

**INTERAGENCY COOPERATION CONTRACT
BETWEEN
THE RAILROAD COMMISSION OF TEXAS
AND
THE UNIVERSITY OF TEXAS AT AUSTIN
BUREAU OF ECONOMIC GEOLOGY**

This Interagency Cooperation Contract ("Contract") is entered into by and between the **Railroad Commission of Texas** ("RRC"), a state agency located at 1701 N. Congress Avenue, Austin, Texas 78701, and **The University of Texas at Austin Bureau of Economic Geology** ("UT" or "Performing Agency"), a Texas State Agency and Public Institution of Higher Education located at 1900 University Avenue Austin, TX 78705 (individually "Party"; collectively "Parties"), pursuant to the authority granted by and in compliance with the provisions of "The Interagency Cooperation Act," Texas Government Code, Chapter 771 and Texas Utilities Code §104.379.

WHEREAS, the RRC is the state agency that regulates the oil and gas industry, natural gas utilities, pipeline safety, and the natural gas and hazardous liquid pipeline industry, in Texas and has been charged with producing a Catastrophic Weather Event Study on measures to mitigate the impact of catastrophic weather events pursuant to Texas Utilities Code §104.379; and

WHEREAS, the RRC does not have experienced or qualified personnel to produce the required Catastrophic Weather Event Study; and

WHEREAS, the RRC has determined that UT is experienced and well qualified to produce the Catastrophic Weather Event Study through Professor Ning Lin ("Principal Investigator"); and

WHEREAS, the RRC and UT find that it would be in their mutual best interest to enter into this Contract whereby UT agrees to complete the Catastrophic Weather Event Study for the RRC.

NOW THEREFORE, in consideration of the mutual covenants and agreements herein contained, the RRC and UT agree as follows:

I. CONTRACTING AGENCIES.

- 1.01.** The Railroad Commission of Texas (Receiving Agency)
- 1.02.** The University of Texas at Austin Bureau of Economic Geology (Performing Agency)

II. STATEMENT OF WORK TO BE PERFORMED.

2.01. SCOPE OF SERVICES. The Performing Agency shall provide research and consulting services ("Research Program") to the RRC and draft a Catastrophic Weather Event Study ("Study") pursuant to Texas Utilities Code §104.379. In accordance with the statute and research proposal attached as *Appendix A*, hereby incorporated by reference, the Research Program shall conduct a study on measures to mitigate catastrophic weather events, including measures to:

1. Establish natural gas storage capacity to ensure a reliable gas supply, including location, ownership, and other pertinent factors regarding gas storage capacity;
2. Assess the advantages and disadvantages of requiring local distribution companies to use hedging tactics to avoid volatile customer rates; and

3. Assess the advantages and disadvantages of prohibiting spot market purchases during a catastrophic weather event that contribute to volatile customer rates.

2.02. The manner of performance of the Research Program shall be determined by the Principal Investigator in coordination with, and approved by, RRC. RRC desires that the Study, inasmuch as possible, shall be neutral, objective, and focus on providing an in-depth discussion of the advantages and disadvantages of strategies to address the three statutory topics listed in section 2.01 above. The manner of Research Program shall adhere to the following general framework and as further detailed in *Appendix A*:

- i. **Phase I –Initial Research & Project Schedule:** Principal Investigator and team shall make a thorough study of all available resources in order to understand the issues presented in the three statutory topics listed in section 2.01. In this phase, Principal Investigator shall consider the best methodologies for executing the Research Program such as, but not limited to, modeling and case studies from other jurisdictions. The key deliverables in this phase will be: 1) a presentation of findings, based on the initial research; and (2) a proposed Project Schedule with anticipated deliverable due dates and review timelines. At a mutually agreeable time, Principal Investigator and RRC will meet to discuss the progress of the initial research and present the proposed Project Schedule. RRC will provide feedback on both deliverables. The estimated duration of Phase I is twelve weeks.
- ii. **Phase II – Draft Outline:** In this phase, Principal Investigator and team will synthesize the research conducted in Phase I into a detailed outline that addresses each of the three statutory topics listed in Section 2.01. The outline will contain headings, subheadings, and brief descriptions of each major section that will be addressed in the Study. The key deliverable in this phase will be the Outline which will serve as a guideline for producing the Study. At a mutually agreeable time within twenty (20) business days of submission, Principal Investigator and RRC will meet to discuss comments and any proposed additions, clarifications, expansions, or deletions in content. The estimated duration of Phase II is four weeks.
- iii. **Phase III – Present Initial Draft:** In this phase, Principal Investigator will submit a rough draft to RRC, substantially complete, and conforming to the approved Outline, that addresses each of the three statutory topics listed in Section 2.01. The key deliverable in this phase will be a rough draft of the Study submitted to RRC for review and comment. RRC will provide in depth written comments on this draft. At a mutually agreeable time within twenty (20) business days of submission, Principal Investigator and RRC will meet to discuss comments and any proposed additions, clarifications, expansions, or deletions in content. The estimated duration of Phase III is six weeks.
- iv. **Phase IV – Produce Final Draft:** In this phase, Principal Investigator will consider and integrate any comments or critiques of the Initial Draft submitted by the RRC into a Final Draft for submission. The key deliverable in this phase will be the complete Study in final form. RRC shall review the Final Draft and within fifteen (15) business days of submission and either accept or return the Final Draft to Principal Investigator requesting further clarifications and/or edits. This process shall continue until the parties are mutually satisfied that Phase IV is complete. RRC shall provide notice of final acceptance of the Study in writing to the Principal Investigator. The estimated duration of Phase IV is four weeks. **NOTE: RRC must receive the Final Draft no later than September 1, 2022, in order to secure required internal agency approvals in advance of presentment to the Legislature no later than December 1, 2022 as required by statute.**
- v. **Phase V – Study Administration:** This phase covers any administrative tasks following production and acceptance of the Study by RRC through the end of the Contract Term. Specific tasks under this phase are unknown at this time, but may include, without limitation, assisting RRC with answering questions related to the Study, or presenting the findings to targeted audiences.

