**Report of the Advanced Conversion Technologies Task Force (ACTTF)**

**To the Joint Minerals, Business and Economic Development Interim Committee**

**Minerals to Value Added Products Facility Feasibility Study Report Summary**

**September 1, 2012**

**Introduction**

In the Sixty-First Legislature of the State of Wyoming 2012 Budget Session, House Bill No. 0121, House Enrolled Act No. 25 was passed by the full Legislature and signed into law by Governor Mead. This legislation appropriated $500,000 in Abandoned Mine Land (AML) funds to the School of Energy Resources (SER) and authorized studies to identify:

* Whether a commercial scale facility which converts minerals to value added products would be economically viable in Wyoming given projected energy prices and regulatory trends:
* Attributes unique to the state of Wyoming which mitigate for and against construction of a commercial scale minerals to value added products facility in the state;
* The best available technologies for the commercial scale conversion of minerals to value added products in Wyoming;
* Potential obstacles to the construction of a minerals to value added products facility in Wyoming and possible strategies to address those obstacles, including, but not limited to the following:
* Regional and national political climate;
* Economic issues;
* Regulatory issues; and
* Transportation.
* Potential input sources of minerals and water for the facility and potential markets for the final value added product and any other products created during the conversion process; and
* Whether, and at what level and in what form, state support is necessary for the development of such a project. The study shall identify possible state incentives available for the construction of a commercial scale minerals to value added products facility and determine which incentives are likely to have the most benefit to industry and the citizens of the state of Wyoming.

**Advanced Conversion Technologies Task Force**

The Advanced Conversion Technologies Task Force (ACTTF) issued a Request for Proposals on April 20, 2012 seeking submissions from principal investigators to conduct studies described above. Proposals were due to the School of Energy Resources (SER) by May 25, 2012. Fourteen proposals were received from thirteen organizations. A total of $2,471,241 was requested. Ten reviewers evaluated two or three proposal each.

On June 18th, the ACTTF met in special session and approved the following two studies:

* Western Research Institute received $162,000 for “Distributed Production of Fuels/ Chemicals from Stranded Natural Gas.”
* ArcTech, Inc. received $329,243 for “Techno-Economic Analysis of MicGASTM Coal Biorefinery Plants for Deployment in Wyoming.”

Reports for each of the studies were received on August 20, 2012, and the principal investigator for each study presented an overview to the ACCTF on August 24, 2012. The ACCTF voted to accept the Western Research Institute (WRI) report as complete, and findings of the report are summarized below. A copy of the complete report is attached.

The ACTTF declined to accept the ArcTech, Inc. report. ArcTech, Inc. was advised by the ACTTF on how to revise their report in order to achieve acceptability and was asked to do so as a priority. Their contract was extended to October 1, 2012. **At such time as the ArcTech, Inc. report is accepted, their findings will be summarized and this report will be amended and re-issued.**

**Summary of WRI Report: “Distributed Production of Fuels/Chemicals from Stranded Gas”**

The authors of the WRI report made several basic assumptions for design of a modular processing plant at the proposal stage. These were:

* Cost – the maximum plant cost could not exceed $100 million
* Capacity – the output capacity of the plant would be 150 barrels per day (bpd) of product, or largest capacity possible that does not trigger EPA oversight. (Following their discussions with DEQ this ended up being around 500 bpd)
* Siting – siting of the plant would avoid federal lands. The plant would be sited on private property only when the resource owner holds an equity position in the plant.
* Product – the plant will produce a fungible product (gasoline, olefins, diesel in that order.)

The plant proposed in this study is configured as a compact, modular process that can be assembled at a fabrication shop and delivered to a natural gas field requiring minimal field assembly. Conversion is carried out without expensive oxygen and with minimal water consumption. Advanced controls allow remote operations and process control of a single or distributed set of units by a remotely monitored, semi-automatic control station to produce and store the product. Modular design will also allow field replacement of components such as desulfurization modules and reactor modules. Refurbishing of gas clean-up modules and catalyst reloading/regeneration is similarly affected in central facilities. Small modular units reduce manufacturing costs and provide scalability.

WRI coined the term Wyoming Stranded Gas (WYSG) to define the resource for the study. WYSG refers to natural gas reserves that are impeded from getting to market by either physical or economic hurdles. With the local price of natural gas at or below $3.00/Mscf, all of Wyoming’s natural gas could be considered economically stranded. Wyoming coalbed natural gas (CBNG), because of its higher production cost, is especially stranded.

Historically on an energy content basis, gas prices and oil prices have been linked. Increased shale gas, associated natural gas, and CBNG production have created an abundant supply of marketable natural gas which has resulted in delinking of the gas and oil prices. Excess production will likely keep the prices low into the foreseeable future.

