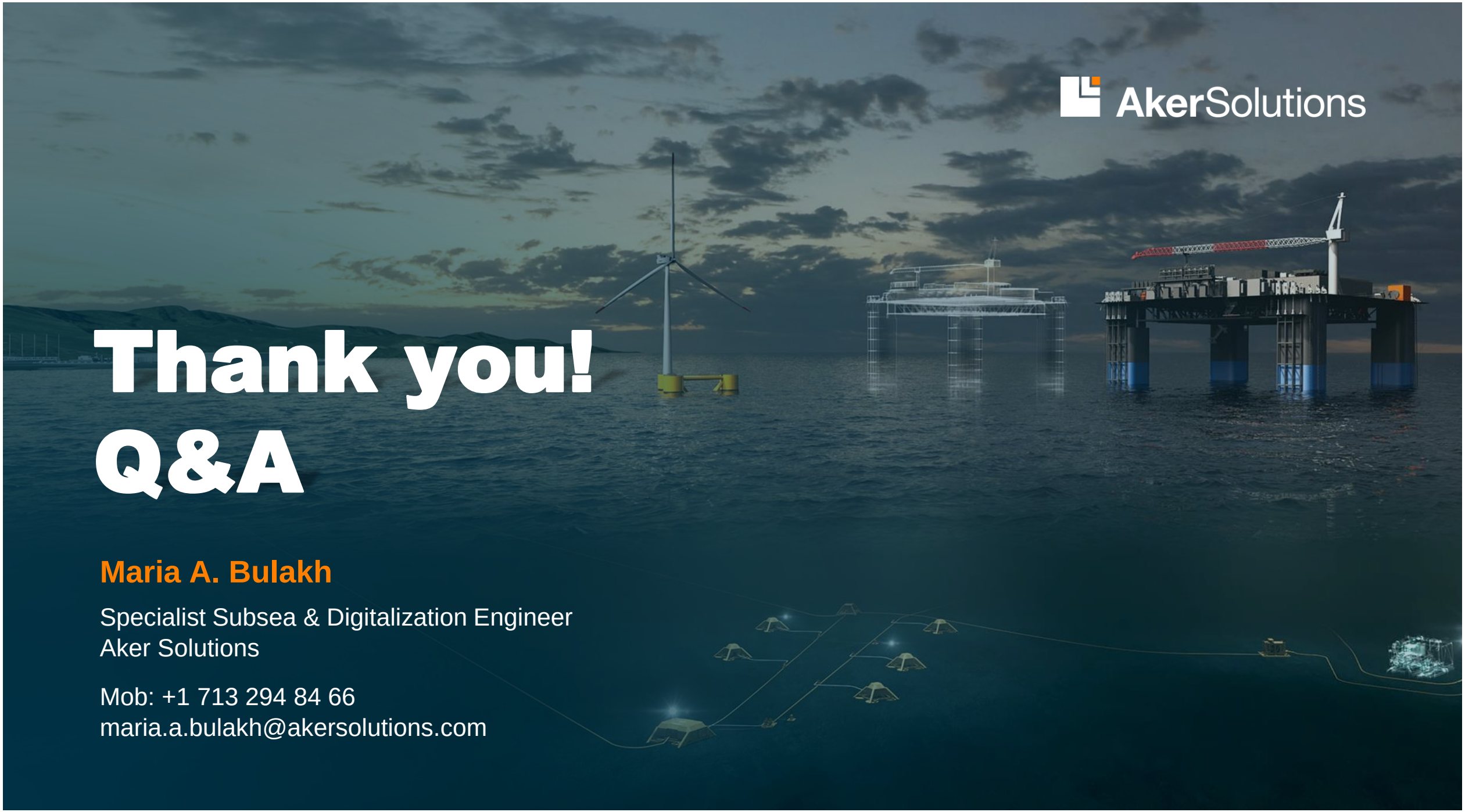

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