2.03. RRC understands the Performing Agency may be involved in similar research and consulting services thru other researchers on behalf of itself and others. The Performing Agency shall be free to continue such research and consulting services provided that it is conducted separately and by different

investigators from the Research Program and RRC shall not gain any rights via this Contract to other research

2.04. Time is of the essence in the performance of this Contract. The Performing Agency shall strictly comply with all deadlines, requirements, and standards of performance for this Contract and in execution of the work. Performing Agency acknowledges and accepts all time limits will be strictly construed and rigidly enforced.

2.05. Pursuant to Texas Government Code §771.006, Performing Agency is authorized to subcontract and purchase the services necessary to complete the Research Program, subject to review and approval of subcontractors by the RRC. Any subcontractors providing service under the Contract shall have the same level of experience and expertise as the Principal Investigator, as solely determined by RRC. No subcontract under the Contract shall relieve the Performing Agency of responsibility for delivery of the services required under the Research Program.

III. CONSIDERATION.

3.01. CONTRACT AMOUNT. As consideration for UT's performance, RRC agrees to pay UT an amount not-to-exceed the sum of **TWO HUNDRED TWENTY-TWO THOUSAND FIVE HUNDRED SEVENTY-SEVEN DOLLARS AND NINETY-THREE CENTS (\$222,577.93)** for providing the research and consulting services required to fulfil the initial term of this Contract.

IV. BASIS FOR COMPUTING REIMBURSABLE COSTS.

4.01. REIMBURSABLE COSTS. Expenditures shall be reimbursed on a cost-reimbursable basis in accordance with the budget attached hereto as *Appendix A*. Reimbursable costs may include travel expense which shall be paid in accordance with state travel and per diem requirements as administered by the Comptroller of Public Accounts in accordance with Chapter 660 of the Texas Government Code and other state law for actual costs incurred. It is not foreseen that travel expenses will be incurred under this Contract, and any such expenses must be approved by RRC in advance.

V. PAYMENT FOR SERVICES.

5.01 PAYMENT. Payments shall be made by the Receiving Agency on a cost-reimbursable basis upon receipt of monthly invoice from the Performing Agency for actual expenditures. Payments under this IAC are due within thirty (30) days from receipt of invoice through the Interagency Transaction Voucher ("ITV") process, in accordance with § 771.008 of the Texas Government Code.

5.02. PAYMENT METHOD. ITV INFORMATION. The FY22 RTI is 223842. The Vendor Number is 3721721721, The Mail Code is 012.

VI. TERM OF CONTRACT.

6.01. TERM. This Contract shall be effective upon the date of the last Party's signature to the Contract and shall continue through August 31, 2023, unless terminated earlier by either party, as provided in Section 6.02

6.02. EARLY TERMINATION. Either party may terminate this Contract, with or without cause at their sole discretion, upon forty-five (45) days prior written notice to the other. Upon receipt of notice of early termination, RRC shall cancel, withdraw, or otherwise terminate outstanding orders which relate to the performance of this Contract and shall otherwise cease to incur any future costs under this Contract. Early termination will be subject to an equitable settlement of the respective interests of the parties accrued up to the date of termination, including but not limited to payment for all work satisfactorily performed up to the

effective date of termination. If this Contract is terminated for any reason, neither party shall be liable for any damages, claims, or losses, or any other amounts arising from or related to any such termination

6.03. AMENDMENT. Performing Agency shall maintain an ongoing relationship with the RRC during the Contract Term and will collaborate with the RRC on any modifications that may be necessary to the Services to meet the objectives of the Contract. A change may not be made to the Services except by written request signed by the RRC and Performing Agency (an "Amendment"). Each Amendment shall be sequentially numbered and deemed to automatically incorporate the terms of this Contract. Any alterations, additions, or deletions to the terms of this Contract shall be by an Amendment, in writing and executed by both Parties to this Contract. Costs not included and pre-approved by the RRC shall not be eligible for reimbursement.

VII. FUNDING.

7.01. NO DEBT. This Contract shall not be construed as creating any debt on behalf of the State of Texas and/or RRC and/or the Performing Agency in violation of TEX. CONST. art. III, § 49. In compliance with TEX. CONST. art. VIII, § 6, it is understood that all obligations of RRC hereunder are subject to the availability of state funds. If such funds are not appropriated or become unavailable, this Contract may be terminated. In that event, the parties shall be discharged from further obligations, subject to the equitable settlement of their respective interests accrued up to the date of termination.

