A Progress Report to the Joint Minerals, Business, and Economic Development Committee

From the
Enhanced Oil Recovery Commission
November 1, 2004 - October 31, 2005
Submitted November 1, 2005

This report is submitted as required under W.S. 30-8-101(e)

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to the

JOINT MINERALS, BUSINESS AND ECONOMIC DEVELOPMENT COMMITTEE

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ENHANCED OIL RECOVERY COMMISSION

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Executive Summary

Created by the Wyoming Legislature in 2004, the Enhanced Oil Recovery Commission oversees the work of the University of Wyoming's Enhanced Oil Recovery Institute (EORI) that is done under direct Legislative funding. Over the past year, the EORI and EOR Commission have fulfilled their legislative mandates by conducting research to develop cutting-edge EOR technologies and by creating an aggressive technology transfer program so that Wyoming producers, and the state as a whole, can benefit from the state's full mineral endowment.

Background

Wyoming's oil fields are, in most cases, declining in production, yet most of the oil in these fields remains underground. While unrecoverable by traditional production methods, significant amounts of oil in these fields can be recovered through enhanced oil recovery (EOR) techniques. According to the Wyoming Geological Survey (WGS), approximately 8 billion barrels of oil remain in Wyoming fields and between 5% and 15% of this oil can be recovered with EOR technologies. Therefore, a broad application of EOR could increase the state's ultimate oil production by anywhere from 400 million to 1.2 billion barrels. Using a conservative estimate that 5% of 8 billion barrels can be recovered using EOR techniques, and assuming that those returns are spread across 20 years, and based on a conservative price of $45 per barrel, the revenues to Wyoming government from royalties and property and production taxes would amount to $150 million annually, or $3 billion across the 20-year period. Furthermore, even a 1% increase in oil production translates to nearly 100 jobs.

The current energy boom has created employment opportunities and extraordinary tax revenues for Wyoming. Over the past five years, 68 percent of all new direct and indirect job creation in our state is a result of the energy boom, creating an average

annual employment growth rate of almost 2% in the state. During the 2004 budget session, Wyoming policymakers identified an opportunity to parlay this strong economy into more lasting benefits for our state. Legislation was enacted providing $2.4 million to the University of Wyoming Enhanced Oil Recovery Institute (EORI). Further, the Enhanced Oil Recovery Commission was created to oversee and direct the use of these funds by EORI. This investment in enhanced oil recovery research and technology transfer will maximize our current and future energy producing capability by aligning higher education research with practical field development know-how.

Throughout the past year, the Enhanced Oil Recovery Commission has been guiding the EORI in fulfilling two overarching goals: 1) developing advanced technologies dealing with CO2 separation, reservoir sweep performance and reservoir displacement efficiency; and 2) forming cooperative associations with, and providing technology transfer opportunities to, Wyoming producers.

The EOR Commission adopted the following mission statement to guide its work:

> *To provide the people of Wyoming increased benefits from their natural resource endowment by promoting and facilitating responsible enhanced oil recovery research and applications.*

The EOR Institute adopted the following mission statement to guide its work:

> *The UW Enhanced Oil Recovery Institute exists to:*
>
> - *Assist Wyoming operators with their EOR projects by applying existing technologies and creating new knowledge when necessary*
> - *Maximize the economic potential and minimize the risk of EOR projects*
> - *Facilitate the testing, evaluation and documentation of EOR recommendations in real world settings*
> - *Transfer this information to Wyoming producers by forming cooperative associations and conducing workshops and conferences*
> - *Develop technologies for capturing CO2 from flue gases.*

Personnel

Pursuant to the statute, the Commission exists to provide direction to the EORI. Appointed by the Governor, the following individuals serve on this Commission:

Lynne Boomgaarden
Governor Dave Freudenthal
Senator Bill Hawks, Chairman
Bern Hinckley
Ambassador Tom Stroock
Dr. Ron Surdam
Hank True
Peter Wold

Dr. James R. Steidtmann directs the EORI. Fifteen full time and part time research scientists and ten graduate assistants are working on the project with Dr. Steidtmann. An organizational chart appears in Appendix A.

Current projects / accomplishments

The following list represents EORI's major activities during the first biennium. The amount of the $2.4 million appropriation dedicated to each activity is listed at the beginning of each section.

