An Alternative Route for Coal To Liquid Fuel

applying the ExxonMobil Methanol to Gasoline (MTG) Process

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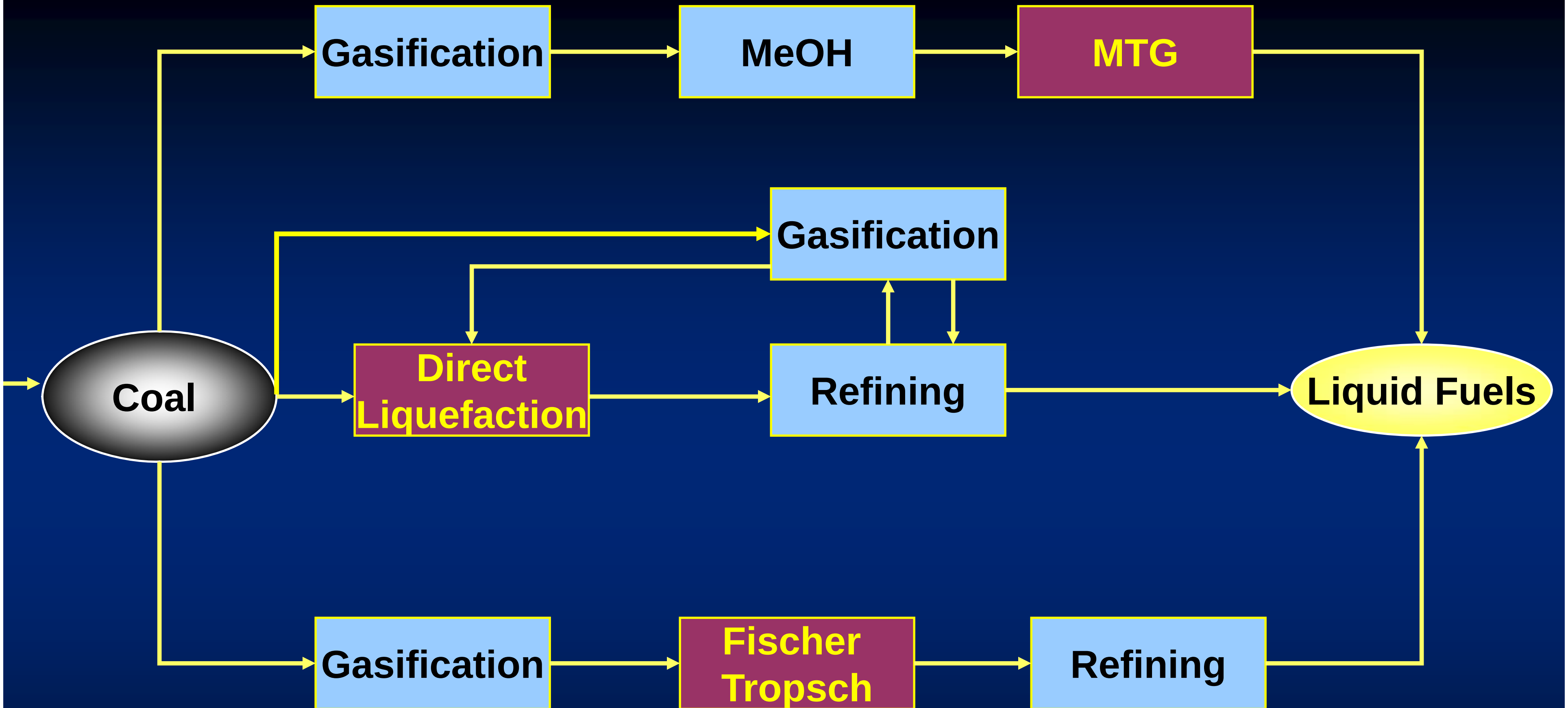
Options for Coal To Liquids



- *All three routes: three step processes*
- *Thermal efficiencies: essentially governed by the carbon hydrogen ratio of the feed and the fuel products.*

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Reactions for Coal to Transportation Fuels

Gasification → MeOH → MTG

Coal → Liquid Fuels

Gasification → Fischer Tropsch → Refining

$$2CH_x + (1+x)/2\ O_2 + (1-x)\ H_2O = (CH_2) + CO_2$$

Theoretical Balance

- All routes have the same end states
- Theoretical efficiencies will be aprox. equivalent and dependent of Coal composition
- Each mole of CH_2 production will requires aprox. two moles of carbon
- Each mole of CH_2 production will have aprox. one mole of carbon rejected as CO_2

