Better Data – Better Decisions
Introduction to GTL-CTL Technologies

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Monthly Oil and Gas Statistics, IEA

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Technologies – Gas-to-Liquids

Overview of the technologies

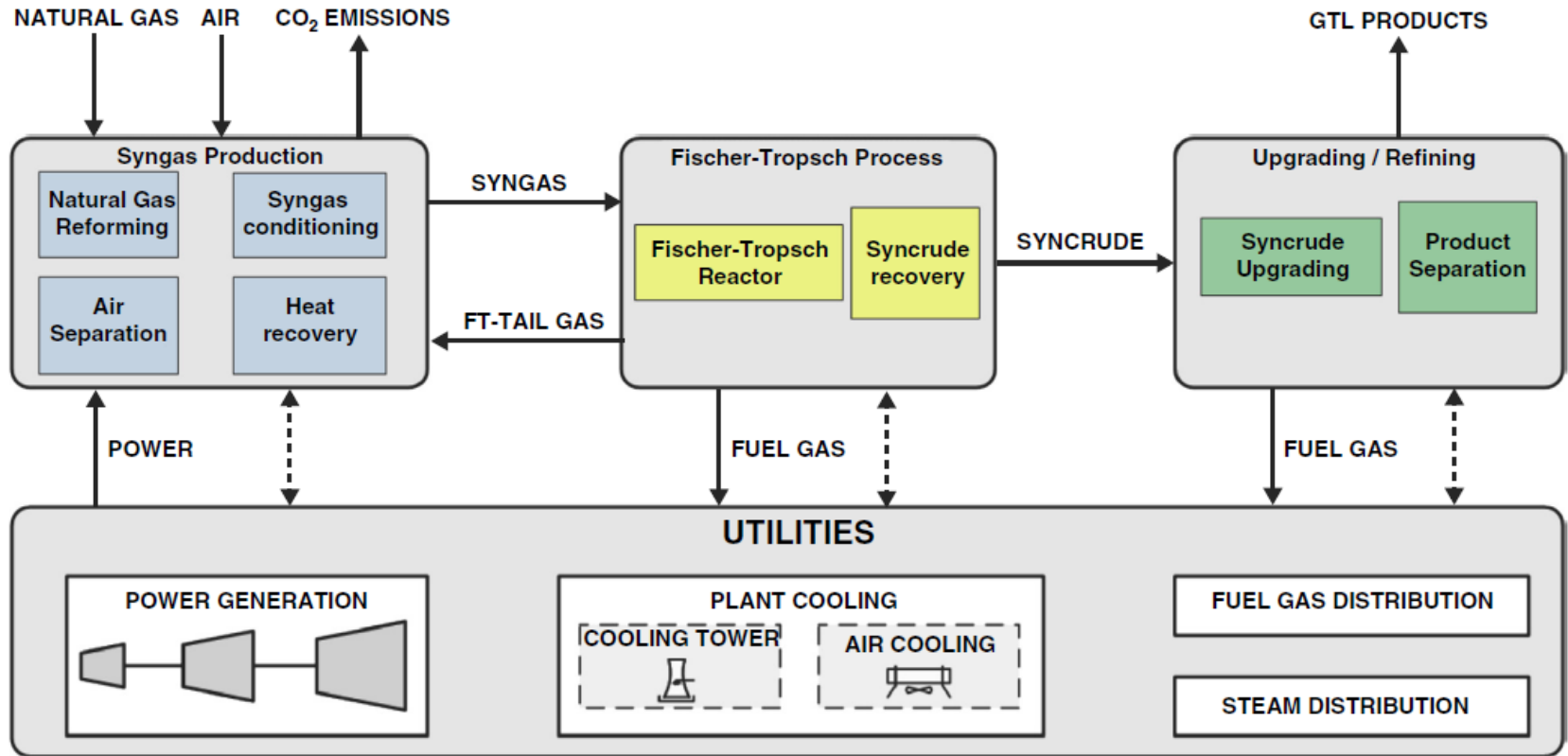- Two possible ways to produce petroleum products from gas

    - **Fischer-Tropsch GTL**

    - **GTL based on Methanol synthesis**

Technologies – Gas-to-Liquids

Fischer-Tropsch process overview

Technologies – Gas-to-Liquids

Syngas generation

- First stage of the GTL process converts dry natural gas (principally methane) into carbon monoxide and hydrogen, commonly known as synthesis gas (syngas).

  - $CH_4 + H_2O \rightarrow CO + 3H_2$ steam reforming
  - $CO + H_2O \rightarrow H_2 + CO_2$ water gas shift reaction
  - $CH_4 + CO_2 \rightarrow 2CO + 2H_2$ hydrogen synthesis

- Zinc oxide is used to remove sulfur from the gas.

