UNIVERSITY OF WYOMING

Hybrid Energy Systems
2012 Workshop – Salt Lake City, UT

Bob Ballard, Project Director

Bob Ballard, Project Director, University of Wyoming

Representing:

State of Wyoming - Governor Matt Mead

Wyoming Business Council - CEO Robert Jensen

UW Research & Economic Development - VP Dr. William Gern

UW School of Energy Resources – Director Dr. Mark Northam

State of Wyoming Energy Resources

- No. 1 Net Energy supplier - 10.4 quadrillion Btu/yr.; Approx. 10% of US Energy use.
- No. 1 Coal Producer – 7.68 quadrillion Btu/yr. - or nearly 450 million tons annually
- No. 1 Uranium Yellowcake supplier – 2 million pounds annually
- Crude Oil – 0.27 quadrillion Btu/yr.
- No. 2 or 3 Natural Gas – 2.36 quadrillion Btu/yr.

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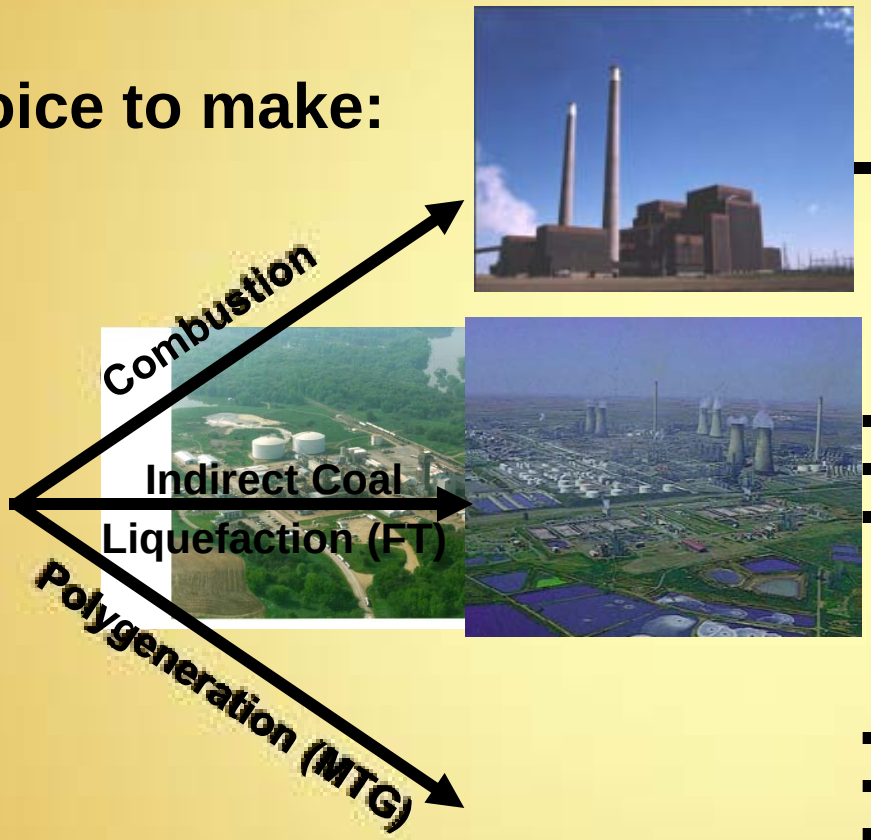
Maximizing the Value of Coal

A choice to make:

1 ton Coal



Electricity Production

Products	Value
3 MWh electricity	$120
Total	**$120**

Fuel and Power Production

Products	Value
0.083 MWh electricity	$3
0.28 bbls naphtha	$13
2.13 bbls diesel fuel	$166
Total	**$182**

Fuel, Power & Fertilizer Production

Products	Value
0.31 MWh electricity	$12
0.30 bbls LPG	$14
1.58 bbls gasoline	$123
0.30 t ammonium nitrate	$105
Total	**$254**

University of Wyoming School of Energy Resources (SER)

Founded in 2006

Mission:

Promote know-how required to solve critical energy challenges faced by society through interdisciplinary academic, research, and outreach programs in engineering, science, economics, and environmental policy to ensure Wyoming fulfills its promise to be a global leader in building a secure and sustainable energy future.

