DEEPSTAR[®] A Global Offshore Technology Development Consortium



DeepStar briefing & updates

The Nippon Foundation International Symposium 2022

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DeepStar Membership & Benefits

2022/2023 Core Program Year (May 2022 – May 2023)

Core members/operators

\$100,000 fee annually (May 2022 - May 2023)

Benefits/leverage value

- Get over 50 times of leverage value with \$100,000 membership fee to access over \$5 million of projects
 - Access to more than \$1.2 million of core projects Deliverables & reports for all (13) Core projects selected for the 2022/2023 DeepStar Program year (May 2022 – May 2023)
 - Access to multi million-dollar of partnership projects Deliverables & reports for over \$4 million of Nippon Foundation (NF) DeepStar partnership (17) projects from May 2022 to May 2023
- Influence future partnerships with DOE, and other entities
- Collaborative discussions amongst members and industry partners on mutually beneficial topics
- Technical forums & workshops to align industry and develop solutions
 - DeepStar Technology Symposium May 5, 2023
- Reduce satellite project administration cost by 25% -
 - $\,\circ\,$ Core Member company pays a discount rate of 10% for the administration fee
 - $\circ~$ non-Core Member company pay a 35% administration fee on any DeepStar Satellite project.





DEEPSTAR® PROJECT

Leading the technology development to meet the industry's deepwater business needs.

FINAL REPORT RELEASE

Continuing Service Guidance for Aging Floating Infrastructure

> iber: DeepStar* Phase XII CTR -12401 Continuing Service Ving Floating Infrastructure

DeepStar[®] Global Offshore Technology Development Consortium 31 Years of Industry Excellence

DeepStar Recruiting Members for DeepStar 2022

DeepStar is the industry's longest running and successful offshore most technology development consortium and it has generated significant value by providing technology transfer to its members and the industry. There is an increased need in the industry for an operatordriven, collaborative technology development program.

DeepStar[®] Core + Satellite Model

Core Program

DeepStar CORE Program focuses on all members' collaborative technology needs; common discusses industry technology issues and develops ideas for larger, elective satellite projects.

Satellite Projects

Focuses on elective Satellite Projects in which the technology advancement is aided by collaborative among interested parties.



Woodside

DeepStar 2022 Model



DeepStar[®] Technical Subcommittees

- **Drilling, Completion and Intervention**
 - Surface Controlled Subsurface Safety Vales
 - High temperature high pressure (HPHT) reservoir monitoring
 - Smart dissolvable plugged nozzle assemblies

Flow Assurance

- Asphaltene Deposition Studies
- Characterization of Hydrates Formed in CO2
- Hydrogen-Natural Gas Blends Phase Behavior for Pipeline Transport of Low-Carbon Energy
- Prevention and Remediation of Asphaltene

Subsea Systems Engineering

- Nanosorbent Technology Platform
- Wireless Communication System
- Study on combined systems of floating offshore wind, wave energy and subsea battery
- Subsea Chemical Storage and Injection System
- **Floating Production Systems & Met-Ocean**
 - Mooring Integrity by Using Machine Learning
 - UT Drone for offshore inspections
 - Vibration Predicting Method Study for risers
- **Autonomous Operations**
 - Robotic Intervention During Outages NUF
 - Explosion proof autonomous inspection
- Green House Gas Emissions / Carbon Abatement
 - Carbon capture, utilization, and storage (CCUS)
 - Other related techs including renewables

Other project areas included:

- Geoscience
- Reservoir

DeepStar Membership Fee

- Core Member (\$100,000 annual)
- Associate Member (\$15,000 annual)

