

2021 Annual Gulf Coast Ecosystem Restoration Council Report
Texas RESTORE Centers of Excellence
(October 1, 2020 – September 30, 2021)

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I. Executive Summary

As the Texas Governor's appointee to the RESTORE Council, Toby Baker, Executive Director of the TCEQ, has established two Centers of Excellence in Texas in accordance with the requirements set forth in the RESTORE Act and U.S. Treasury regulations. On behalf of Baker and the Governor, TCEQ has received two awards from Treasury. In August 2020, Texas Commission on Environmental Quality (TCEQ) continued to fund the previously competitively selected two consortia, the Texas A&M University Corpus Christi - Texas OneGulf Consortium and University of Houston (UofH) - Subsea Systems Institute. This report focuses on Grant II activities.

OneGulf

The mission of the Texas OneGulf (OG) Center of Excellence is to gather and improve knowledge about the Gulf of Mexico to inform decision-making around the challenges to environmental and economic sustainability of the Gulf of Mexico and its impact on the health and well-being of Texans and the nation. Texas OneGulf is designed with the capacity and flexibility to address all five disciplines denoted in Section 1605 of RESTORE. This Center has been awarded funding for operational purposes, has begun activities on one project, and is receiving project applications for a second project. Highlights for this reporting period include: Geospatial Framework and Analysis for Coastal Resilience, South Texas Coastal Bend project has commenced and have posted a Notice of Funding Available for a second project.

Subsea Systems Institute

The Subsea Systems Institute (SSI) represents a collaboration between the University of Houston, Rice University and NASA/Johnson Space Center. The mission of SSI is to improve the safety and efficiency of offshore energy development by conducting translational engineering and technology development for offshore energy production. The key outcomes from the work of the SSI are:

- Unbiased third-party validation to build public trust in the safety and operation of offshore energy production;
- Deployment of advantaged safest technologies for offshore energy development to ensure safety and operational excellence in offshore applications; and
- Attraction of talent for jobs and investment in the local, state and national economy and reinforce Houston and the state of Texas's reputation as the Energy Capital of the World.

An Advisory Board has been established to guide and support the strategic planning and technical direction of SSI. Membership is on a volunteer basis drawn primarily from industry entities related to their mission.

The scope of SSI research activities includes the offshore technologies shown below:

Hardware	Systems
<ul style="list-style-type: none"> • Drilling <ul style="list-style-type: none"> ○ Risers ○ BOPs ○ Well Control • Wellbore <ul style="list-style-type: none"> ○ Integrity ○ Monitoring • AUVs 	<ul style="list-style-type: none"> • Integrated Systems <ul style="list-style-type: none"> ○ Subsea Power ○ Automation <ul style="list-style-type: none"> ▪ Digitalization ▪ Sensors ▪ Robotics ○ Human Factors • Flow Assurance • Renewable Energy • Emissions Reduction • Materials • Decommissioning

All work of SSI focuses on discipline (3) of Section 1605 of the RESTORE Act “Offshore energy development, including research and technology to improve the sustainable and safe development of energy resources in the Gulf of Mexico.”

II. Programmatic Elements

Award Recipient

Annual TCEQ accomplishments include:

- completed sub-awarding process for two Proposal of Grant Activities to the Centers;
- monitored and reviewed deliverables of Centers;
- responded to inquiries from Centers;
- reviewed invoices and processed eligible expenditure reimbursements;
- generated and submitted required federal reporting;
- participate in associated task forces and advisory boards established by the Texas Centers; and
- oversight of activities for active projects.

Award Subrecipient(s)

Texas OneGulf Consortium

The nine participants in the Texas OneGulf Consortium include:

- Texas A&M University Corpus Christi, Harte Research Institute for Gulf of Mexico Studies;
- Texas A&M University at Galveston, Marine Biology, Science and Engineering Departments;
- University of Houston Law Center, Center for U.S., and Mexican Law;
- Texas A&M University, Center for Translational Environmental Health Research (CTEHR);
- Gulf of Mexico Coastal Ocean Observing System-Regional Association (GCOOS);
- University of Texas Medical Branch at Galveston, Sealy Center for Environmental Health and Medicine (UTMB);
- Texas A&M University, Geochemical and Environmental Research Group (GERG);
- University of Texas Rio Grande Valley, Biological and Environmental Sciences; and
- Texas State University, The Meadows Center for Water, and the Environment.

The five participants in the Texas OneGulf Agency Council include:

- Texas Commission on Environmental Quality
- Texas Division on Emergency Management
- Texas General Land Office
- Texas Parks and Wildlife Department
- Texas Water Development Board

Below is information on the grant activity descriptions (GADs) awarded to date.