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SER Funding

Since 2004, $228.6 million committed

$20.5 M Enhanced Oil Recovery Commission (2005-12) ($17 M)*

$46.9 M School of Energy Resources (2006-12) ($33 M)*

$30.9 M Clean Coal Technology Fund ($11 M)*

$53 M Carbon Management Institute ($7 M)*

$50 M High Plains Gasification – Advanced Technology Center ($4 M)*

$23 M NCAR Wyoming Supercomputing Center

$2.7 M Wyoming Reclamation and Restoration Center

$1.6 M In situ Recovery of Uranium Research

*Dollars Spent though FY2011 - approximately $96 million

Additionally…

$52.6 M private funds & state match for facilities construction and endowments

$150.4 M have been captured to fund energy research

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SER Research

Centers of Excellence

Bring together faculty and graduate students from multiple disciplines to develop important energy research programs.

8 Centers

- Energy Econ/Public Policy
- Biogenic Natural Gas
- Photoconversion/Catalysis
- Reclamation/Restoration
- Wind Energy
- Subsurface Flow
- Enhanced Oil Recovery
- Carbon Management

SER Future FY2012-2016

Create Balance -- Create Distinction

3 Areas of Focus

1. Unconventional Reservoirs

- Tight gas
- Shale gas
- Shale oil
- Residual oil zones

2. Climbing the Value Chain

- Add value to existing resources
- Create products
- Create markets
- Hybrid Energy Systems; Advanced Conversion Technologies

3. Wind and Solar Energy

- Improve efficiency
- Mitigate intermittency
- Energy Storage

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2012 Wyoming Legislature Funding

Joint Wyoming Business Council and Idaho National Lab ($500,000) Study – Wyoming Hybrid Energy Systems – Report Due 11/1/12 (Contract Under Review)

University of Wyoming SER ($500,000) Advanced Conversion Technologies Study (Value Added to State Mineral Production) - Report Due 9/1/12 (Solicitation Issued mid-April)

Governor Matt Mead's Project Seed Fund (2012-2013) for preliminary studies and pre-FEED for near term projects selected by the State.