Present DeepStar Core Members



DeepStar Associate Members & Contractors

Aker Solutions	ALTISS Technologies	AMOG Consulting
Baker Hughes A GE Company	Colorado School of Mines	Daido Steel Co.
Det Norske Veritas	FSubsea	Genesis / TechnipFMC
Halliburton	JGC Holding Corporation	JETRO
Mitsubishi Heavy Industries	Nagano Keiki	Nissan Chemical Corporation
Ocean Power	OTM Consulting	Reaction 35 LLC
Rice University	SAIPEM	SBM Offshore
Schlumberger	Shimadzu Corp	Spire Engineering
SOFEC	Stress Engineering	Strohm
Subsea 7	Tridiagonal Solutions	Veros Systems
Yokogawa Electric	University of Tulsa	

DeepStar[®] 2022/2023 Board & Management Structure



DeepStar Program Framework



Core Program

- Funded with membership fees from core members, associated members, admin fees from Satellite program and Partnership program
- Focused on small projects and multiphase projects on common industry needs
- Set to develop ideas for Satellite program
- Core members can participate in Satellite projects with only 10% project admin fee
- Proposal due date: May 31, each year
- Project selection date: Aug, each year



Satellite Program

- Satellite projects are funded with separate cash calls from the project participants (mainly operator companies)
- A Satellite project must be led by at least one DeepStar Core operator company
- Non-DeepStar members/operators can participate in any Satellite project with 35% project admin fee
- Two participants can start a Satellite project
- Proposal due date: anytime

DeepStar Program Framework (cont.) Partnership Program Nippon Foundation (NF) DeepStar Partnership



(The first MoU for NF DeepStar Partnership 2019-2022 signed in May 2018; and second MOU for 2022 – 2026 signed in Dec 2022)

- Projects are funded with financial support from the Nippon Foundation (80%) & Japanese vendors (20%); and guided with technical support from DeepStar core operators
- Proposals are evaluated, reviewed, and selected by DeepStar; and approved by NF
- Projects are managed by DeepStar (guided by DeepStar champions & chairs)
- DeepStar Core members can access to NF DeepStar partnership projects without additional cost reports/deliverables are shared with all DeepStar Core members
- Project contractors/vendors are Japanese companies or other companies collaborated with Japanese companies
- Funded 12 new DeepStar 2022/2023 phase 1 projects in 2nd MOU along with funding 5 existing phase 2 projects in 1st MOU.
- Submit proposals(one-pagers) to the Nippon Foundation between Jan 14 and Feb 14, each year (or any updated dates Nippon Foundation provides).

Nippon Foundation DeepStar Partnership Projects (2022 - 2023)

(new projects & phase II projects)

Subsea Systems Engineering

Nanosorbent Technology Platform for the Removal and Recovery of Metals from Produced Water

Application Study and Field Trial of Omni-Directional Optical Wireless Communication System

Feasibility Study on combined systems of floating offshore wind, wave energy and subsea battery

Greenhouse Gas & Carbon Abatement

Optimization of compression performance of CCUS using process model-based control technology

- Semipermanent Ocean Bottom Seismic Node for CCS monitoring
- Wave Energy Harvesting System Utilizin
 PVDF Piezoelectric Film
- Ammonia Production Offshore Gas Monetization



- UT Drone for offshore inspections
- Flow-Induced Vibration Predicting Method Study for Subsea Flowlines/Risers

Autonomous Operations

- Robotic Intervention During Outages NUF
- PoC of YRSP (Yokogawa Robotics Services Platform) and EX ROVR (explosion proof autonomous inspection robot developed by Mitsubishi)
- Reducing operational and capital risks through unified PPSO process & turbomachinery automation solution development

Flow Assurance

- Hydrogen-Natural Gas Blends Phase Behavior for Safe Offshore Pipeline Transport of Low-Carbon Energy
- Prevention and Remediation of Asphaltene Deposition and Hydrate Formation at Field Conditions -Assessment and Modeling