Reservoir modeling ($337,000)

EORI research scientists are creating a reservoir modeling framework to evaluate Wyoming reservoirs for potential EOR work. Specialized computer hardware and software have been acquired to assist in building these reservoir models. The reservoir analysis team is developing scale models of the Tensleep Formation at Mahoney Dome. This scale model will provide a base for the study of other reservoirs in the Tensleep Formation, the most prolific reservoir in Wyoming. The team is also developing a knowledge repository database. The purpose of this database is to archive key EOR documents and research results to facilitate access by scientific staff and Wyoming producers.

Reducing the proportion of water produced from oil wells ($160,000)

Accumulation of water around a wellbore, commonly described as waterblock, is widely recognized as a serious cause of decreased production of hydrocarbons (oil, gas, or condensate). EORI scientists have developed and patented a method of well treatment to remove and prevent further accumulation of water around a production well. The method was successfully tested by NERD Gas in a Crooks Gap, Frontier formation, gas well. Comparison of gas production before and after treatment showed that gas production had been at least doubled.

Scoping models and economic analysis ($412,000)

Once technologically sound EOR techniques are identified for an individual reservoir, an analysis must be undertaken to determine whether the approach is economically feasible. To do this, EORI scientists and economists are creating two scoping models, the Characterization of Wyoming Reservoirs, and the Wyoming CO2 Scoping Model.

The Characterization of Wyoming Reservoirs Model will create statistical performance groups against which operators can compare the performance of their fields to a statistical norm. Initial characterization work is based on information from the Powder River Basin. A digital database of field and reservoir characteristics from the Wyoming Geological Association is being integrated with digital production data from IHS Energy and the Wyoming Oil and Gas Conservation Commission. All of the data and the model will be available to Wyoming producers.

The Wyoming CO2 Scoping Model will help producers determine the potential use of CO2 for enhanced oil recovery and assist in identifying reservoirs that are candidates for CO2 flooding as well as other EOR techniques

A cost-benefit analysis tool is being developed for companies to use in determining if EOR is economically feasible in their field, what process should optimally be used and the optimal time at which to start the EOR process. This analysis tool will eventually take the form of a spreadsheet that uses as its input the results of EORI's geological and engineering analyses of the field in question as well as data on capital and operating costs.

Research on CO2 capture ($530,000)

Injecting CO2 into well bores to move the remaining oil for recovery has proven to be very successful in numerous reservoirs. While CO2 is not the only substance relevant to EOR, there is particular interest, as well as direction from the Wyoming Legislature, to improve techniques for separating CO2 from flue gasses. EORI scientists are studying techniques to do so in a cost effective and energy efficient manner.

Highlights of the CO2 capture research include

- Development of synthetic compounds that have higher absorption than liquids (provisional patent application filed)
- Development of concepts for appropriately modifying inorganic membranes (provisional patent application filed)
- Development of a poly (ionic liquid) CO2 sorbent
- Development of two polymer membranes with high CO2 selectivity and permeability

Research on reservoir fluids characterization ($484,000)

In an effort to improve the quality of reservoir modeling, EORI engineers are developing models to predict how reservoir fluids that contain CO2 will behave given differences in temperature, pressure, and chemistry. The knowledge gained from their efforts will make CO2 flooding more efficient for Wyoming producers.

Highlights of the reservoir fluids research include:

- Development of equations that describes the behavior of fluids, particularly CO2, in reservoirs
- Creation of a theory for estimating the behavior of salts and water in reservoir systems.
- Collection of preliminary data estimating the viscosity of fluids in reservoirs

Technology Transfer ($320,000)

Providing information about, and support for, the use of EOR technologies to Wyoming producers is a primary goal of the Commission and EORI. Over the first year of the Legislature's EOR program, it became clear that Wyoming producers are inhibited from attempting EOR because of high capital costs, risk of failure, limited knowledge about appropriate technologies, and lack of available manpower. Given these inhibitors, coupled with the favorable window of opportunity provided by the current petroleum price structure, an aggressive plan for reaching out to producers has been implemented. Highlights include:

- Presentations to the Wyoming Geological Association
- Presentations to the Petroleum Association of Wyoming
- Presentations to the Rocky Mountain Section of the American Association of Petroleum Geologists
- Presentations to the Wyoming Natural Gas Fair
- Technology workshops (e.g. Polymer and Polymer-Gel Water Shutoff Treatments: What it takes to be Successful and Illustrative Field Applications).
- Tensleep Reservoir producer working group
- Classes and seminars both on and off the UW campus.