GAD 1/Grant II 582-21-22150: General Operations of Center of Excellence project, principals Dr. Kateryna Wowk Porter (Harte) and Dr. David Yoskowitz (Harte), awarded 01/20/2021, Scope of Work - This project's task is to operate the CoE and perform research on the Gulf Coast Region as defined in 31 CFR 34.2. OneGulf will perform research across all five of the CoE disciplines and will use the information to help state and local officials make decisions that will benefit Texas. Status of performance and annual accomplishments include:

- Met the reporting requirements of the COE and continue to oversee the day-to-day operations and administration of the COE.
- Updated and revised the TONE list
- Annually updated the SRAP in consultation with the TOCL and TOAC.
- Fund projects in the best interest of the state of Texas
 - Met with TOAC to identify the priority needs, in consultation with Executive Management, of agency staff and scientists, so that funded projects will reflect with needs expressed by TOAC and are responsive to the SRAP.

- Completed OneGulf Priority Needs

GAD 2/ Grant II 582-21-23371: Geospatial Framework and Analysis for Coastal Resilience, South Texas Coastal Bend project, principals Dr. Kateryna Wowk Porter (Harte) and Dr. Jim Gibeaut (Harte), awarded 06/10/2021, Scope of Work – This project’s task is will improve the science and practice of resilience through completing a quantitative and qualitative resilience assessment template for civic infrastructure, facilities, natural assets and disaster risk factors for three Coastal Bend counties (Nueces, Kleberg and Kenedy) that lack capacity to conduct this work, and develop data and assessment for a web-based, user-friendly, and visually-compelling tool that is extensible and scalable to a wide range of communities, can integrate with existing and future climatological, oceanographic and meteorological models to assess flood, inundation and sea-level rise, and can form the basis for a standard approach to risk assessment and mitigation for communities and their co-located assets.

- This project has launched and begun initial assessments.

Subsea Systems Institute Consortium

Below is information on the grant activity descriptions (GADs) awarded to date.

GAD 1/Grant II 582-21-10565: General Operations of the Center of Excellence

PI: Ramanan Krishnamoorti

Notice to Commence received January 21, 2021

This project covers the overhead and administration costs for the Subsea Systems Institute. This includes part of the overall time and salary cost for the PI and Key Personnel.

GAD 2/Grant II 582-21-22981: Multi-port Energy Router Using Intelligent Transformers (MERIT) to Interconnect Renewable Resources and Subsea Oil and Gas Factories via HVDC Link

PIs: Dr. Harish Krishnamoorthy & Dr. Kaushik Rajashekara, University of Houston

Notice to Commence received March 1, 2021

Project Focus: Power Electronics for Offshore Systems and integration of renewable resources using intelligent energy routers for offshore systems

Objective: To facilitate the co-location of renewable resources (wind, wave, floating solar, etc), energy storage (batteries) and the subsea processing systems regardless of distance from shore or depth of installation. The project also explores the control strategy of the MERIT system to reduce the intermittency of the renewable energy sources, to ensure the safety and stability of the grid interconnection.

Key Findings/Accomplishments:

- Design and Development of Multi-port Energy Router (MER):
 - Design of Power circuit diagram of the proposed MER
 - Determination of the operating frequency of the MER

o Determination of the control scheme of the MER

- Development of a power control scheme for the MERIT system
- Performance validation Resistive-Superconducting Fault Current Limiter (R-SFCL) integrated Direct Current Circuit Breaker (DCCB) topology for different parameter settings of superconducting materials
- Hardware-in-the-loop validation of R-SFCL integrated hybrid circuit breaker for both unidirectional and bidirectional power flow

Industry Impact: The proposed MERIT system incorporates the features like, instantaneous voltage compensation, power outage compensation, fault isolation, and bi-directional power flow capability. Widespread implementation of the developed synergies will improve the economics of both renewables and oil and gas projects and can lead to over 50% reduction in the emissions caused by the activities in oil and gas production.

GAD 3/Grant II 582-21-22982: Asset Integrity of Valves and Bolted Connections

PIs: Dr. Zheng Chen & Dr. Gangbing Song, University of Houston

Notice to Commence received March 1, 2021

Project Focus: Robotics to improve safety and efficiency of offshore operations and ensure asset integrity.

Objective: To develop robotics that will enable valve inspection and operation for offshore oil platforms. To develop tapping-listening approaches to detecting the looseness of flange.

