



THE WYOMING GAS INJECTION INITIATIVE

Progress Report

(Prepared for the Wyoming Joint Appropriations Committee)

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A. OVERVIEW AND OBJECTIVES

The Wyoming Gas Injection Initiative (WGII) has been approved to receive \$22 MM of matching funds from the State of Wyoming (State) to implement, in close collaboration with The Dow Chemical Company and oil and gas Operators (Operator/s), multiple Field Pilot Projects in the State of Wyoming. The initiative involves field pilot testing of advanced enhanced oil recovery (EOR) technologies, such as foam-assisted gas injection using recovered hydrocarbon gases, carbon dioxide, or other gases, for revitalization of oil fields as well as mitigation of greenhouse gas emissions by operations in the State. It also includes laboratory-scale de-risking of the recovery schemes, both research and technical services using site-specific rock and fluid samples at relevant field implementation conditions, at the world-leading Center of Innovation for Flow through Porous Media (COIFPM) of the University of Wyoming (University). Both components (field pilot testing and laboratory-scale studies) will receive funding to advance implementation. This grant will fund projects over a 3-to-5-year period to enhance well productivity and recovery from existing fields/well in the State that are in significant decline. The funding will support the Operator for field implementation and the University for the laboratory work. The total appropriation for this initiative is \$25 MM, however a portion of the funding (\$3 MM) shall be retained for cost overruns, project emergencies, etc. This amount too will be matched dollar-for-dollar.

B. PARTNERSHIP WITH DOW

Dow plays a critically important role in supporting the field implementation and the research activities to be conducted at COIFPM by providing appropriate conformance control agents (foaming additives) and sharing insights from previous field pilot projects. Dow and The University of Wyoming will work closely on evaluating the static and dynamic properties of foams suitable for WGII pilots using the world-class foam generation and evaluation facility at COIFPM (see Sec. I below). They will also actively collaborate with the Operators on reducing the implementation risk of the technology. Specifically, the State-supported field pilot projects will utilize selected surfactant formulations to achieve the goals of improving gas utilization and increasing oil recovery. The Dow Chemical Company has diversified surfactant and solvent portfolios coupled with a strong R&D pipeline to provide solutions for this challenging problem. Moreover, they have well-established surfactant developmental workflows that include all stages from formulation design, through lab-scale synthesis and pilot plant R&D, to the commercial scale deployment. All the available expertise and capabilities will be leveraged to support WGII. Dow will invest up to \$3 MM (in-kind) in support of R&D, depending on the number of projects approved. The support will include items such as formulation design, surfactant recommendations and supply, and foam field trial implementation.

C. REQUEST FOR PROPOSAL

A Request for Proposal (RFP) document for the Wyoming Gas Injection Initiative (WGII) has been composed and is ready to be released in June 2023 to encourage submission of proposals by oil and gas Operators in Wyoming. The document has been reviewed and approved by the stakeholders from Dow and the University of Wyoming as well as members of a technical advisory committee, and contains all the relevant information regarding the objectives of the initiative, budget structure, Operator selection criteria, critical deadlines, and other essential data. The RFP sets the principal objectives for the initiative as field pilot testing of advanced enhanced oil recovery technologies. To this end, all proposed projects must be conducted on existing producing fields/wells in the State. It also lists the measures adopted



concerning laboratory-scale de-risking of the recovery schemes, encompassing both research and technical services using site-specific rock and fluid samples at relevant field implementation conditions. Both the field pilot testing and laboratory-scale studies will receive funding to advance implementation. Projects will be funded to reinvigorate fields that have been in significant decline by enhancing well productivity and recovery. The mechanism of disbursement of funds through the University of Wyoming to support the Operator for field implementation and the University for the laboratory work is outlined in the RFP. The RFP also offers directions and instructions on the mechanism of in-kind contributions that may be used for a portion of the funds, including the required criteria for cash and third-party in-kind contributions. The latter also specify the provisions that the contributions (1) must be verifiable from the Operator's records, (2) are not included as contributions to any other project or program, and (3) are necessary and reasonable for the proper and efficient accomplishment of the proposed project objectives. Lastly, the RFP seeks all relevant supporting information and documents, including details on their geological assets, capabilities, capacities, development strategies, prevision of outcomes, and workforce compositions.