VIII. CLAIMS

8.01. Both parties agree that upon receipt of a notice of claim or action arising out of the Research Program, the party receiving such notice will notify the other party promptly. RRC agrees, to jointly coordinate any defense against any actions brought or filed against UT, System, their Regents, officers, agents and/or employees with respect to the services provided to RRC under this Contract, whether such claims or actions are rightfully brought or filed; and subject to the statutory duty of The Texas Attorney General.

IV. FORCE MAJEURE.

9.01. FORCE MAJEURE. Except as otherwise provided, neither RRC nor UT is liable to the other for any delay in, or failure of performance, of a requirement contained in this Contract caused by force majeure. The existence of such causes of delay or failure shall extend the period of performance until after the causes of delay or failure have been removed, provided the non-performing party exercises all reasonable due diligence to perform. Force majeure is defined as acts of God, war, strike, fires, explosions, or other causes that are beyond the reasonable control of either party and that by exercise or due foresight, such party could not reasonably have been expected to avoid, and which, by the exercise of all reasonable due diligence, such party is unable to overcome. Each party must inform the other in writing with proof of receipt within three (3) business days of the existence of such force majeure.

X. MISCELLANEOUS PROVISIONS.

10.01. INCORPORATION BY REFERENCE. Incorporated by reference the same as if specifically written herein are the rules, regulations, and all other requirements imposed by law, including but not limited to compliance with those applicable rules and regulations of the State of Texas and the federal government, all of which shall apply to the performance of the services under this Contract.

10.02. GOVERNING LAW AND VENUE. This Contract shall be governed and construed in accordance with the laws of the State of Texas. **VENUE OF ANY SUIT BROUGHT FOR BREACH OF THIS CONTRACT SHALL BE FIXED IN ANY COURT OF COMPETENT JURISDICTION IN TRAVIS COUNTY, TEXAS; provided, however, the foregoing shall not**

be construed as a waiver of sovereign immunity by either party.

10.03. DISPUTE RESOLUTION. The parties agree to use good-faith efforts to decide all questions, difficulties, or disputes of any nature that may arise under or by this Contract; provided however, nothing in this paragraph shall preclude either party from pursuing any remedies as may be available under Texas law.

10.04. SEVERANCE. Should any one or more provisions of this Contract be held to be void, voidable, or for any reason whatsoever of no force and effect, such provision(s) shall be construed as severable from the remainder of this Contract and shall not affect the validity of all other provisions of this Contract, which shall remain of full force and effect.

10.05. HEADINGS. The headings contained in this Contract are for reference purposes only and shall not in any way affect the meaning or interpretation of this Contract.

10.06. NOTICES. Any notice required or permitted to be delivered under this Contract shall be deemed delivered when deposited in the United States mail, postage prepaid, certified mail, return receipt requested, addressed to RRC or UT at the addresses set forth below:

RRC:

The Railroad Commission of Texas
Attention: Theresa Lopez, Director of Procurement and Contracts
1701 North Congress Ave
Austin, TX 78701

UT:

The University of Texas at Austin
Attention. Dr. Ning Lin
P.O. Box X
Austin, TX 78713

Notice given in any other manner shall be deemed effective only when received by the party to be notified. Either party may change its address for notice by written notice to the other party as herein provided.

XI. ACCESS TO PUBLIC INFORMATION.

11.01. UT is required to make any information created or exchanged with RRC pursuant to this Contract, and not otherwise excepted from disclosure under the Texas Public Information Act, available in PDF or other format that is accessible by the public at no additional charge to RRC.

11.02. During the course of the work and/or services to be provided under this Contract, UT may come in contact with confidential information of RRC. UT agrees to, subject to applicable law and limitation, treat as confidential the information or knowledge that becomes known to UT during performance of this Contract and not to use, copy, or disclose such information to any third party unless authorized in writing by RRC or in accordance with applicable law. This provision does not restrict the disclosure of any information that is required to be disclosed under applicable law. UT shall promptly notify RRC of any misuse or unauthorized disclosure of its confidential information and upon expiration of this Contract shall return to RRC all confidential information in UT's possession or control. UT shall further comply with all the RRC's applicable information security policies.

XII. GENERAL PROVISIONS.

12.01. Both Parties are state agencies whose authority and appropriations are subject to actions of the Texas Legislature. If either Party becomes subject to a legislative change, revocation of statutory authority, or lack of appropriated funds which would render either Party's delivery or performance under the Contract impossible or unnecessary, the Contract will be terminated or cancelled and be deemed null and void. In the event of a termination or cancellation under this section, neither party will be liable to the other party for any damages, which are caused or associated with such termination or cancellation. The party terminating or cancelling under this section shall not be required to provide advance notice.

12.02. The Parties do hereby certify that (1) the services specified above are necessary and essential for activities that are properly within the statutory functions and programs of the effected agencies of State Government, (2) the proposed arrangements serve the interest of efficient and economical administration of the State Government, and (3) the services, supplies or materials contracted for are not required by Section 21 of Article 16 of the Constitution of Texas to be supplied under contract given to the lowest responsible bidder.

12.03. RRC certifies that it has the authority to contract for the above services by authority granted in Tex. Gov. Code Ann., Chapter 771.

12.04. UT certifies that it has the authority to perform the services contracted for by authority granted in Tex. Gov. Code Ann., Chapter 771.

12.05. Neither party may assign its rights or obligations under this Contract without the prior written consent of the other party hereto.