Key Findings/Accomplishments:

- Developed a mobile platform which can climb stairs
- Developed a valve operation and inspection tool
- Developed a lane detection algorithm for the mobile platform
- Developed a machine learning based valve detection algorithm
- Developed a machine learning approach to train in-air and in-water impact-induced sound signals
- Developed a deep learning approach to train in-air and in-water impact-induced sound signals
- Classified flange looseness status to 5 classes using the proposed approaches

Industry Impact: Timely unmanned inspection and operation of valves is the key to extend the lifetime of offshore asset and ensure safety if assets are considered for repurposing (for renewable energy development, reefing, etc).

GAD 4/Grant II 582-21-23426: High Accuracy Localization and Underwater Communication

PIs: Dr. Aaron Becker, Dr. Miao Pan & Dr. Julien Leclerc, University of Houston

Notice to Commence received April 6, 2021

Project Focus: Magnetic induction (MI)-based localization and communication for underwater autonomous agents Objective: To develop methods to perform short distance, high accuracy localization underwater using MI. To use triaxial coil antennas mounted on underwater autonomous agents transmit and receive signals to convey information and determine position and orientation

Key Findings/Accomplishments:

- Utilizing only magnitude information, a particle filter approach has been implemented to determine the relative position between two agents
- Current hardware can detect metallic objects within a few centimeters

Industry Impact: Current underwater localization methods, such as acoustics and optics, have constraints such as multi-path fading and line-of-sight requirements. Even though the MI approach cannot propagate far, it is theoretically less susceptible to environment parameters. This project aims to fill the gap for high accuracy localization and robust communication needs at short distances (less than ten meters).

GAD 5/Grant II 582-21-23428: Developing Bio-Inspired Buoyancy Control for Subsea Service AUVs

PIs: Dr. Zhen Chen, University of Houston & Dr. Fathi Ghorbel, Rice University
Notice to Commence received April 6, 2021

Project Focus: Developing buoyancy control for autonomous underwater service vehicles (AUVs)

Objective: picking up and dropping a tool causes dramatic buoyancy change in service robots, which calls for an efficient and automatic buoyancy control.

Key Findings/Accomplishments:

- Developed a volume-to-electricity engine enabled by reversible fuel cell
- Developed buoyancy control device (BCD) using that engine
- Developed a service robot with BCDs and robotic gripper
- Developed a 6-degree of freedom dynamic model for the service robot
- Developed a hybrid control of hard and soft actuators for both depth and orientation control.

Industry Impact: Service robot with efficient buoyancy control will save energy for AUVs when they deliver and replace tools to subsea infrastructures, which will extend the lifetime of subsea infrastructures and ensure safety if assets are considered for repurposing (for renewable energy development, reefing, etc).

GAD 6/Grant II 582-21-24162: Sensors Based on Organic Electrochemical Transistors (OECTs) for Deep Sea Leakage and Chemical Detection

PIs: Dr. Haleh Ardebili, University of Houston & Dr. Rafael Verduzco, Rice University

Notice to Commence received June 14, 2021

Project Focus: A novel platform for continuous, real-time monitoring of chemicals and contaminants underwater.

Objective: To design, fabricate, and model compact, low cost and autonomous chemical sensors for early detection of leakages and spills in subsea applications.

Key Findings/Accomplishments:

- Fabrication of OECTs is complete
- Device tested to establish baseline conductivity and demonstrate functionality

Industry Impact: Pipeline networks are the most efficient method to transport oil, gas, and other liquids but leaks are common and oftentimes go undetected. A better leak detection method will improve the safety and efficiency of offshore oil and gas production and could be used in the future to monitor for leaks when carbon or hydrogen is stored offshore.

GAD 7/Grant II 582-21-24163: High-Energy and High-Power Quasi-Solid State Lithium Batteries for Subsea Applications

PIs: Dr. Pulickel Ajayan & Dr. Babu Ganguli, Rice University

Notice to Commence received June 14, 2021

Project Focus: Life Extension and Decommissioning of Offshore Assets

Objective: To fabricate quasi-solid state lithium battery by balancing power and energy to be operable at wide temperature range and high pressure

Key Findings/Accomplishments:

- Identified high voltage cathode - High Energy Density
- Cycling studies of quasi solid-state electrolyte with lithium

Industry Impact: This project will provide safe and reliable power supply for charging underwater unmanned vehicles, well monitoring, decommissioning applications to extend operation of offshore infrastructure (including repurposing for renewable energy development, reefing, etc).