D. ELIGIBILITY

This program is open to all Operators with at least one currently producing field in the State that have the capability to partner in leading-edge research and development to enhance the output and recovery efficiency of the State's existing oil fields. To be considered for the State match, all Operator proposals must provide a written and verifiable statement of commitment of their project funds in the form of a signed letter. In-kind contributions may be used for a portion of the funds, provided the amount is again verifiable, and the approval is solely at the discretion of the University.

E. TIMELINE

Below a tentative timeline for the initial steps is included:

- RFP opens during the month of June 2023.
- Deadline for application submission: four (4) months after the RFP is released. This is intended to provide the Operators with sufficient amount of time to prepare and submit their applications.
- The selected applicant(s) will be notified in about two (2) months after the application submission deadline.

F. BUDGET

The WGII shall distribute the matching funds (\$22 MM from the State) through the University to (i) Operators whose field pilot projects are selected, and (ii) COIFPM to perform the necessary laboratory testing in support of the selected field pilot projects. The total appropriation for this initiative is \$25 MM, however a portion of the funding (\$3 MM) shall be retained for cost overruns, project emergencies, etc. This amount too will be matched dollar-for-dollar.

An approximate distribution of the 22 MM State funds is expected to be:

- \$15 MM to implementing multiple field pilot projects in the State. We intent to support at least three pilots in the first phase.



- \$3 MM to performing advanced research on the related technologies at COIFPM in support of implementation of the field pilots.
- \$4 MM to highly specialized technical services focused on de-risking the technologies through laboratory studies using site-specific rock and fluid samples at COIFPM's technical services branch in support of the implementation of the field pilots.

The entire \$22 MM will be used to match dollar-for-dollar the project funds committed by the Operators and Dow on project specific bases. For each project, the total maximum estimated funding from the State is approximately \$7.33 MM. Additionally, the in-kind contribution from Dow will be up to \$1 MM per project in the form of R&D and research material support (the specific amount to be determined by each individual project scope). **Table 1** lists an example of fund allocation per selected field pilot. The underlying assumption is that the field pilot execution will need 100% of the State matching funds (i.e., \$7.33 MM). In this scenario, the total project estimated cost is \$14.66 MM, whereby the State provides \$7.33 MM, the Operator \$6.33 MM, and Dow \$1 MM. The Operator receives \$5 MM and COIFPM receives \$2.33 MM. One should note that if the selected project has a smaller proposed field implementation budget, the State matching contribution will be reduced proportionally. The State matching funds must be expended in proportion to the project expenditure and spent within the same project period. Selected awardees will be required to document and verify their expenditures. The University may issue multiple awards under this RFP, but not to exceed the \$22 MM State matching funds.

Table 1: Sample Field Pilot Funding Contribution Breakdown

Activity	Implementation Lead	Funding		Matching Fund			Project Total (\$MM)
		Source	Amount (\$MM)	Source	Amount (\$MM)	Comment	
Field Pilot Implementation (In-kind + cash)	Operator	Operator	6.333	State of Wyoming (Cash)	5.000	to Operator (Not to Exceed)	11.333
Advanced Research	COIFPM			State of Wyoming (Cash)	1.000	to COIFPM (Not to Exceed)	1.000
Technology Application/De-risking	COIFPM (Technical Services)			State of Wyoming (Cash)	1.333	to COIFPM (Not to Exceed)	1.333
Conformance Chemical Formulation R&D (in kind)	Dow	Dow	1.000				1.000
							14.666

Contribution Summary

Operator (In kind+ Cash) 6.333

Dow (In kind) 1.000

7.333

State of Wyoming (Matching Fund) 7.333

G. EVALUATION CRITERIA AND AWARD

Proposals will initially be reviewed for compliance regarding proposal format and contents, with special attention given to verification of funding commitments for the pilot. Proposals that are found to be in compliance with the requirements will be further evaluated according to the technical aspects of the project, including the potential well productivity and recovery enhancement impact, as well as the proposed commitment level by the Applicant.