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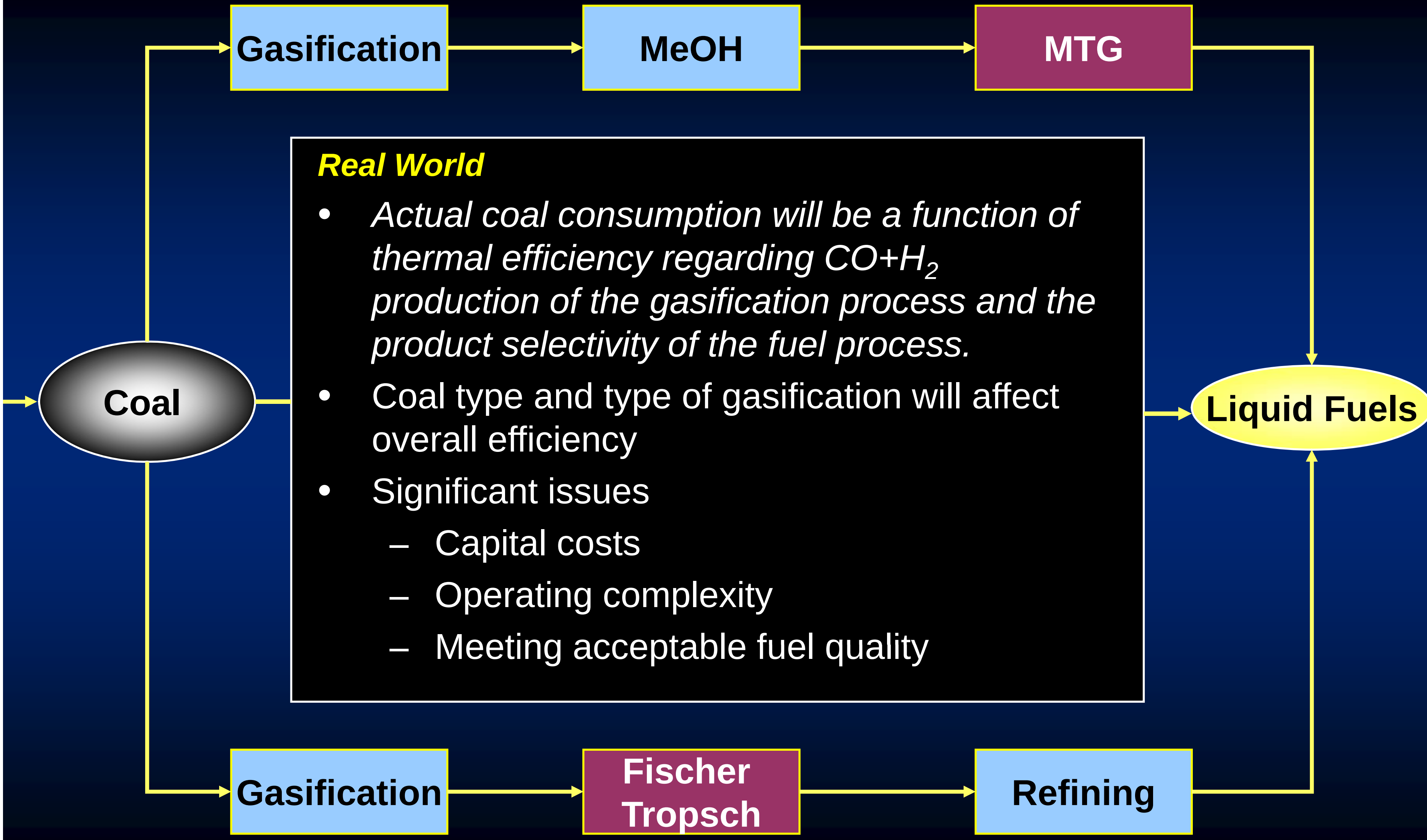
Coal Type and Process Selectivity Affect Efficiency



Real World

- *Actual coal consumption will be a function of thermal efficiency regarding CO+H_2 production of the gasification process and the product selectivity of the fuel process.*
- Coal type and type of gasification will affect overall efficiency
- Significant issues
  - Capital costs
  - Operating complexity
  - Meeting acceptable fuel quality

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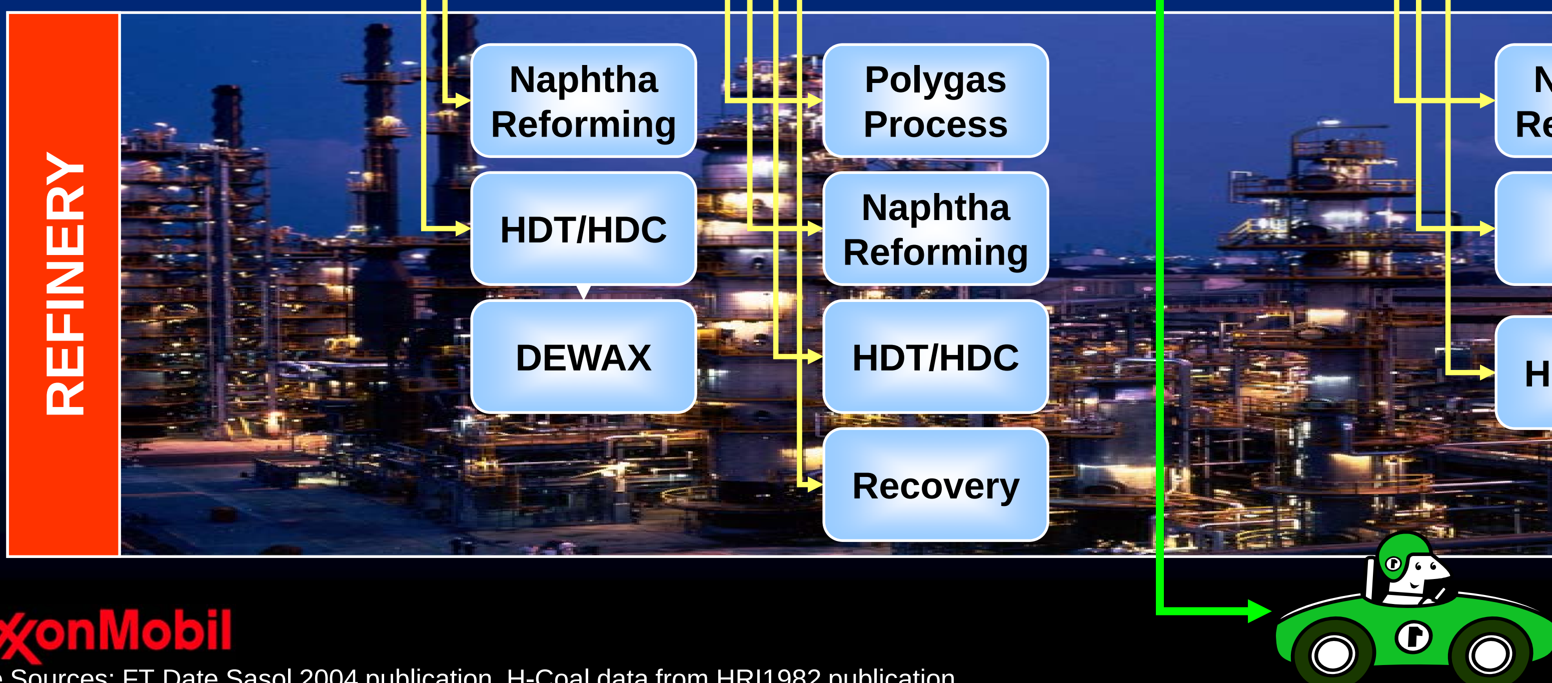
Product and Process Simplicity for MTG