In addition, EORI has entered into cooperative association agreements with several producers for field assessments and studies to gather geologic data and operators' observations. EORI cooperative associations include:

- Safford Oil: fluid rock data is being gathered and EOR strategies are being tested in the Crooks Gap field.
- Nerd Gas: Geologic description, core analysis and reservoir simulation for the Second Frontier at the Brooks Ranch field.
- Nance Petroleum: Geologic description, core analysis and reservoir simulation for the Tensleep Formation at the Mahoney Dome field.
- Merit Energy Partners: Geologic description, core analysis and reservoir simulation for the Madison Formation at Wertz and Lost Soldier fields.

- DOE Big Sky Carbon Sequestration Partnership: EORI has partnered with the Big Sky Partnership to provide DOE with information about CO2 sequestration in a carbonate reservoir.

Administration and Commission Activities ($168,000)

A modest amount of the appropriation was used for commission meetings and administrative expenses.

2007-2008 Biennium

During the next biennium, and with the support of the Wyoming Legislature, the Commission and EORI will continue the work described above and expand their research partnership efforts with Wyoming producers in the following areas:

- A technical outreach specialist will be hired to conduct problem identification meetings with producers.
- Continue work on the development of a knowledge repository database.
- Secure additional scientific staffing to increase the EORI's ability to enter into cooperative associations with Wyoming producers
- Develop a cost-sharing program that will allow EORI scientists and engineers to gather broadly-applicable information and expertise in a "natural laboratory" provided by producers while at the same time allowing the producer to gain valuable information about his reservoir.
- Creation of a student intern program to be focused on knowledge and manpower issues encountered by producers.

Conclusion

The EOR Commission has partnered effectively with the EOR Institute. The projects and plans show an aggressive and efficient response to the legislative mandate for enhanced oil recovery in Wyoming. The Commission and the Institute anticipate that current and future projects will go forward rapidly to meet the Commission's goal of providing the people of Wyoming increased benefits from their natural resource endowment by promoting and facilitating responsible enhanced oil recovery research and applications.