H. APPLICATION SUBMISSION MECHANISM

A dedicated web portal has been designed and built to release the RFP and other essential instructions and materials for the WGII, which will be accessible to the public through the official University of Wyoming website. This web platform is currently undergoing internal testing and is expected to go live during June 2023. The portal will allow interested Operators to submit proposals and supporting materials via an application submission channel. Necessary measures regarding supported file formats and size, confirmative two-way communication, contact forms, and storage for the received proposals as well as security and confidentiality of the documents and information, have been carefully implemented and verified. A dedicated email account, WGII@uwyo.edu, has been created solely for the WGII-related communications and incorporated into the application submission form, which will allow all submitted proposals and supporting information to be received and stored on the assigned data storage platform. If an applicant is unable to submit through the online portal, proposals may also be emailed directly to mpiri@uwyo.edu.

I. ADDITIONAL ACCOMPLISHMENTS

- **Laboratory capability and capacity development:** The Wyoming Gas Injection Initiative benefits from access to the world-class experimental facilities at the University of Wyoming's Center of Innovation for Flow through Porous Media. This is, to the best of our knowledge, the world's largest experimental research facility focused on flow through porous media problems with applications primarily in oil and gas recovery and carbon utilization and storage. It has been developed using more than \$100 million investment and provides imaging and flow capabilities at atomic, nano, micro, and macro scales. Furthermore, it offers a massive capacity for users to conduct numerous studies in parallel.

In this Center, a massive Foam EOR Laboratory has been developed with the capacity to conduct eighteen (18) reservoir-conditions foam evaluation tests in parallel. This unique platform establishes a vital set of capabilities and capacities in support of WGII. For instance, this facility has already been used to complete more than 1,400 high-pressure, high-temperature (HPHT) foam experiments to date, which is, to the best of our knowledge, the world's largest dataset of its kind. The experimental data and insights developed through these studies not only directly support the implementation of the field pilots under WGII but also provide the Dow and COIFPM scientists with the key technical and procedural insights to more effectively de-risk the technology for field deployment.

Furthermore, since the approval of the WGII, significant progress has been made in enhancing the center's capabilities and capacities needed in the de-risking of the foam-assisted gas injection technology, and other recovery processes, using Operators' site-specific rock and fluid samples. Examples of such developments include (i) acquisition, installation, and commissioning of a state-of-the-art robotic (single-arm) x-ray imaging system (imaging resolution: 120 μm per pixel) with the capacity to consecutively scan eight (8) rock samples under two- and three-phase flow conditions, (ii) acquisition of ten (10) new ovens for experiments, (iii) acquisition of (at the final stages of issuing the PO) twenty-five (25) 10,000 psi, Hastelloy dual-cylinder Quizix pumps for flow experiments, and (iv) doubling the capacity (from 4 to 8 rock samples) of the existing robotic x-ray imaging system.