COAL TO LIQUID

	Fischer Tropsch Co Catalyst @220C	Fischer Tropsch Fe Catalyst@340C	MTG	H-Coal™ Direct Liquefaction
Fuel Gas	6	15	1.1	Not Reported
LPG	6	23	10.0	
Naphtha	19	36	88.8	36.7
Distillate	22	16		43.3
Fuel Oil/Wax	46	5		20
Oxygenates	1	5	0.1	0.34

REFINERY



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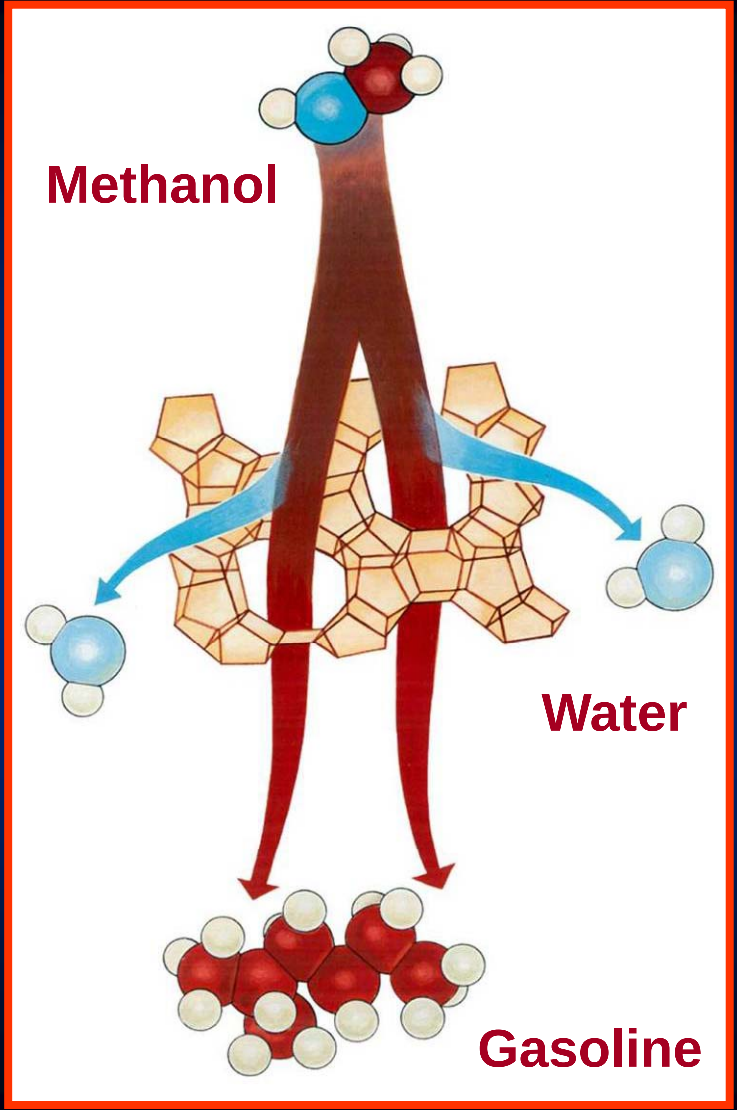
Date Sources: FT Date Sasol 2004 publication. H-Coal data from HRI1982 publication

Unique Shape Selective Chemistry

- Unique *"Shape Selective*" chemistry discovered in the early 1970's
- Development complete through the 70's/80's on a variety of process options
- Plant started up 1985 and operated successfully for ~10 years until conversion to chemical grade Methanol production
- Second generation Coal based plant scheduled for end of 2008 start-up in China
- Two additional plants in Engineering for US applications