12.06. This Contract contains all of the agreements of the parties hereto, and no verbal or written agreement shall have any force or effect if not contained herein.

12.07. Both parties certify that each is presently and at all times shall comply with all applicable state and federal laws governing or otherwise relating to this Contract.

IN WITNESS WHEREOF, the Parties hereto have made and executed this Contract to be effective as of the date of the last Party's signature hereto. By signatures below, each signatory represents and warrants that they have the authority to execute the Contract on behalf of the respective Party.

RAILROAD COMMISSION OF TEXAS

DocuSigned by:
By: Wei Wang
Wei Wang, 78B01444...
Executive Director

Date of Execution: 3/11/2022

THE UNIVERSITY OF TEXAS AT AUSTIN

DocuSigned by:
By: Mark D. Featherston
Mark D. Featherston,
Associate Director of Contracts and Agreements

Date of Execution: 3/11/2022

RRC use only below this line.

Div. Director: ME

CM COO: RL

Procurement & Contract Director: TL

OGC: PS

APPENDIX A**OFFICE OF SPONSORED PROJECTS
THE UNIVERSITY OF TEXAS AT AUSTIN**

*3925 West Braker Lane, Suite 3.340 • Mail Stop A9000 • Austin, TX 78759
(512)471-6424 • Fax (512)232-6649 • osp@austin.utexas.edu*

Date: 3/1/2022

To whom it may concern:

The University of Texas at Austin is pleased to endorse the following proposal enclosed for your review.

Title of Application:	TX Strategic Storage Gas Storage Study	OSP Number:	202200564-001
Principal Investigator:	Ning Lin, PhD		
Project Total Costs:	\$222,578		
DUNS:	170230239	Cage Code:	9B981
Project Dates:	3/1/2022 to 8/31/2022		

LEGAL IDENTITY

The University of Texas at Austin is an agency of the State of Texas and a component institution of The University of Texas System, governed by the Board of Regents. All awards and agreements must be executed by an authorized official of The University. Individuals, Departments, or Organized Research Units may not directly enter into sponsored research agreements or legally bind The University.

The Office of Sponsored Projects (OSP) serves as the coordinating office for externally funded research projects submitted by The University of Texas at Austin. All proposals to external funding sources for sponsored projects must be submitted through OSP and all awards received for sponsored research must be processed by OSP.

Mailing Address: The University of Texas at Austin
Office of Sponsored Projects
3925 W. Braker Lane, Suite 3.340 (Mail Code A9000)
Austin, Texas 78759-5316

Telephone Number (512) 471-6424
FAX Number (512) 232-6649

AWARD NEGOTIATION

The University of Texas at Austin reserves the right to negotiate the terms and conditions of any awarded grant or contract. As an institution of higher education, The University of Texas at Austin intends to perform the work under any awarded grant or contract as fundamental research and reserves the right to: 1) require that the provider notify the University if it is to provide any export controlled information; 2) to deny receipt of any export controlled materials; and 3) to reject any restrictions on the University's right to publish or otherwise disseminate information relating to this research.

The University's Principles and Policies Guide for Sponsored Research clarifies the fundamental issues that govern the manner in which research is conducted at The University. The Guide can be found here: <https://research.utexas.edu/osp/resources/principles-and-policies-guide/>

AUTHORIZED OFFICIAL



Elena V. Mota, BA, CRA, Assistant Director, Office of Sponsored Projects
The University of Texas at Austin

ADDITIONAL CONTACTS

Administrative and budgetary matters regarding the proposal:

Ryan Rousch, Proposal Analyst
The University of Texas at Austin
Office of Sponsored Projects
Phone: (512) 232-5651
Email: rousch@austin.utexas.edu

Negotiation and execution of agreement:

The University of Texas at Austin
Office of Sponsored Projects
3925 W. Braker Lane, Suite 3.340 (Mail Code A9000)
Austin, Texas 78759-5316
Phone: (512) 471-6424; FAX: (512) 232-6649
Email: osp@austin.utexas.edu

Enclosures:
Proposal Statement of Work
Budget
Budget Justification

DRAFT Catastrophic Weather Event Study/Report SOW

There are four parts of the study: a discussion dedicated to optimal LDC Winter Gas supply plans (Part I), a summary of Texas Underground Natural Gas Storage (Part II), modeling for strategic storage needs (Part III), and the advantages and disadvantages of mandating hedging and prohibiting spot purchases (Part IV).

Part I: Discussion of the winter gas supply plan for a Texas natural gas local distribution company

This section is a general discussion of the thought process and practice of constructing a winter gas supply plan for a Texas natural gas local distribution company. It is to explain the components and options for the gas supply plan for a LDC in Texas.

1. Goals
2. Components
3. Costs and benefits of various gas supply portfolios
 - a. e.g., hedging/storage vs. spot
 - b. cost components of each type of gas supply
4. Summer vs. Winter gas supply

Part II: Summary of Texas Underground Natural Gas Storage

1. Inventory of Texas natural gas storage
 - a. Location, Ownership, and Limits to use of each facility
 - b. Working gas in storage by facility
 - c. Maximum withdrawal capacity
 - i. Per facility and total
 - ii. Max withdrawal capacity curve over average winter
2. Planned Expansion of Texas Storage
3. Interstate Storage facilities and options for Texas gas consumers
4. Primary drivers and barriers to expansion of storage capacity
5. Types of storage service available (e.g., firm, interruptible) by type of customer for each facility (Survey)
 - a. BEG team is responsible for analyzing the data but will need help from RRC in coordinating and conducting the survey. There may be conditions for only sharing certain confidential or proprietary information under the purpose of this study.
6. Discussion/Survey of ownership of working gas in storage and available statistics
7. Discussion of concept of a Texas underground natural gas strategic reserve. This discussion stays objective on the concept without making any particular recommendation.