Drilling, Completions & Intervention

4

- Thermally Stable CRA and Sealing Technology for Enhanced Geothermal Systems
- Establishment of cost-effective monitoring method for HPHT reservoir and downhole by using P-T sensorequipped flowable ball
- Smart Dissolvable Plugged Nozzle Assemblies (DPNAs) to be Installed on Limited Entry Liners with Tracer -Release Capability for Extended Reach Deviated Wells

DeepStar 2022/2023 Program Projects

(DeepStar Core Program Projects & Satellite Projects)



Drilling, Completions & Intervention

 Electric surface controlled subsurface safety valves (SCSSV)

Fixed Floating Offshore Production & Metocean

- Inverse Wave Field Estimation and Mooring Integrity by Using Machine Learning
- Fiber Ropes to Replace Top Chain for Offshore Mooring- Extended Marine Exposure
- Surface Current Imager Nowcast System (SCINS)



Greenhouse Gas Emissions & Carbon Abatement

- Dynamic HVDC (high voltage direct current) TQ
- Renewables for Subsea Power
- Subsea Processing Impact on GHG emission and decarbonization

Flow Assurance

- Asphaltene Deposition Studies in Pipe Flow Conditions
- Characterization of Hydrates Formed in CO2-Rich Systems
- Hairy-Nanoparticles to Prevent Asphaltene
 Deposition in the Near-Well Region

Autonomous Operations

Electrification of normally unattended facilities (NUF) NUF without HVAC (heating, ventilation, airconditioning) system



Subsea Systems Engineering

- Optimized Chemicals for Subsea Chemicals Storage and Injection Systems (SCSIS)
- Subsea Chemical Storage and Injection System
- Brownfield AUV: Subsea Control System Interfaces Supporting Subsea Wireless Devices
- Low-cost thickness sensors for subsea applications



Nippon Foundation & DeepStar Partnership

Advisory Committee

DeepStar Core Members/Operators (Chevron, CPC, Equinor, ExxonMobil, HESS, JX Nippon, Oxy/Anadarko, Petrobras, Shell, and TotalEnergies)



Projects Focus Areas ¹ DeepStar Focus Areas: Drilling, Completions & Intervention

Projects Ideas

Contractor Network

Subsea Systems Engineering Fixed Floating Production Systems & MetOcean

Flow Assurance

Autonomous Operations

Greenhouse Gas & Carbon Abatement

Management

Funds

Partnership Funding and Time:

- First round partnership signed in 2018, Nippon Foundation provides \$10 million from 2019 to 2022
- Second round partnership signed in 2021, Nippon Foundation provides \$10 million from 2022 to 2026

Technology Service Providers:

Japanese technology companies and international technology companies

Nippon Foundation DeepStar Partnership New Program (2022 - 2026)

Themes added

- 1. Geothermal generation by using high temperature in preserver (renewable energy)
- 2. Wind power/Ocean current power generation to supply offshore oil & gas production facilities (renewable)
- 3. Cost reduction technology for flammable gas removal and re injection at production facilities (global warming)
- 4. Establishment of oil spill drift forecast simulation method by using local ocean current monitoring by aerial drone (marine environment)
- 5. Hydrogen related technologies
- 6. Safety related techs including NUF (normally unattended facilities) and robotics
- 7. Water treatment related technologies

The second MoU for the Nippon Foundation and DeepStar Partnership (2022 – 2026)

signed virtually on Dec 6, 2021 (Japan time)



https://www.nippon-foundation.or.jp/.../20211206-65274.html Nippon Foundation, DeepStar Launch Joint (oedigital.com)

DeepStar expectations for Japanese companies

- Communicate with the Nippon Foundation and DeepStar to understand general needs for proposals requested funding from the NF DeepStar Partnership Program.
- Engage with DeepStar core members/operators to understand DeepStar operators' business and technical needs.
- Find overlapped areas between the needs of DeepStar operators and the technical capabilities of Japanese companies.
- Develop ideas for proposals in such overlapped areas a Japanese company can also work with another international tech company to jointly deliver a project.
- Convince at least one technical representative from a DeepStar core member/operator to champion the idea to develop it into an official proposal.
- Submit the one-pagers/proposals to the Nippon Foundation between Jan 14 and Feb 14, 2023 (or any updated dates Nippon Foundation provides).
- Plan to attend the DeepStar Technology Symposium on May 5, 2023, in Houston.
- Get ready to start the projects by June 2023 (if the proposals are approved).
- Proactively get engaged with DeepStar core companies during the project work.