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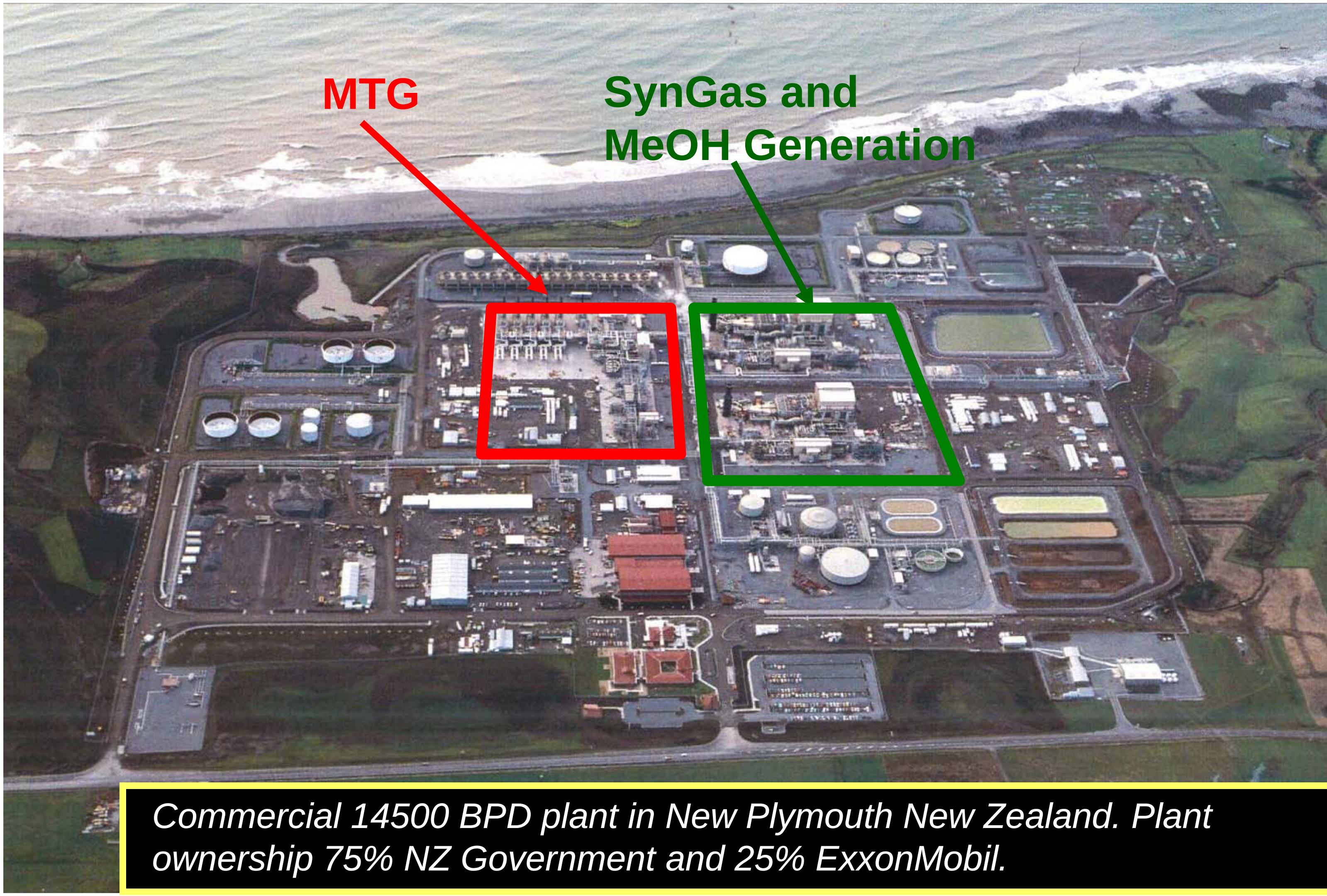
MTG Was Commercially Operated



Commercial 14500 BPD plant in New Plymouth New Zealand. Plant ownership 75% NZ Government and 25% ExxonMobil.

New Zealand Finished Gasoline Quality

	Average	Range
Octane Number, RON	92.2	92.0 – 92.5
Octane Number, MON	82.6	82.2 – 83.0
Reid Vapor Pressure, kPa	85	82 – 90
Density, kg/m^3	730	728 – 733
Induction Period, min.	325	260 – 370
Durene Content, wt%	2.0	1.74 – 2.29
Distillation		
% Evaporation at 70° C	31.5	29.5 – 34.5
% Evaporation at 100° C	53.2	51.5 – 55.5
% Evaporation at 180° C	94.9	94 – 96.5
End Point, °C	204.5	196 - 209

MTG Gasoline vs. U.S. Conventional Gasoline

- **MTG Gasoline is completely compatible with conventional gasoline infrastructure.**
- **MTG Gasoline contains essentially no sulfur and low benzene contents.**