Part III: Modeling for strategic storage need

To the extent necessary to support Parts I and II, use the GPCM (gas pipeline competition model) model to simulate relevant scenarios.

1. **Baseline:** what would have happened to demand and supply of natural gas under a similar condition like Texas experienced in February 2021 if there were no outages across the natural gas supply chain and power plants (e.g., if all critical equipment were weatherized).

- a. This scenario requires simulating increased gas consumption, due to cold weather, by LDCs, industrials, power plants and export facilities that would have occurred without any physical constraints in the system.
 - b. Importantly, this analysis may reveal that supply might have fallen short of demand due to extreme cold. This finding could support the need for additional storage even in the absence of any physical constraints in the gas and power systems.
2. **Possible Future:** It is important to consider changes in Texas energy markets as we assess the need for new storage capacity. The demand of gas for power generation will have more competition from LNG and pipeline exports from Texas and may become more volatile as the share of wind and solar capacity continue to increase. Electrification of other end-user markets (e.g., heating) may also impact demand for natural gas. We will use a scenario based on forecasts (including forecasted natural gas production) from the EIA, ERCOT and others for a date where these forecasts are commonly expected as realistic (e.g., 2030).

Part IV: Hedging and Spot Market

We will evaluate advantages and disadvantages of mandating LDC hedging and prohibiting LDC spot purchases utilizing several methodologies.

1. Overview of all available hedging tactics (e.g., physical, financial).
2. Advantages and disadvantages of mandating hedging and/or prohibiting spot purchases.
3. Review of existing reports, analyses, and testimonies.
4. Survey/interview of stakeholders. We will focus on potential gaps we may identify during our review. Possible questions and stakeholders include the following.
 - a. Questions
 - i. What are the actions taken in response to Uri?
 - ii. Any changes to gas contracting strategy (e.g., duration of contracts, exposure to spot market) post Uri?
 - iii. Any changes to hedging strategy post URI?
 - iv. Any plans to expand pipeline and/or storage capacity post-URI?
 - b. Stakeholders (Gas LDCs)
5. Case studies. LDCs in other regions have dealt with extreme winter events more frequently than LDCs in Texas. A couple of case studies on how these LDCs dealt with such extreme events (e.g., 2014 Polar Vortex) could reveal some lessons learned.
 - a. Northeast gas LDCs & markets
 - b. Midwest gas LDCs & markets
6. As a final step of due diligence, we will seek external review of our findings. Reviewers may include experts from firms such as Enverus and academic colleagues.

Research team

- PI: Dr. Ning Lin, energy economist with focus on natural gas market, leads and coordinates the project, will be responsible in GPCM modeling & gas market analysis; interviews, lead Part I, II and III.
- Dr. Gurcan Gulen: energy economist with focus on power and gas markets, will contribute on gas market analysis & link to power market; case studies; interviews, contributes to Part I and II, and lead Part IV.

- Dr. Lorena Moscardelli: research scientist, contributes on comments on availability and any geological consideration of additional storage in Texas, contributes to Part I and II for technical consideration.
- Dr. Ren Bo: low carbon energy recovery engineer and associate researcher, contributes on any technical consideration of operation parameters on underground gas storage (withdraw rate versus working gas level, and possibility of performance boundary of gas storage), contributes to Part I and II for technical consideration.
- GIS specialist: Guinevere Mcdaid, contributes to Part I and II for map illustration and data support.
- RBAC Inc. team: assisting modeling capability and provide industry knowledge and contacts, for Part I, II and III. Detailed description of tasks please see Appendix I.
- External experts for interview and discussion for Part I and IV.

Proposed budget summary and schedule:

Schedule	Description	Start	End	week
Phase1	Initial Research & Project Schedule:	3/1/2022	5/24/2022	12
Phase2	Draft Outline	5/25/2022	6/22/2022	4
Phase3	Present Initial Draft	6/23/2022	8/4/2022	6
Phase4	Produce Final Draft	8/5/2022	9/1/2022	4
Phase5	Study Admission			

26

ITEM	BUDGET
SALARIES	78,480.49
FRINGE	24,250.47
BEG ADMIN. FEE	28,122.07
MATERIALS/SERVICES	60,500.00
COMPUTER USAGE FEES	2,193.00
TOTAL DIRECT COSTS	193,546.03
IDC (15%)	29,031.90
TOTAL	222,577.93

Appendix 1. Summary of capabilities and scope of work and responsibilities

PART I

- 1) Dr. Ning Lin as leader of the task, will coordinate and orchestrate the research plan for this part. Construct a workflow and design primary research plan including surveying and interviewing with LDCs, literature reviews, and market data collection.
- 2) RBAC will assist in the identification of and, to the extent necessary, interviewing key contacts with current and/or previous LDC gas utility experience. RBAC team also participates interviews if time allows and provide their respective non-LDC insights from previous hedging and risk management employment. RBAC team will deliver their feedbacks and insights as inputs to the technical write up, based on their industry experience and knowledge.
- 3) Dr. Gulen will assist the identification of relevant topics for the technical discussion and participates in brainstorming with the team and interviews if time allows. Dr. Gulen will provide feedbacks and insights based on his experience in gas and power industry.