- **Identification and commercialization of superior foaming agents:** COIFPM has identified foaming agents (surfactants) with superior performance through the large set of HPHT foam evaluation tests mentioned above. We are currently taking the necessary steps to (i) protect the intellectual property rights related to these chemicals and (ii) allow the potential production of the superior agent(s) at commercial volumes for potential use in WGII.
- **Establishment of application review committees:** two review committees have been tentatively formed to assist with the application review process: (1) a technical review committee consisting of selected professionals from Dow and COIFPM, and (2) a technical advisory committee that includes at least two senior professionals from the oil and gas industry with experience in EOR processes. These two committees will collaboratively evaluate the WGII applications to be submitted by the Operators in Wyoming. The members of the committees collectively possess significant amount of technical expertise relevant to different aspects of WGII. The review process will include evaluating the Operator profile, reservoir candidates, well and facility information, previous gas injection projects and experiences, data from past laboratory evaluations, proposed timeline and budget, letters of commitment, expansion strategy, etc. Proposals will initially be reviewed for compliance with the proposal format and contents, with special attention given to the verification of funding commitments for the pilot. Proposals found to be in compliance with the requirements will be further evaluated according to the technical aspects of the project, including the potential well productivity and recovery enhancement impact, as well as the proposed commitment level by the applicant.

It is worth noting that the procedures and infrastructures that are being developed for the Phase 1 of WGII will also support the future phases of this initiative.

- **Interactions with potential applicants (oil & gas operators in Wyoming):** Several oil and gas Operators, such as Devon Energy Corporation, True Oil, Occidental Petroleum, Continental Resources, and Denbury Resources, have already expressed interest in joining this initiative. These entities provided formal letters of support in the proposal submitted to the State of Wyoming in December 2021. Furthermore, some of these Operators have already identified candidate sites in Wyoming for consideration for field pilot testing of the techniques discussed earlier in this document. Since the approval of WGII, COIFPM has hosted technical and executive teams from Wyoming oil and gas Operators such as Devon Energy and Occidental Petroleum. The visits included tours of the facility and technical discussions around the Operators' assets in the State, potential candidates for testing the gas injection technology, access to gas, and the infrastructures needed for the field pilot implementations. COIFPM and Dow have also been in contact with True Oil and Denbury Resources regarding the progress of the initiative and the potential release date of the RFP.
- **Financial management:** COIFPM has been working with UW administration to put in place an effective system to administer the exceedingly complex budget of WGII to ensure accurate and efficient financial management of the project. This will support essential components such as financial planning, effective budgeting, and efficient processing of expenses, payments, etc. It will also ensure that we meet the dollar-for-dollar match requirements. To this end, we have started the process to recruit a new staff member to manage such activities, allowing efficient monitoring of the project metrics, financial tracking, data consistency, and potential risks for the WGII.



J. TECHNICAL DATA

The COIFPM and Dow have set the guidelines and benchmarks to evaluate and manage the data to be received from the Operators with their proposals and, later, the data to be generated from the execution of the project plans. The Operators are asked to supply data such as field/reservoir name, locations, rock and fluid properties, original oil in place (OOIP), production history, current forecast (Do Nothing Case), and recoverable volume estimates. These will inform the decision-making process regarding the selection of suitable candidates for the project. This information will also be utilized to evaluate the potential for efficacy of specific gas injection technologies in particular reservoirs proposed by the Operators. Furthermore, candidate field well and facility information such as development well count, well completion detail, DSU details, and well spacing/fracture data (Unconventional reservoir development) will also be considered for proposal selection and field implementation. Access to injection gas, gas composition, presence of gas pipeline, and available injection facilities will be reviewed. Data from previous laboratory evaluations, including oil and gas PVT data, oil viscosity, formation water salinity, and SCAL studies, will be acquired and managed effectively. Furthermore, a data repository system is being implemented for efficient information sharing among participating entities. Portions of the data generated from the field implementations and laboratory-scale tests will be made available publicly to, for instance, inform and optimize the future phases of the WGII project.

K. MARKETING

Shortly after the RFP is released, several announcements on the WGII and RFP conveying the main objectives of the project and eligibility criteria for the applicants will be made through University's websites, and websites of organizations such as Petroleum Association of Wyoming (PAW), Society of Petroleum Engineers (SPE), and Dow Chemical Company. To this end, key highlights about the initiative and RFP will be made available through digital banners and magazine articles. This will enable outreach in the oil and gas community at the State and national levels and procure large-scale exposure for the initiative.