A major product from refining of crude oil is fuels for the transportation sector. The transportation sector in the United States currently makes no significant use of natural gas. Lower resource prices represent a major incentive for conversion of natural gas to transportation fuels (gasoline and diesel) and to petrochemicals. The process is called gas-to-liquids (GTL).

Large facilities, such as Shell’s Pearl GTL plant under construction in Qatar has an estimated capital cost of $24 billion and a capacity of 140,000 bpd, are not suited for Wyoming due to limits in the availability of:

* Natural gas feedstock
* Process water
* Work force
* Market

Smaller (±500 bpd), modular plants are far more suited to the attributes unique to Wyoming. Such plants are appropriate for monetizing WYSG for the following reasons:

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* A plant can be assembled at a fabrication shop and delivered to a natural gas field requiring minimal field assembly.
* Advanced controls will allow remote operations and process control of single or distributed sets of units at a remotely monitored, semi-automatic control station. This will apply to both production and storage of the product.
* Modular design will also allow field replacement of components such as desulfurization modules and reactor modules, and refurbishing of gas clean-up modules and catalyst reloading/regeneration units.
* Small modular units reduce manufacturing costs and provide scalability.

Plant sizes as small as 150 bpd can be made profitable. Facilities in the range of 500 bpd to 2000 bpd could be located on gathering facilities or gas compressor stations.

For this study, WRI evaluated GTL conversion to gasoline. Their plant configuration has the following attributes:

* No air separation unit is required. Their design uses steam/methane reforming and can accept elevated levels of CO2 and is thus suited for CBNG.
* No recycle. Tail gas rich in hydrogen is used for reforming (lower carbon emissions).
* Compact reactors that result in a smaller plant footprint.
* Integral water treatment for water reuse that results in the consumption of one bbl of water for each bbl of product.
* Integration of proven technologies.
* Product is shipped in tanker trucks.
* The market is refineries in WY, CO and MT for:
	+ Gasoline blending
	+ Diluents for heavy oil in Canada
* Product fetches a $5 to $23/bbl premium over West Texas Intermediate (WTI). For present day WTI at $89/bbl, the product price is in the $94 - $112/bbl. Similar or better spreads are expected for diesel production.

Simple economics show that a 500 bpd plant is estimated to have a capital cost of approximately $40 million, and the payoff is calculated to be around 9 years. Multiple units and centralized control and servicing centers improve profitability substantially.

Process simulation shows that 500 bpd will need about 10 MMcf/d of natural gas. Smaller GTL plants in Wyoming can be operational in 3-5 years whereas larger facilities will take considerably longer. Smaller facilities are easier to permit as they fall below many of the critical emission limits. A 500 bpd GTL plant could be classified as a minor source.

The WRI report provides details for required oversight and permits. The following is a brief list of requirements.

* OSLI – Special use lease for siting GTL facilities on state land
* DEQ-AQD – minor source permit
* DEQ-SHWD – Although not a major producer of solid waste oversight required
* DEQ-WQD – General Permit Storm Water Pollution Prevention Plan
* SEO – Permit to appropriate ground water or surface water
* County Zoning – Specific to individual county potential zoning requirements

Potential hurdles for permitting exist where the statutes are either silent or vague as far as they would affect GTL facilities. These include:

* OGCC: Need to clarify whether the GTL process and facilities are subject to the Oil and Gas Act, providing that such processes are not considered part of the natural gas operations or production
* OGCC: Need to clarify whether OGCC has authority to regulate the sale of natural gas from the producer directly to the end user
* PSC: Provide a statuary exemption that the PSC does not have authority to oversee the sale of natural gas to GTL facilities
* DEQ-AQD: Consider assumption of state primacy over the PSD permitting program for greenhouse gas emissions, currently regulated by the EPA.

OSLI – Office of State Lands and Investments

DEQ – Department of Environmental Quality (WQD – Water Quality Division; AQD – Air Quality Division; SHWD – Solid and Hazardous Waste Division)

SEO- State Engineer’s Office

OGCC - Oil and Gas Conservation Commission

PSC – Public Service Commission

PSD – Prevention of Significant Deterioration

EPA – Environmental Protection Agency

Finally, WRI suggests potential incentives and recommendations for encouraging GTL conversion in Wyoming. Chief among these are:

* The state should consider a severance tax exemption by reducing or eliminating the severance tax for natural gas consumed by the plant. This would incentivize new technology development and implementation.
* To attract investment in small-scale GTL in Wyoming, consider a sales tax exemption or reduction for a number of years to help developers recoup construction costs sooner.
* The state should consider direct investment in a pilot or first commercial facility. Such a facility can be used for process refinement for efficiency improvements and for work force development and education.