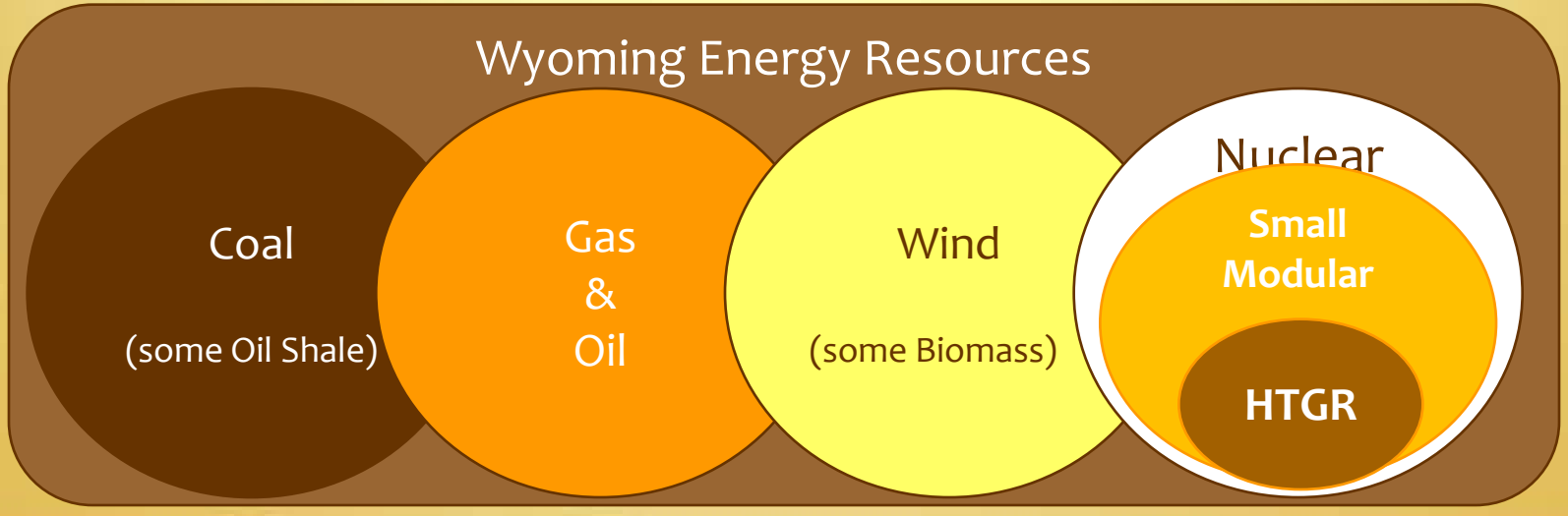
Hybrid Energy Systems Study

Joint Wyoming Business Council and Idaho National Lab ($500,000) Study – Report Due 11/1/12

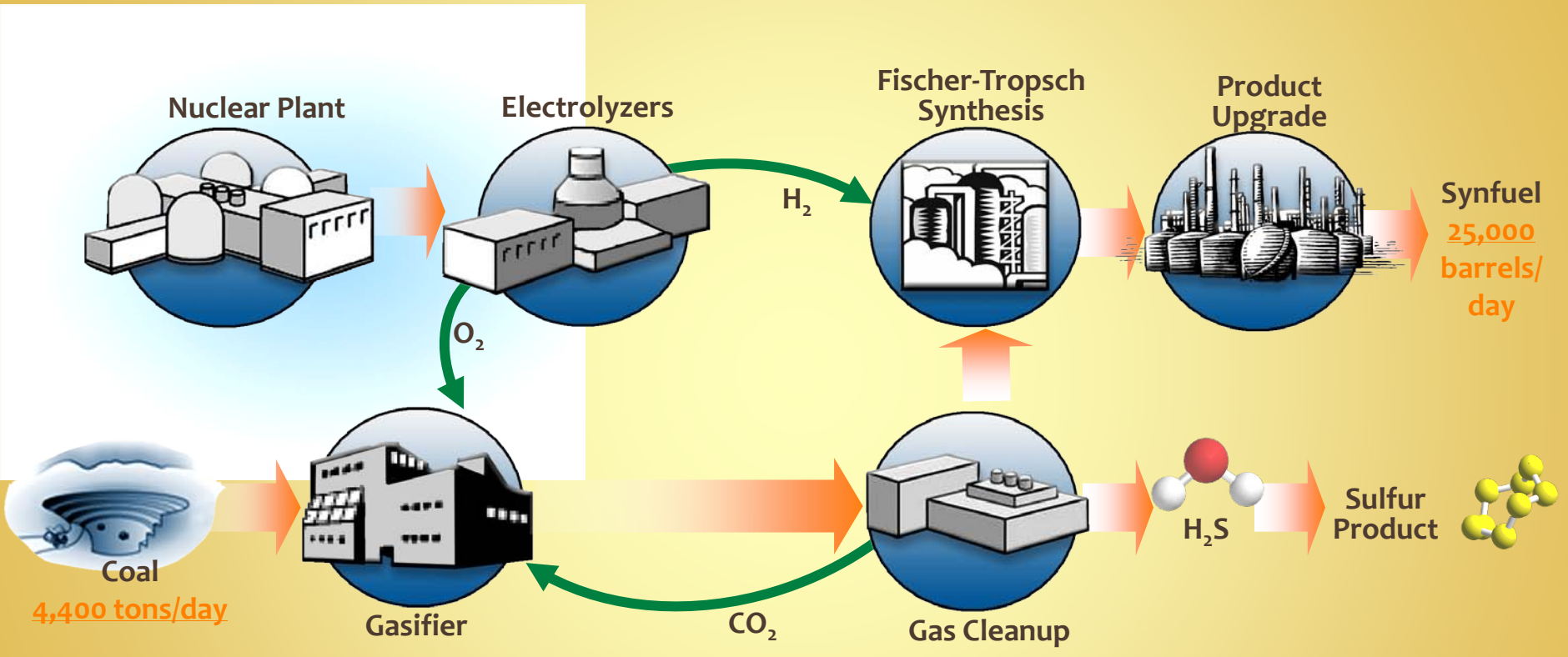
- Facilities located in WY; value added to WY resources
- Consider Next Generation Nuclear Plant
- Hybrid energy to include coal and coal gasification, NG, Oil, renewables, and other
- Evaluate Supply Chain (equipment/feed stocks)
- Suggest legislation to encourage locating facilities in Wyoming
- Address Water, Capex, Jobs, other