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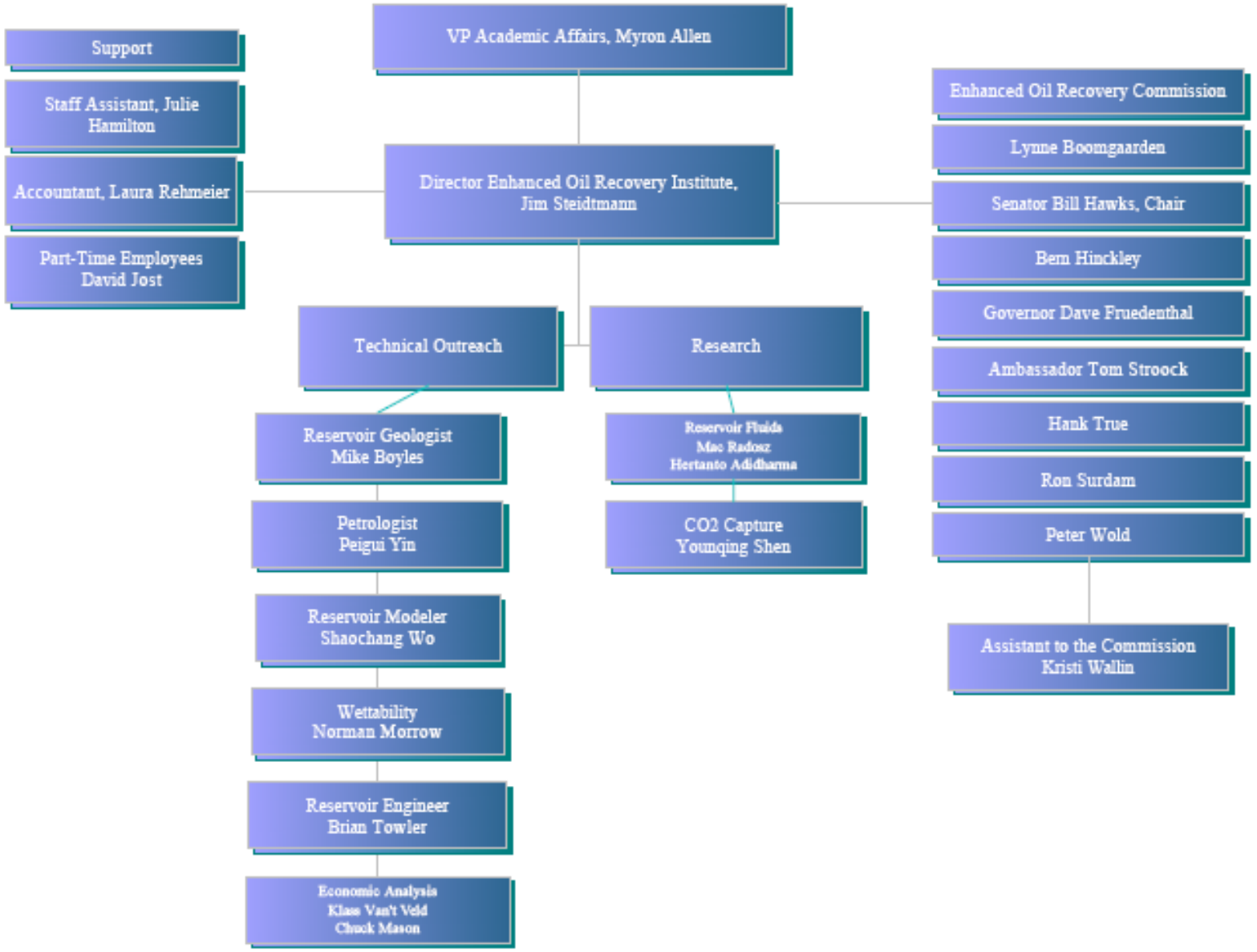
APPENDIX A
EORI Organization Chart



Appendix B

2007-2008 Proposed Budget

	FY07-08 Biennium Request	Ongoing	New	Biennium Total
A.	Technical Outreach			
	1. Online services	20,000	252,616	272,616
	2. Workshops/work groups	50,000		50,000
	3. Cooperative Associations	721,102	1,351,856	2,072,958
	4. Reservoir Scoping	274,336	0	274,336
	5. Project Cost Sharing	0	1,100,000	1,100,000
	6. Regulatory Issues	0	201,688	201,688
	7. Intern Program	39,882	199,406	239,288
	Total Technical Outreach	1,105,320	3,105,566	4,210,886
B.	Research			
	1. Reservoir Fluids	388,000	0	388,000
	2. CO2 Capture	388,000	0	388,000
	3. Wettability	48,730	46,556	95,286
	4. Reservoir Scoping	62,112	0	62,112
	5. Reservoir Analysis	79,996	375,064	455,060
	6. Regulatory Issues	0	59,146	59,146
	7. Reservoir Modeling development	82,696	53,500	136,196
	8. Intern Program	12,182	60,910	73,092
	Total Research	1,061,716	595,176	1,656,892
C.	Federal Grant Matching	0	750,000	750,000
	Total Grant Matching	0	750,000	750,000
X.	External Cost Adjustment (ECA)	87,590	107,263	194,853
	Total External Cost Adjustment (ECA)	87,590	107,263	194,853
	070-0201-Technical Outreach & Research	2,254,626	4,558,005	6,812,631
D.	Support	234,464	24,568	259,032

	Total Support	234,464	24,568	259,032
E.	Commission	10,000	24,000	34,000
	Total Commission	10,000	24,000	34,000
X.	External Cost Adjustment (ECA)	9,320	0	9,320
	Total External Cost Adjustment (ECA)	9,320	0	9,320
	070-0101-Commission & Support	253,784	48,568	302,352

070-0101-Commission & Support	253,784	48,568	302,352
070-0201-Technical Outreach & Research	2,254,626	4,558,005	6,812,631
Grand Total	2,508,410	4,606,573	7,114,983