DeepStar recent technology deployments

Examples	No 1: Surface Current Imaging Nowcast System	No 2: Topside Monitoring of Subsea Pump Systems	No 3: Database of Mooring Integrity Issues and Lessons Learned
Value Proposition	 Accurately reporting real- time surface current Out-of-water instrument easy to maintain Cost effective 	 Monitoring mudline pumps and ESPs (electric submersible pumps) Minimizing down time of rotating equipment 	 Preventing the same mooring failures from happing again Industry wide influence
Key Suppliers	Areté	Veros / Baker Hughes	Spire Engineering
Operators	Chevron, Shell, TotalEnergies, Equinor, ExxonMobil, Oxy, Petrobras, JX Nippon	Chevron, ExxonMobil, Oxy, Shell, Petrobras, Equinor, JX Nippon, TotalEnergies	Chevron, Equinor, ExxonMobil, Hess, Oxy, JX Nippon, Petrobras, Shell, TotalEnergies, CPC
		Host floater	AND







DeepStar recent technology deployments (cont.)

Examples	No 4: Surface Controlled Subsurface Safety Valves (SCSSV)	No 5: 20K HPHT Vérification and Validation	No. 6: Cost-effective monitoring method for High Temperature High Pressure – Flowable Sensor Ball
Value Proposition	 Maintaining production following valve failure Remedy for chronic failures 	 Better apply API 17TR8 for design verification and validation Industry wide influence 	 Cost-effective alternative to production logging Applicable in extreme downhole conditions
Key Suppliers	Baker Hughes, GE	Structural Integrity Associates	Nagano Keiki & Damorphe
Operators	Chevron, Equinor, Petrobras, and Tullow Oil	Chevron, Equinor, ExxonMobil, Oxy, TotalEnergies	Chevron, Shell, TotalEnergies, Hess, Equinor, ExxonMobil, Oxy, Hess Petrobras, JX Nippon





DeepStar Contacts



General contacts

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Technical sub committee contacts

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Flow Assurance co-chairs

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www.theDeepStar.com

Back-up Slides

DeepStar 2020/2021 Program Projects

(DeepStar Core Satellite projects)



Drilling, Completions & Intervention

- Topside Monitoring of Subsea Pump Systems
- Through Tubing Surface Controlled Subsurface Safety Valves (continues satellite project)

Fixed & Floating Offshore Production

- Database of Mooring Integrity Issue and Lesson Learned
- Management of Safety Devices in a NUF Environment
- Floating Production Normally Unattended Installation (NUI)



Flow Assurance

- Hydrate Formation and Transportability in Co2 Rich Systems
- Hairy-Nanoparticles to Prevent
 Asphaltene Deposition in the Near-Well
 Region
- Optimal facility operability envelope in erosion / corrosion environment



Subsea Systems Engineering

- Remote zero carbon power for electric subsea operations
- AUV Interface Standards Phase 3
- Application for Thermoplastic Composite Pipe in Deepwater
- Subsea Large Particle Detector
- AUV Collision De-Risking via Simulation
- 20Ksi HPHT Vérification and Validation

DeepStar 2021/2022 Program Projects

(DeepStar Core Program Projects & Satellite Projects)



Drilling, Completions & Intervention

- Waste Completion Fluids to Clear Brines
 - Through Tubing Surface Controlled Subsurface Safety Valves (continues satellite project)