PART II

- 1) Dr. Ning Lin will lead and coordinate the data research process for part II for Texas underground gas storage. Dr. Ning Lin will collect and gather market data on underground storage and coordinate any interactions with local underground storage facilities for gathering information's and interviewing industry contacts in discussing the available service options for utilities on storage backups. Dr. Ning will design and develop the survey and interview questions to ensure that the appropriate and necessary data can be obtained.
- 2) Dr. Ning Lin will lead the write up covering the "Primary Drivers and Barriers" to TX storage capacity expansion with assistance with RBAC team. Dr. Ning Lin will also lead cross-disciplinary research on any related geological topics on underground gas storage, storage capacities and deliverability characteristics by storage type, which requires inputs from rest of the BEG team, including Dr. Ren, Dr. Moscardelli and Guin Mcdaid.
 - a) Questions include any geological availability or constraints for additional storages
 - b) Operational limits for existing of future gas storage, like working gas limits and maximum withdrawal capabilities
- 3) Dr. Lin will lead the "Discussion/Survey of Working Gas Storage Ownership and Available Statistics", with assistance from RBAC team and Dr. Gulen.
- 4) RBAC team will assist in collecting, and updating data related to TX natural gas storage facilities which much of this information exists within RBAC's GPCM model *database (covering location, ownership, operation parameters)*. RBAC team will focus on research related to "Planned Expansions" of TX storage facilities and "Interstate Storage Facilities / Options for TX gas consumers"

PART III

- 1) This section utilizes both GPCM monthly model and daily model. Dr. Ning Lin will be leading the designing and development efforts of market simulation for the project, and Dr. Brooks from RBAC team will be assisting any GPCM daily model.
- 2) The RBAC team will help with monthly GPCM model which would set up the baseline of gas balance from monthly to month covering 2021 through 2030, with calibrated historical periods. The daily GPCM model is applied for "snapshots" of a more granular period, like 2 weeks during February 2021, as well as February 2030, based on the monthly model results, to delve into the additional market day to day interactions under extreme weather events.

- 3) These are a tentative list of scenarios and assumptions. The first set of assumptions are used to set up the scenarios mimicking supply and demand during an extreme weather condition
 - a) General gas balance: GPCM Daily Baseline (from GPCM monthly base case) plus adjusted demand that in line with EIA’s latest AEO scenario for the region, if needed. David and Robert (with Bethel and/or Scott assistance) can extract supply/demand data requirements using either/both EIA and subscription services to support the “Modeling Simulations for Similar Extreme Weather Events”
 - b) Extreme weather event conditions
 - i) Increased demand representing extreme weather conditions
 - ii) Increased supply representing lack of freeze-offs
 - iii) Freeze-offs included coupled with increased GFG demand representing lack of rolling brown/blackouts
 - c) Look at the future snapshot of 2025, 2030, in addition to 2021.

Scenario set up	2021	2025	2030
Extreme weather demand + supply without freeze-offs	✓	✓	✓
Extreme weather + supply with constrained from freeze-offs	✓	✓	✓

- d) In each scenario setup, the focus is to experiment with storage deliverability. Therefore, there could several (2-3) different storage strategies can be tested. This could include –
 - i) Additional gas storage close to demand center
 - ii) Additional working gas withdrawal (into the cushion gas layer)
 - iii) Higher working gas inventory ex ante
- 4) These strategies are set up the same way across all scenarios, hence, the impacts of storage strategies can be assessed and compared using market simulation scenarios above. Model simulation results and analysis will be conducted by the GPCM Team (with Dr. Brooks assistance as needed) for all scenarios developed and executed to support the “Strategic Storage Needs” assessment

PART IV

- 1) Dr. Gulen will be leading the designing Part IV of the project, and while RBAC’s Bethel and Scott have expertise in hedging and risk management and will apply this knowledge and expertise through reviewing items related to
 - a) Overview of all available hedging tactics (e.g., physical, financial)
 - b) Advantages and disadvantages of hedging mandates and/or prohibiting spot purchases
 - c) Due diligence / external review of findings

Appendix 2 – Data sources

- 1) GPCM base case database – including monthly demand, supply, and pipeline flow
- 2) The primary sources of data include
 - a) EIA
 - i) Forms 191 A & M
 - ii) EIA’s annual energy outlook scenarios
 - b) Criterion Research – data subscription services provides daily
 - i) Pipeline flows
 - ii) Pipeline capacities
 - iii) Interconnectivities

- 3) Primary research – interviews and surveys, with additional help from Texas RRC in connecting with LDCs or gas storage operators.