Award Subrecipients

Three subawards have been executed by SSI:

- 1) GAD #5-582-21-23428. Pass-through entity is University of Houston to subrecipient: Rice University. Start date 4/6/2021. Met with subrecipients monthly to monitor progress.
- 2) GAD #6-582-21-24162. Pass-through entity is University of Houston to subrecipient: Rice University. Start date 9/1/2021. Met with subrecipients monthly to monitor progress.
- 3) GAD #7-582-21-24163. Pass-through entity is University of Houston to subrecipient: Rice University. Start date 9/1/2021. Met with subrecipients monthly to monitor progress.

III. Financial Elements

TCEQ has received two grants from Treasury to implement the Centers of Excellence program. Grant I amounts: \$4,036,238 awarded on June 9, 2015 and \$2,194,350 awarded on October 31, 2017. Grant II funds were awarded on August 1, 2020 in the amount of \$3,504,900. The Treasury awarded grants address all five disciplines denoted in Section 1605 of RESTORE (1605). On April 28, 2021, TCEQ submitted the close out documents for Grant I to the Department of Treasury.

Award Recipient

A contract with One Gulf was executed on November 16, 2020 for \$1,612,450.00. The Subsea Systems Institute Contract was executed October 5, 2020 for \$1,612,450.00. Through August, \$354,932.82 (22.01%) was invoiced by SSI and \$73,624.98 (4.57%) was invoiced by OneGulf.

Award Subrecipient

Texas OneGulf:

Center	Project	Awarded to Center	Expended through 08/31/ 2021	Lower Tier Subawardee	Awarded to Subawardee
Texas OneGulf	1-22150	\$427,585.00	\$73,624.98	Amazee	\$0
Texas OneGulf	2-23371	\$432,574.00	\$0	Coastal Bend Council of Governments	\$0

Subsea Systems Institute:

Center	Project	Awarded to Center	Expended through 08/31/ 2021	Lower Tier Subrecipient	Awarded to Lower Tier Subrecipient
SSI	1-22029	\$490,022.00	\$58,421.92	N/A	N/A
SSI	2-22981	\$139,500.00	\$76,300.04	N/A	N/A
SSI	3-22982	\$139,500.00	\$124,954.07	N/A	N/A
SSI	4-23426	\$139,500.00	\$48,793.33	N/A	N/A
SSI	5-23428	\$128,264.80	\$42,669.79	Rice University	\$56,664.80
SSI	6-24162	\$127,190.58	\$3,793.67	Rice University	\$55,315.58
SSI	7-24163	\$107,650.00	\$0.00	Rice University	\$93,900.00

Gulf Coast Ecosystem Restoration Council Element

Leveraging Multipliers

OneGulf

GAD1/Grant II 582-21-22150 Coordination between RESTORE Centers of Excellence Texas OneGulf plays a leading role in establishing coordination between both designated and presumptive COE's. There is a monthly call between the Centers, where the focus has been on joint research activities.

The Gulf Restoration Science Programs Ad Hoc Coordination Forum, hosted by the NOAA RESTORE Science Program, provides a venue for all Gulf science programs to come together to develop common data management, share funding opportunities and look for synergies and activities that can be shared. The Texas OneGulf Director and Program Coordinator participate in the monthly call and attend events like the Gulf of Mexico Conference. These face-to-face meetings serve to enhance coordination and joint actions, reduce duplication and afford opportunities to leverage individual actions.

Coordination of Gulf of Mexico Impacts Metrics Working Group

Texas OneGulf played a leading role for establishing the Gulf of Mexico Impacts Metrics Working Group and leads the virtual monthly calls. The Gulf Impacts Metrics Working Group is an ad-hoc, informal collaboration of Gulf scientists and experts working to develop a common approach to understanding “impacts,” meaning the significant economic, societal and/or environmental benefits that result from Gulf science.

The Texas OneGulf Executive Director also serves on the Friends Board of the Florida Institute of Oceanography, providing additional opportunities for coordination of COE funding. This Board also acts as part of the Florida COE Management Team and provides review and approval for funding FLRACEP projects. The management team looks for opportunities to minimize duplication and promote coordinated research.

SSI

SSI participates in monthly coordination calls between the Centers.

SSI participates in the Gulf Restoration Science Program Ad Hoc Coordination Forum hosted by NOAA RESTORE Science Program. SSI participates in events like Gulf of Mexico Conference (GOMCON) to enhance coordination of research efforts.

Funds from the Power electronics-Energy storage-Microgrids and Subsea Electrical Consortium (PEMSEC) have been directed to broaden the scope of GAD 2-582-21-22981. The broader scope is complementary and not overlapping with the tasks listed in the GAD and is enabled by the work funded by SSI.