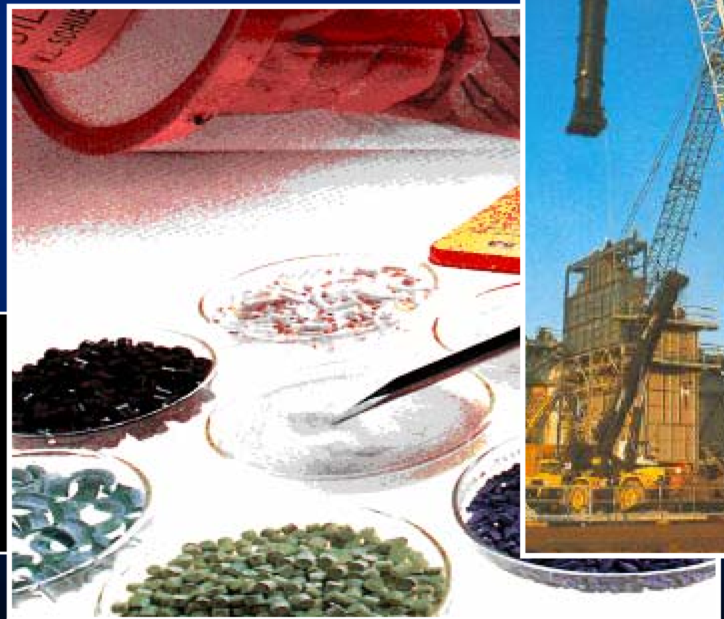
	2005 Summer	2005 Winter	MTG Gasoline	US Regulation
Oxygen(Wt%)	**0.95**	**1.08**		
API Gravity	**58.4**	**61.9**	**61.8**	
Aromatics(%Vol)	**27.7**	**24.7**	**26.5**	
Olefins(%Vol)	**12**	**11.6**	**12.6**	
RVP(psi)	**8.3**	**12.12**	**9**	
T50(F)	**211.1**	**199.9**	**201**	
T90(F)	**330.7**	**324.1**	**320**	
Sulfur(ppm)	**106**	**97**	**0**	**30**
Benzene(%Vol)	**1.21**	**1.15**	**0.3**	**1 (0.62)**

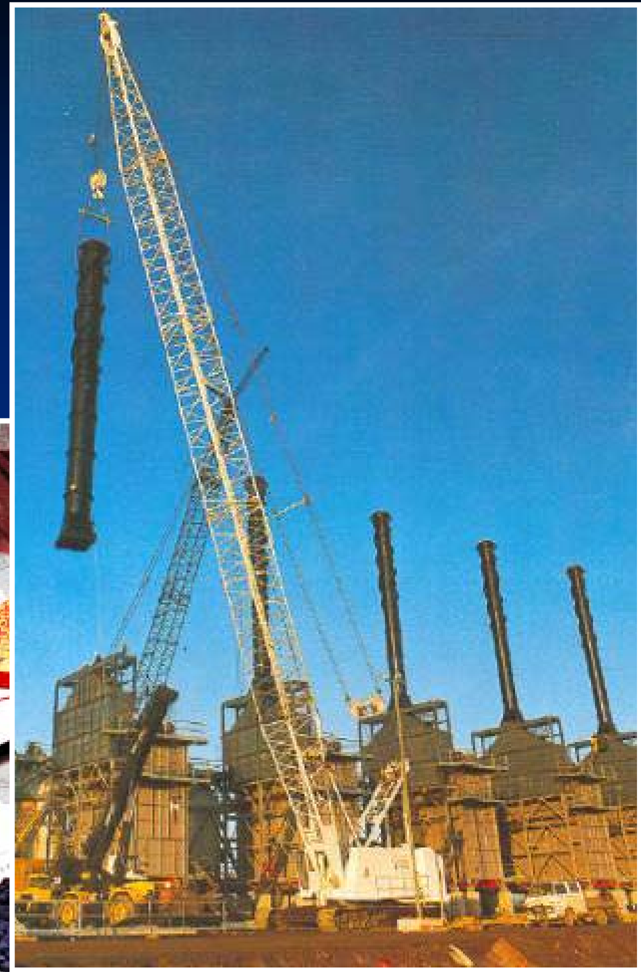
Date Sources: US Average gasoline data from US EIA website.

2nd Generation MTG Technology

- Second Generation Design based on 10 years learning's from NZ operation
- Improved heat integration
- Improved process efficiency
- Process re-optimized for coal-based methanol

Reduced capital cost
Reduced operating cost





ExxonMobil is the world leader In catalyst development and we manufacture our own catalysts.