NUCLEAR / NON-NUCLEAR HYBRID STUDY

- Address non-nuclear and nuclear hybrid energy systems based on Wyoming natural resources and market conditions
- INL directed research leveraged through INL Programs
- Produce multiple energy services: power, hydrocarbon fuels, and chemicals
- Determine opportunities for small modular reactors and buildup of appurtenant nuclear industries in State
- Address environmental aspects and sustainability
- Address education and work force needs and benefits



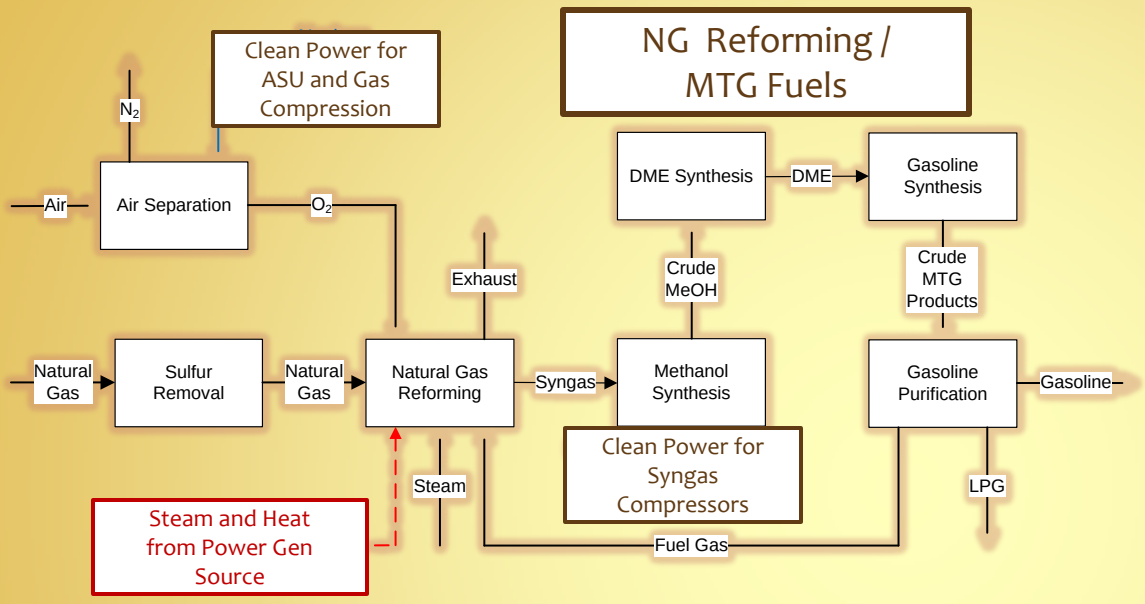
Hybrid LWR Nuclear Coal-To-Liquid

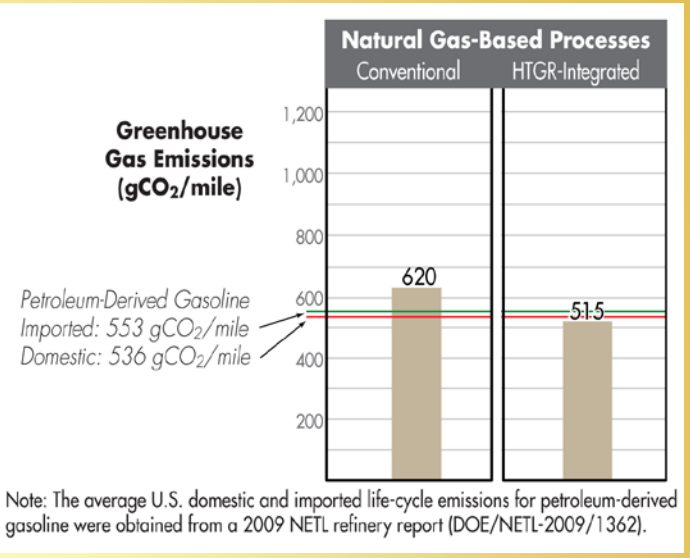


- ✓ Hybrid systems uses 70% less coal
- ✓ Little carbon is converted to CO_2

- ✓ Small amount of CO_2 is recycled to gasifier
- ✓ Effectively no CO_2 emissions

Nuclear HTGR / Nat. Gas Conversion to Gasoline



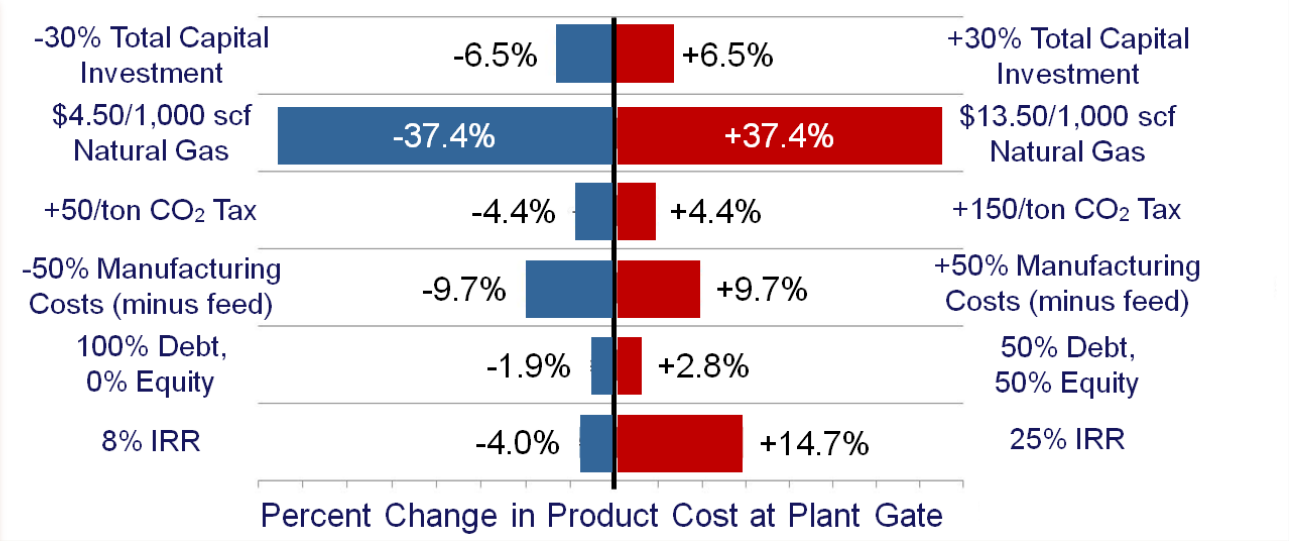


Reference Case:

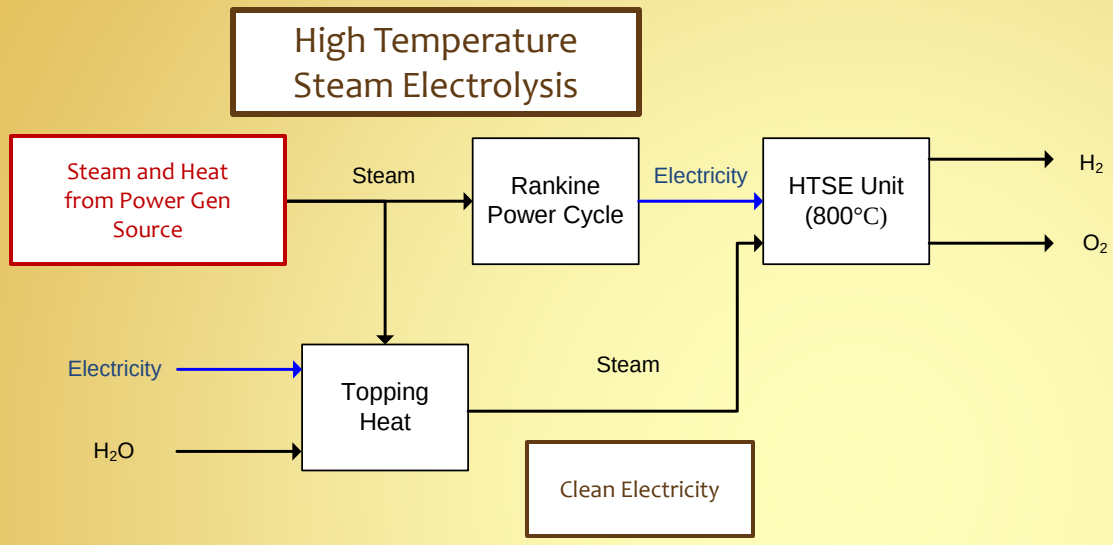
- HTGR with 750 °C ROT
- $9.00/1,000 scf NG
- $100/ton CO_2 Tax

Result:

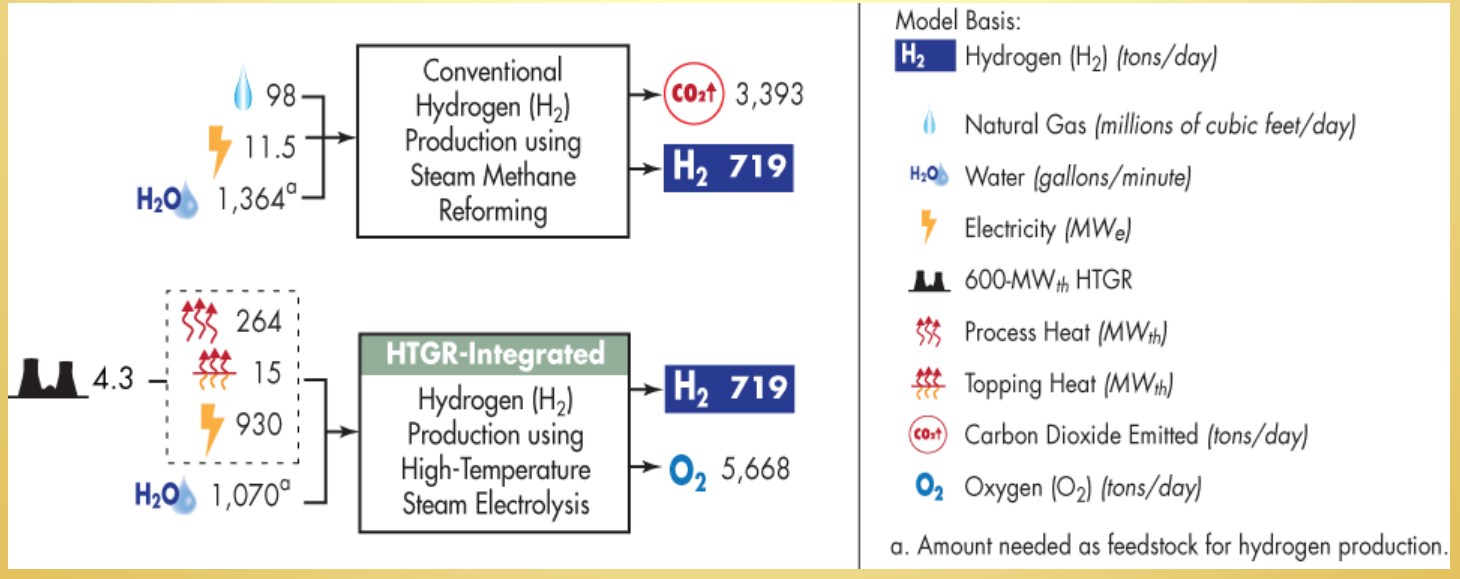
- $2.32 per gallon gasoline product at plant gate
- CO_2 footprint less than conventional fuel