Appendix 3 - Team qualifications

Dr. Ning Lin joined the Bureau of Economic Geology at The University of Texas at Austin as the chief Economist in 2019 with 12 years' experience in natural gas and power markets. In her former roles, Dr. Lin managed market analysis capabilities for Shell, Koch Industries, and Tenaska, and served commercial leader on capital projects covering natural gas and power, petrochemical derivatives, and chemicals industries. She had direct experience in supporting natural gas trading and business development for natural gas projects, including gathering pipeline and underground storages. Her current research interests focus on areas where she lends her business acumen to economic analysis that leverages energy and environmental scientific research, such upstream oil and gas resources assessment; oil and gas infrastructure analysis, global LNG market, regional electricity grid integration, environmental resource management (flaring, water, and land); and system modeling of energy policy and technology choices in energy transition.

Dr. Gurcan Gulen is an Energy economist with 25 years of international experience in oil, natural gas, and electric power value chains; strategic technical assistance and customized capacity building in numerous countries, working with ministries, regulatory agencies, private and state companies, universities, and NGOs. Currently Dr. Gulen is participating in life-cycle analysis of environmental impacts across global supply chains of several minerals needed for gas-fired, wind and solar power plants and batteries, and contributes to gas market assessment and upstream economics for Bureau's unconventional resource project.

Dr. Lorena Moscardelli is a Research Scientist and leader of the State of Texas Advanced Resource Recovery (STARR) program at BEG. Her expertise is in seismic geomorphology and interpretation, sedimentology and stratigraphy and geoscience data integration. She received a degree in Geological Engineering from Central University of Venezuela (2000) and a PhD in Geological Sciences from The University of Texas at Austin (2007). She specializes in the study of deep-water deposits with emphasis on subaqueous landslides, deep-water mixed siliciclastic-carbonate systems, and planetary geology. She started her career as an exploration geologist working for PDVSA (2000 – 2003). Prior to her current position at STARR, Dr. Moscardelli was a Principal Researcher at Equinor (2013 – 2021) where she performed a wide range of activities from research in the Americas to field development in the Norwegian Continental Shelf. Her BEG career includes the co-funding and co-direction of the Quantitative Clastic Laboratory (QCL) (2007-2013) and her actual involvement as leader of STARR.

Dr. Bo Ren is a research associate (improved low-carbon energy recovery engineer), working for the State of Texas Advanced Resource Recovery (STARR) program at the Bureau of Economic Geology, The University of Texas at Austin (UT-Austin). His research interests include subsurface energy storage, in situ hydrogen generation in oil reservoirs, CO₂ enhanced oil recovery, and geologic carbon sequestration. He develops and uses full/reduced-physics (first-principles) and physics-guided machine learning models to predict fluid flow, energy/gas storage, and energy production. He has published over 40 technical papers based on the work, with the most recent publications focused on the understanding of gas/water/oil multiphase flow and its interaction and reservoir geological/petrophysical heterogeneity.

Dr. Robert Brooks, founder of RBAC, is an applied mathematician, energy economist, and software systems designer with over thirty-five years of experience in developing decision support systems for business and government. Dr. Brooks has earned degrees from the University of California at Berkeley, the University of Texas at Austin, and MIT. His doctoral research involved development of the first large-scale linear programming model of the North American natural gas pipeline grid. After receiving his PhD from MIT, Dr. Brooks developed specialized natural gas grid models for use by DOE, FERC, and EPRI. He led technical development of President Carter's National Energy Transportation Study, identifying probable bottlenecks in US energy transportation infrastructure over the next 20 years.

Bethel King, senior director, GPCM at RBAC has over thirty years of energy industry experience. As Senior Director of Market Analysis at RBAC, she provides customized analysis using the GPCM Market Simulator for North American Gas and LNG™. She is responsible for a team that produces the quarterly GPCM databases as well as training and mentoring energy analysts using this system. Ms. King's experience includes natural gas operations for Phillips Petroleum and Williams; along with five years in natural gas marketing on the trade floor of Williams.

Scott McKenna, director, Global Energy Analysis at RBAC, has over 30 years' experience in energy commodities trading, risk management and analysis with specific interest and focus on natural gas, NGLs and crude/refined products. Scott has worked at both asset-based energy companies as well as in hedge fund environments which provides him with unique expertise and insights related to the varying analytical focus and approaches employed by energy market participants. For RBAC, he applies this expertise in supporting the quarterly updates to the GPCM® Market Simulator for North American Gas and LNG™ as well as developing, analyzing, and publishing articles on relevant scenarios impacting the natural gas market.

Sponsor:	RRC
Proposed Start Date:	3/1/2022
Proposed End Date:	8/31/2022
Total Amount:	\$222,577.93