Fixed Floating Offshore Production & Metocean

- Database of Mooring Integrity Issu PHASE 2
- Testing of Serpentina FPSO HMPE Mooring Ropes
- Qualification of Fiber Ropes to Replace Top Chain for Offshore Mooring
- Surface Current Imager Nowcast System (SCINS)



Flow Assurance

- Effect of JT cooling on hydrate formation and deposition mechanisms
- Large scale, multiphase flow wax deposition for crude oil systems – UPDATED
- Hairy-Nanoparticles to Prevent Asphaltene Deposition in the Near-Well Region

tonomous Operations

Management of Safety Devices in the NUF Environment – Stage 2 – Overpressure Protection (PSVs) Management of Safety Devices in the NUF

Environment – Stage 2 – Fire and Gas detection



Subsea Systems Engineering

- Applying Free Space Optics subsea wireless communication
- Barrier fluid-less subsea condensate
 pump
- Applications for Thermoplastic Composite Pipe in Deepwater
- Analysis of Reliability and Availability of Subsea Chemical Storage and Distribution System
- Gas/liquid separation at high pressure
- Pipeline Plug Phase II: Localization
 using Acoustics

Nippon Foundation DeepStar Partnership Projects

(2020 - 2022)

Subsea Systems Engineering

Subsea Omni Directional Optical Wi-Fi System Demonstration of Layout Free & flexible Directional UOWC system

Autonomous Operations

- Reducing operational and capital risks through unified FPSO process & turbomachinery automation solution development
- Standardization of Inspection to Enable Digital Twin

Fixed Floating Offshore Production

- Acid Gas Removal (AGR) and Reinjection Project
- Flow-Induced Vibration Predicting Method Study for Subsea Flowlines/Risers



Flow Assurance

- NanoActive EFT (Enhanced Flowback Technology) for Offshore Application -Nissan Chemical Corporation
- Prevention and Remediation of Asphaltene Deposition and Hydrate Formation at Field Conditions -Assessment and Modeling

Drilling, Completions & Intervention ESP with Magnetic Drive System (MDS) for Deep WaterSurface Controlled Subsurface

4!

- Establishment of cost-effective monitoring method for HPHT reservoir and downhole by using P-T sensorequipped flowable ball
- Smart Dissolvable Plugged Nozzle Assemblies (DPNAs) to be Installed on Limited Entry Liners with Tracer -Release Capability for Extended Reach Deviated Wells



Nippon Foundation & DeepStar Partnership

Advisory Committee

DeepStar Core Members/Operators (Chevron, Equinor, ExxonMobil, HESS, JX Nippon, Oxy/Anadarko, Petrobras, Shell, and TotalEnergies)



Projects in 2021/2022

Second Call Phase 2 projects

- Prevention and Remediation of Asphaltene Deposition and Hydrate Formation at Field Conditions Assessment and Modeling (20122) – Yokogawa Electric Corp
- 2. Data Standardization Tool Development for Floating Facilities (20144) Mitsubishi Heavy Industries
- 3. Flow-Induced Vibration Study for Intelligent Production Integrity Operating Window (Ip-IOW) module (20143) Mitsubishi Heavy Industries
- 4. Reducing operational and capital risks through unified FPSO process & turbomachinery automation solution development (20142) Yokogawa Electric Corporation
- 5. Establishment of cost-effective monitoring method for HPHT reservoir and downhole by using P-T sensor equipped flowable ball (20152) Nagano Keiki Co
- 6. Smart Dissolvable Plugged Nozzle Assemblies (DPNAs) to be installed on Limited Entry Liners with Tracer Release Capability for Extended Reach Deviated Wells (20153) Daido Steel Co

First Call Phase 2 projects

- 1. ESP with Magnetic Drive System (MDS) for Deep Water (20151) Mitsubishi Heavy Industries
- 2. Acid Gas Removal (AGR) and Re-injection Project (20141) JGC Corp
- 3. Subsea Omni Directional Optical Wi-Fi System Demonstration of Layout Free & flexible Directional UOWC system (20133) Shimadzu Corp
- 4. nanoActive EFT (Enhanced Flowback Technology) for Offshore Application (20121) Nissan Chemical Corp