Hydrogen Produced by High Temperature Steam Electrolysis with HTGR



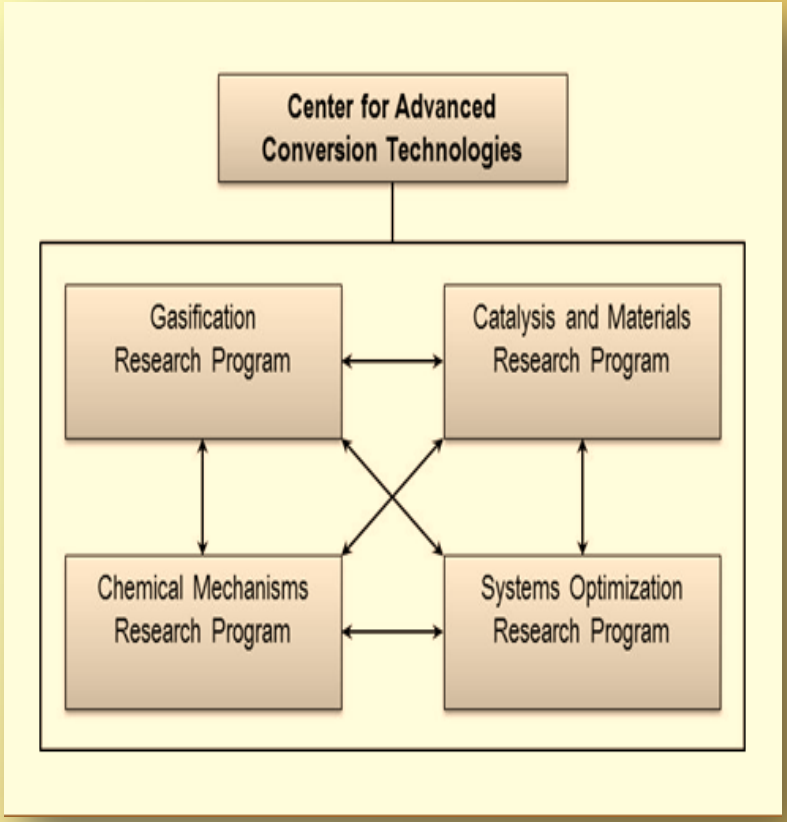
- Results compare Steam-Methane Reforming with HTSE and HTGR clean heat and electricity source
- Eliminates CO_2 emissions associated with reforming
- Heat source may be excess heat from nuclear or fossil fuels power plant



Advanced Conversion Technologies

University of Wyoming SER ($500,000) Advanced Conversion Technologies Study (Value Added to State Mineral Production) - Report Due 9/1/12

- Economically viable commercial scale located In Wyoming
- Attributes of State for & against development of commercial scale project in state
- Best available technologies of minerals to value added products
- Identify obstacles to construction of identified Facilities
- Identify potential input sources of minerals and Water and markets for the products
- Identify possible state incentives for the construction of facility
- Value added to WY resources