SubAccount

Title of Project: *Texas Railroad Commission Texas Strategic Gas Storage Study*

		Sponsor 3/1/22-8/31/22	Sponsor TOTAL	Sponsor TOTAL
			Funds	EFFORT
PERSONNEL	Months / Hours T1			
Lin, Ning (PI)	5.50	62,210.50	62,210.50	5.50
Gulen, Garcan (Researcher)	\$65 an hour 1.00	11,266.67	11,266.67	1.00
Moscardelli, Lorena (Researcher)	0.10	1,129.42	1,129.42	0.10
Ren, Bo (Researcher)	0.10	723.00	723.00	0.10
Guin McDaid (Researcher)	0.25	1,267.04	1,267.04	0.25
Shuster, Mark (Assoc. Director)	0.01	200.55	200.55	0.01
TBD (Graphic Illustrator)	0.10	500.00	500.00	0.10
TBD (Editor)	0.25	1,183.31	1,183.31	0.25
12	SUBTOTAL SALARIES	7.31	78,480.49	78,480.49
14	FRINGE BENEFITS - Salaries		24,250.47	24,250.47
29	BEG Admin.		28,122.07	28,122.07
50	MATERIALS & SERVICES			
	Reproduction and publications		500.00	500.00
	RBAC service provider for analytical inputs, modeling, etc.		50,000.00	50,000.00
	TBD Service Provider for for daily natural gas pipeline flow and storage data		5,000.00	5,000.00
	TBD Service Provider for for daily natural gas pipeline flow and storage data		5,000.00	5,000.00
			0.00	
			0.00	
	SUBTOTAL MATERIALS & SERVICES		60,500.00	60,500.00
67	COMPUTER (usage) IT Service Center		2,193.00	2,193.00
	VR Usage		0.00	
	Workstation		0.00	
		2,193.00	2,193.00	
TOTAL DIRECT COSTS		193,546.03	193,546.03	
Modified Total Direct Costs (MTDC)		193,546.03	193,546.03	
90	Total Indirect Costs @ 15.0%	29,031.90	29,031.90	
Total Project Costs		222,577.93	222,577.93	

BUDGET JUSTIFICATION

1. SALARIES

All personnel are UT employees, employed through the Bureau of Economic Geology. Salary rates are based on currently approved salaries for FY22 and are derived from University approved pay plans for the job categories. Salary rates used in the budget are annual salaries, plus longevity pay for those employees who receive it, divided by 12 (months).

Total effort is as follows:

Personnel	Total Effort Months
Ning Lin, PI	5.5
Garcan Gulen, Researcher	1.0
Lorena Moscardelli (Researcher)	.10
Bo Ren (Researcher)	.10
Guin McDaid (Researcher)	.25
Mark Shuster, AD	.01
Graphic Illustrator-TBD	.10
Editor-TBD	.25
Total	7.31

Categories of Work

Ning Lin – Principal Investigator, Project Manager, All aspects of project. leads and coordinates the project, will be responsible in GPCM modeling & gas market analysis; interviews, lead Part I, II and III.

Garcan Gulen – Researcher participating in gas market analysis & link to power market; case studies; interviews, contributes to Part I and II, and lead Part IV.

Lorena Moscardelli– Researcher participating in comments on availability and any geological consideration of additional storage in Texas, contributes to Part I and II for technical consideration.

Bo Ren – Researcher participating in technical consideration of operation parameters on underground gas storage (withdraw rate versus working gas level, and possibility of performance boundary of gas storage), contributes to Part I and II for technical consideration

Guin McDaid – Researcher participating in Part I and II for map illustration and data support.

Mark Shuster - AD providing management advising and project coordination.

A graphic illustrator and editor, both employed by The University of Texas at Austin, Bureau of Economic Geology, will assist in the reporting and preparation of the technical printed material of the research project.

2. FRINGE BENEFITS, VACATION AND SICK LEAVE BENEFITS

Fringe benefits are a direct cost to a sponsored project (The University's fringe rates are negotiated with its cognizant agency (DHHS) and are part of the University's **F&A Cost Rate Agreement**. Rates beyond August 31, 2022 are estimates and are provided for budgeting purposes. Fringe will be charged at the applicable rate at the time the cost is incurred.

Approved	Projections for Planning Purposes				
	FY22 9/1/21 – 8/31/22	FY23 9/1/22 – 8/31/23	FY24 9/1/23 – 8/31/24	FY25 9/1/24 – 8/31/25	FY26 9/1/25 – 8/31/26
Benefits Eligibility					
Full-time (including GRAs)	30.9%	31.4%	31.9%	32.4%	32.9%
Part-time					
Ineligible	4.7%	4.7%	4.7%	4.7%	4.7%

Additional fringe benefit rate information can be found at [UT Austin Payroll](#). The current **F&A Cost Rate Agreement** includes the fringe benefit rates for FY22. Questions about fringe rates can be directed to: PooledFringe@austin.utexas.edu

3. OTHER DIRECT COSTS

A) **MATERIALS, SUPPLIES AND SERVICES**

This category includes all expendable supplies for research activities as well as photocopying, report preparation expenses, long distance and cell telephone charges, other standard project expenses related to this project's report. RBAC, a developer of natural gas market simulator GPCM, is budgeted for \$50,000 and will provide analytical inputs, modeling and data support of GPCM model. Additional data needs from another tbd service provider \$5,000 for daily natural gas pipeline flow and storage data and \$5,000 for industrial expert interview and survey. Estimates are based upon experience and actual expenses as incurred will be charged.

B) ADMINISTRATIVE COSTS The administrative cost rate is 17.0% of the total direct costs on projects with a reduced indirect cost rate.

C) **COMPUTER EXPENSES**

Researchers utilize existing computer systems that include a variety of Windows NT and LINUX workstations, UNIX workstations, mass storage devices, printers and plotters. Separate rates approved by the University are charged for connect time, processing time, and printing. PC usage is based on fixed monthly rates of \$300/month, approved by the University business office. Computer charges in the budget were computed by the total funded personnel effort months plus personnel effort contributed multiplied by \$300 per month.

4. INDIRECT COSTS

The indirect cost rate of 15.0% of total direct costs is based on the based on the state agreed rate at the time of the proposal.