Nippon Foundation DeepStar partnership projects for 2022/2023 program year

Twelve (12) new projects funded for phase one for 2022/2023 program year (with new MOU)

1. Optimization of compression performance of CCUS using process model-based control technology; DeepStar champions: ExxonMobil & Chevron; Vendor: Omega Simulation

2. Hydrogen-Natural Gas Blends Phase Behavior for Safe Offshore Pipeline Transport of Low-Carbon Energy; DeepStar champions: ExxonMobil & Chevron; Vendor: Omega Simulation

3. Nanosorbent Technology Platform for the Removal and Recovery of Metals from Produced Water; DeepStar champions: TotalEnergies & Equinor; Vendor: Kureha Group

4. Wave Energy Harvesting System Utilizing PVDF Piezoelectric Film; DeepStar champions: TotalEnergies & Chevron; Vendor: Kureha Group

5. Application Study and Field Trial of Omni-Directional Optical Wireless Communication System; DeepStar champions: Chevron, ExxonMobil, Equinor & TotalEnergies; Vendor: Shimadzu

6. Thermally Stable CRA and Sealing Technology for Enhanced Geothermal Systems; DeepStar champions: Chevron & ExxonMobil; Vendor: Daido Steel

7. UT Drone for offshore inspections; DeepStar champions: Chevron, Petrobras, Shell & ExxonMobil; Vendor: Terra Drone

8. Feasibility Study on combined systems of floating offshore wind, wave energy and subsea battery; DeepStar champions: Chevron & ExxonMobil; Vendor: JGC Corp.

9. Semipermanent Ocean Bottom Seismic Node for CCS monitoring; DeepStar champions: TotalEnergies and Chevron; Vendor: Nippon Marine Enterprise

10. Robotic Intervention During Outages NUF; DeepStar champion: Chevron; Vendor: Hibot

11. Ammonia Production – Offshore Gas Monetization; DeepStar champions: ExxonMobil, Chevron & Shell; Vendor: MHI (Mitsubishi Heavy Industries)

12. PoC of YRSP (Yokogawa Robotics Services Platform) and EX ROVR (explosion proof autonomous inspection robot developed by Mitsubishi); DeepStar champions: Chevron, TotalEnergies & Petrobras; Vendor: Yokogawa Electric

Nippon Foundation DeepStar partnership projects for 2022/2023 program year (cont.)

Five (5) phase two projects received funding for 2022/2023 program year (under the previous MOU signed in May 2018):

13. Prevention and Remediation of Asphaltene Deposition and Hydrate Formation at Field Conditions - Assessment and Modeling; DeepStar champions: ExxonMobil, Chevron (Doug Estanga), Petrobras and JX Nippon Oil & Gas; Vendor: Yokogawa Electric Corp.

14. Reducing operational and capital risks through unified FPSO process & turbomachinery automation solution development; DeepStar champions: ExxonMobil and Chevron; Vendor: Yokogawa Electric

15. Flow-Induced Vibration Predicting Method Study for Subsea Flowlines/Risers; DeepStar champions: DeepStar champions: Chevron, TotalEnergies, and ExxonMobil; Vendor: Mitsubishi Heavy Industries (MHI)

16. Establishment of cost-effective monitoring method for HPHT reservoir and downhole by using P-T sensor equipped flowable ball; DeepStar champions: Chevron & Shell; Vendor: Nagano Keiki

17. Smart Dissolvable Plugged Nozzle Assemblies (DPNAs) to be Installed on Limited Entry Liners with Tracer - Release Capability for Extended Reach Deviated Wells; DeepStar champions: Chevron and Shell; Vendor: Daido Steel