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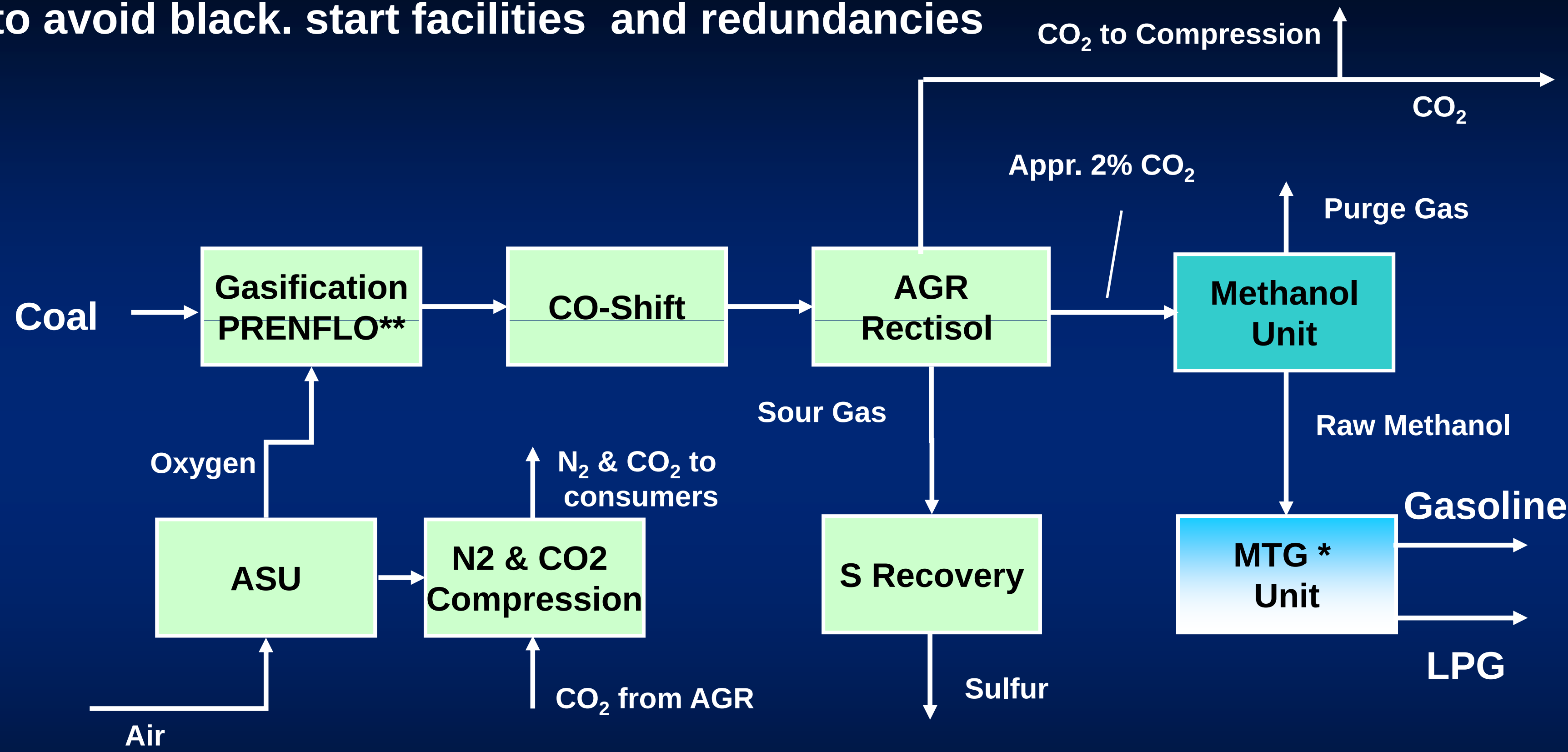
Case Study: CTL based on MTG

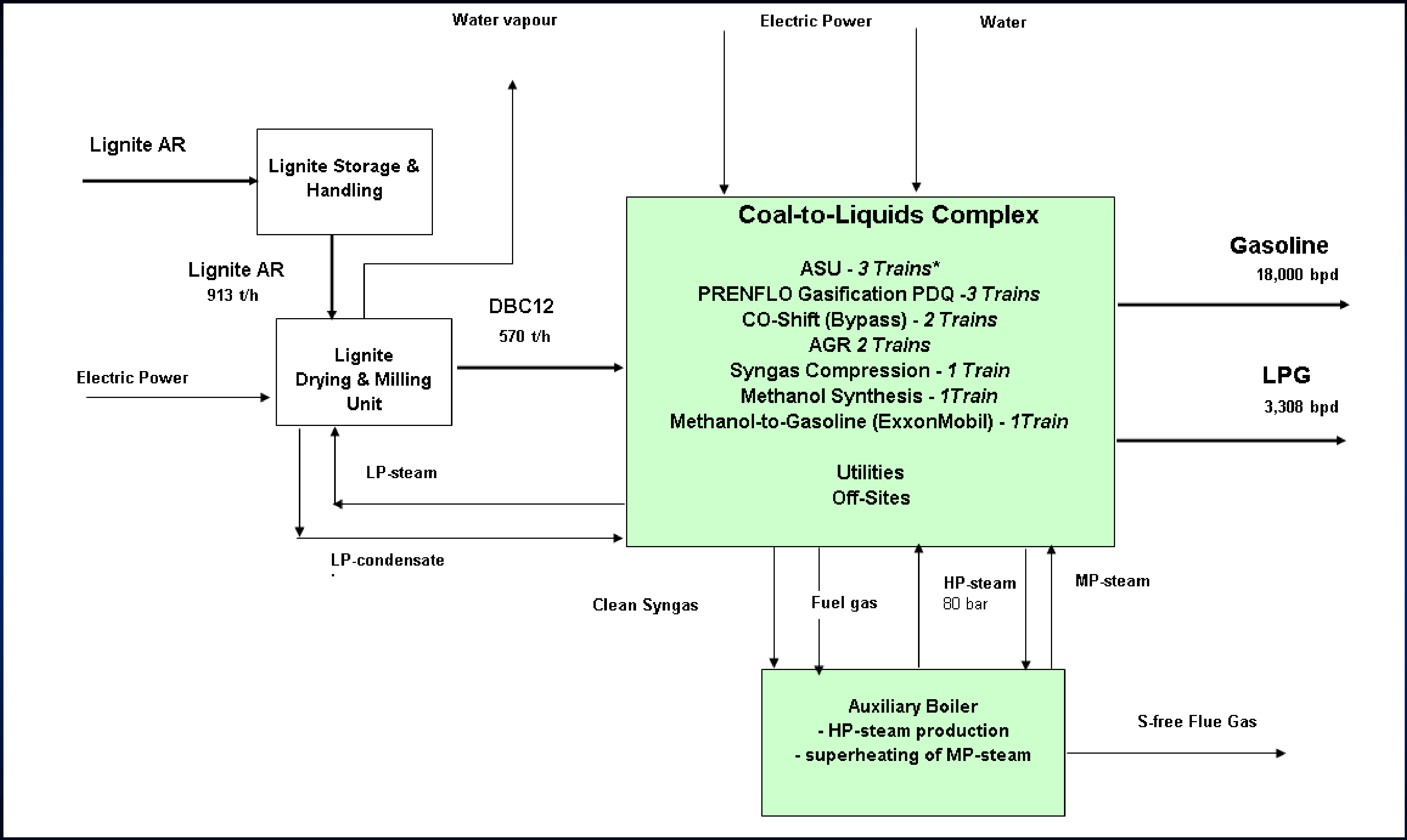
Concept: CTL Complex, self-sufficient....Import of a small amount of power to avoid black. start facilities and redundancies