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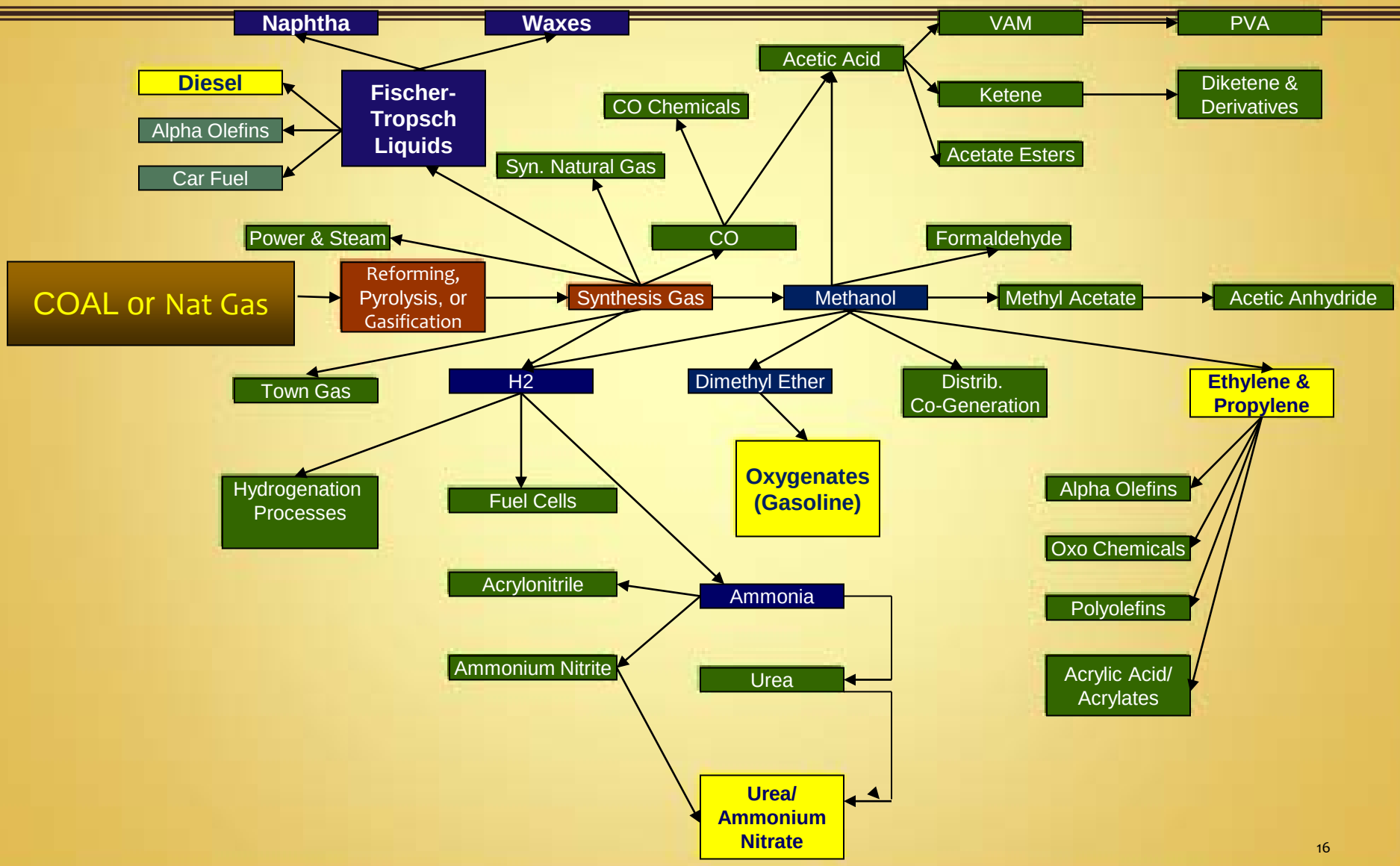
Moving up the value chain…



Governor Mead's Matching Fund

$9,000,000 fund to support engineering, design, construction and operation of commercial scale facility which converts minerals to value added products.

- Applications for grants to be received by Clean Coal Task Force (contact UW SER).
- Grants to be given with recommendation of WY Joint Minerals, Business & Economic Development interim committee
- Funds may not be used for salaries, requires dollar for dollar (non-WY) match, and signed agreement with UW SER and grantee
- Must receive recommendation of Clean Coal Task Force that grant has reasonable likelihood of success
- Commercial scale minerals to value added project facility may include minerals to liquid fuels or other value added product facilities, BUT shall not include any facility that derives 50% or more of revenues from generating electricity

SER Energy Innovation Center (EIC)

Northeast View (Completion Fall 2012)

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Building a sustainable energy future for Wyoming, the region, and the nation.

Creating distinction for Wyoming's University.

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