* MTG: ExxonMobil

** PRENFLO with Direct Quench (PDQ): Uhde

Case Study: CTL based on MTG, self-sufficient



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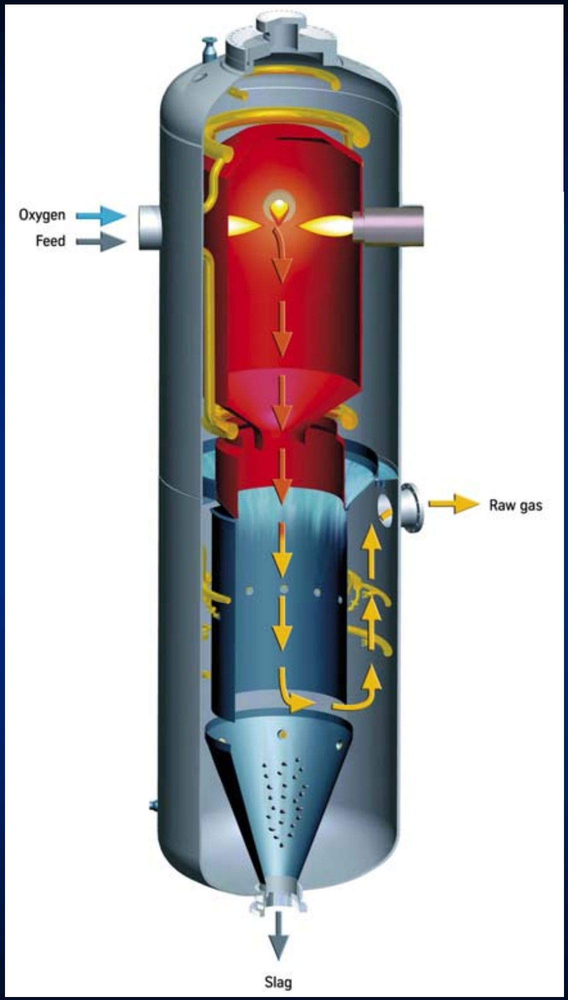
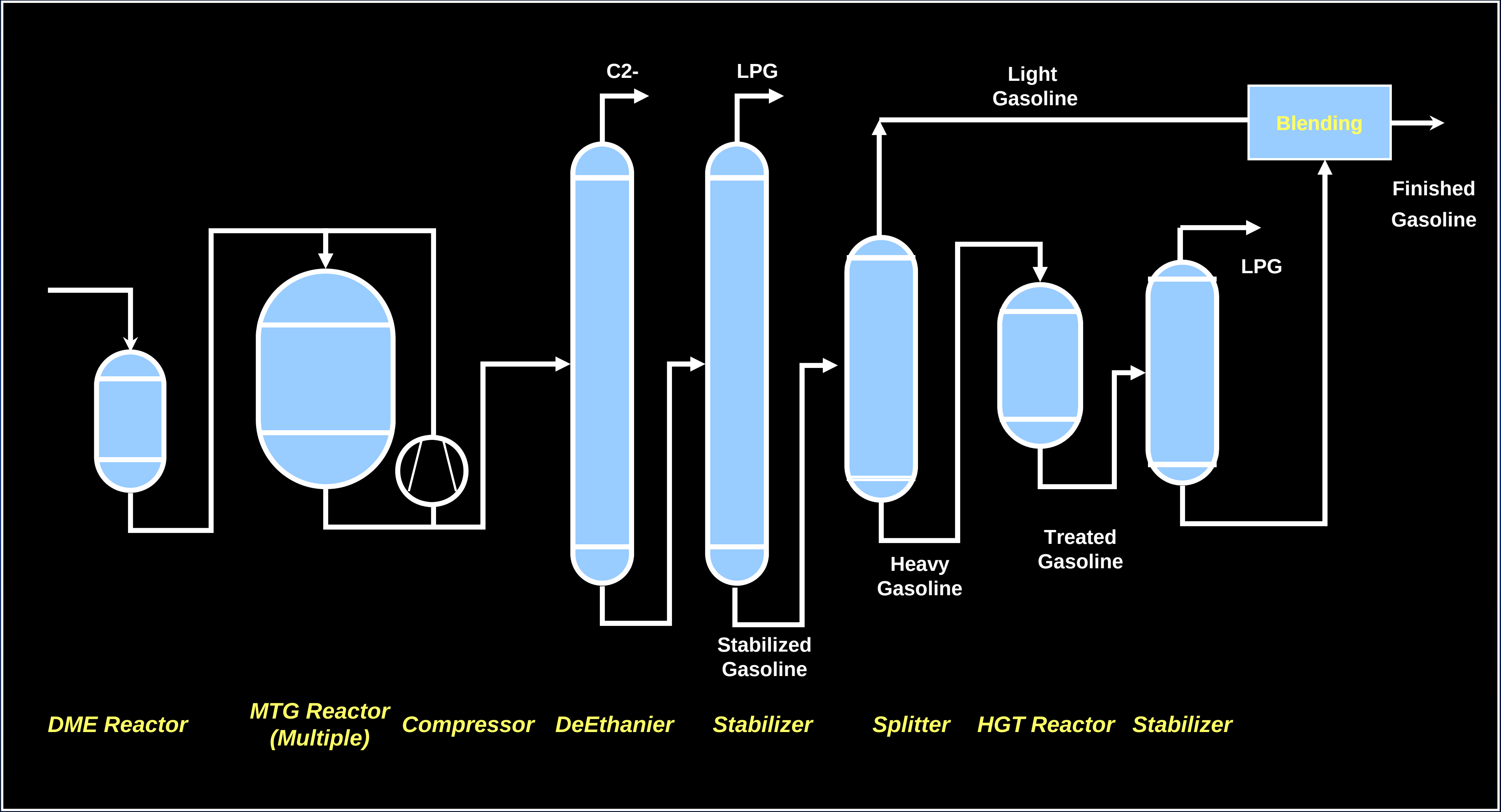
Case Study: PRENFLO PDQ, Gasifier and Key Features



- **Pressurized entrained-flow gasification: 25-42 bar**
- **Dry coal dust feeding: with N_2 or CO_2 as transport gas**
- **Oxygen as gasification agent**
- **Temperature in gasifier: 1,350-1,600 °C (slagging conditions)**
- **4-6 side burners, tangential flow**
- **Gasifier protected by membrane wall (steam) and slag layer**
- **Full water quench for syngas saturation**
- **Simple and robust process concept**

MTG Process Flow Diagram



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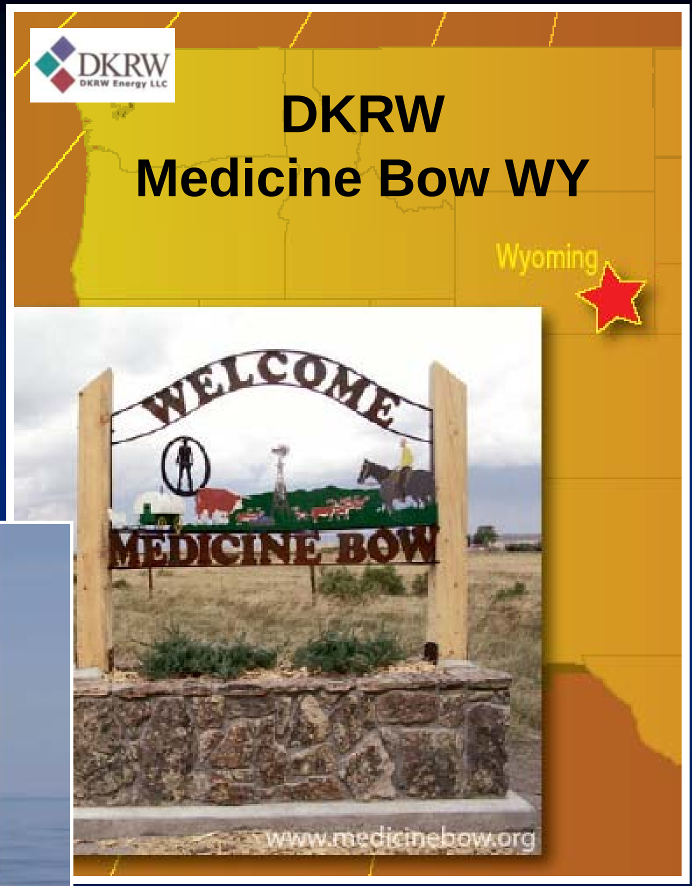
Case Study: CTL based on MTG, self-sufficient - Overview

Item	Unit	Lignite	Hard Coal
Coal Feed as Received	t/h	913	378
Coal Feed to Gasifier	t/h	570	353
Gasoline Product @92 R+0	bbl/d	18,000	18,000
LPG Product	bbl/d	3,300	3,300
Syngas to Liq. Thermal Efficiency	% on HHV	Base	+0.2%
CTL Thermal Efficiency*	% on HHV	Base	+5.4%

* Reported CTL efficiencies very strongly dependent on utility and upgrading assumptions, and CO2 disposition assumptions in addition to Coal quality

- Lignite with high water and medium high ash content
- Hard coal with a low water content and a medium high ash content

Current MTG Licenses



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MTG JAMG Project in Shanxi China

- MTG plant currently under construction at JAMG is second generation Fixed Bed MTG Process. Start up scheduled for YE 2008.

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Key Project Considerations

Technical Risk

- Methanol to Gasoline (MTG), Gasification and Methanol Synthesis are commercially proven technologies

Simplicity

- MTG does not require a “refinery” to make a marketable fuel product.

Operability

- Methanol is storable which enhances operability between stages

Constructability

- MTG uses gas phase conventional type fixed bed reactors

Flexibility

- MTG can be used for methanol from other sources such as coal bed methane or coke oven gas.
- MTG can be added downstream of existing methanol plants

EMRE/Uhde Partnership Provides Full Range of CTL Services

Coal → Gasification → Methanol → MTG → Gasoline

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