- Carbon dioxide formed in water gas shift reaction is recycled back to prevent other side reactions and maintain desired carbon monoxide to hydrogen ratio for FT synthesis.

- Excess carbon dioxide is sent to utilities for sequestration or vented to atmosphere.
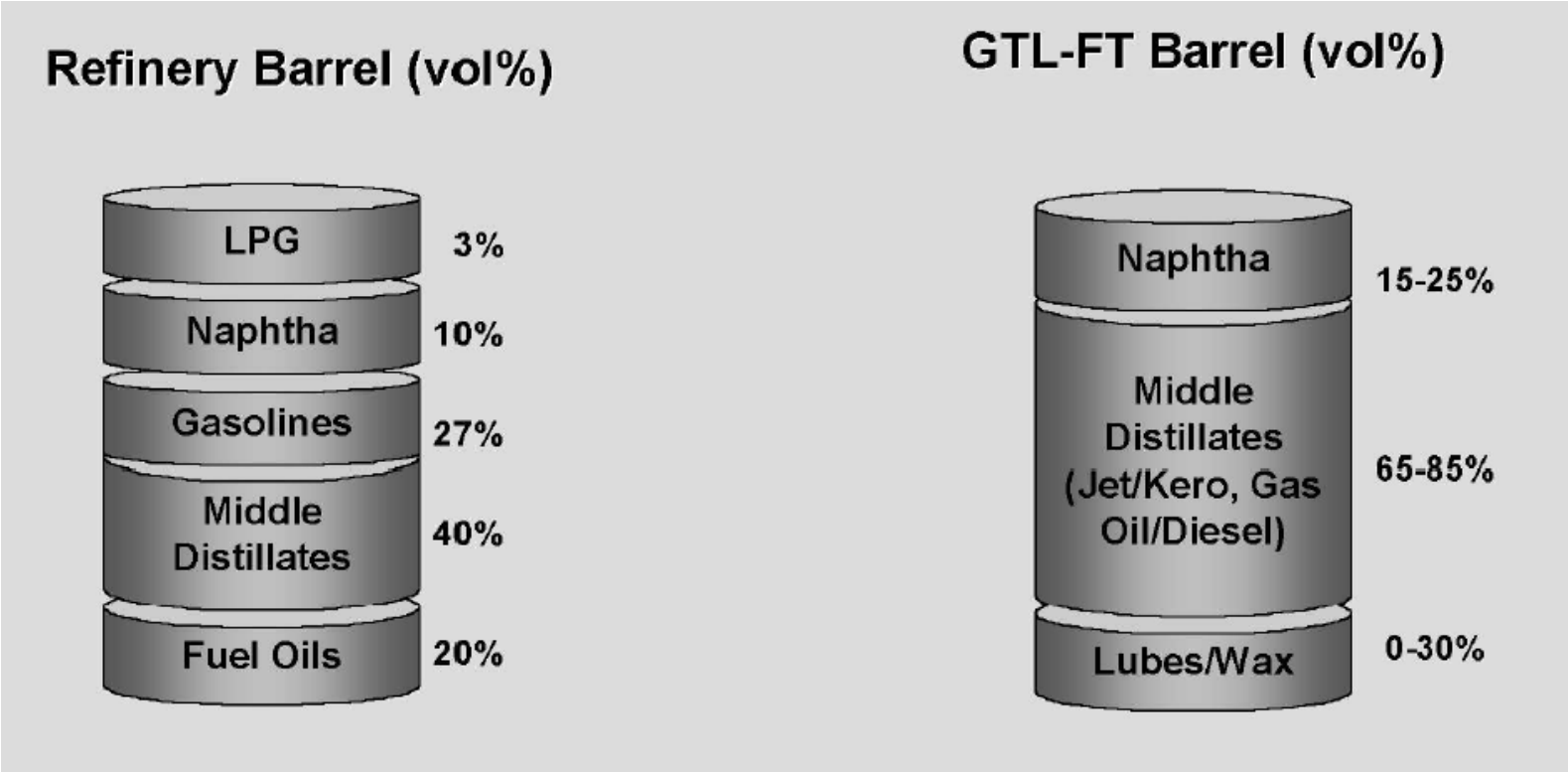
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FT synthesis & product finishing

- FT process converts synthesis gas into liquid hydrocarbon fuels
  - $(2n+1)H_2 + nCO \rightarrow C_nH_{(2n+2)} + nH_2O$ FT reaction

- The products of the FT process are C1-C4 hydrocarbons, naphtha, distillate, and waxes.
- Waxes are further hydrocracked to produce more distillate, naphtha and C1-C4 hydrocarbons.
- C1-C4 hydrocarbons are converted to higher molecular weight hydrocarbons using oligomerization process.

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Technologies – Gas-to-Liquids

GTL-FT products

Refinery Barrel (vol%)

LPG	3%
Naphtha	10%
Gasolines	27%
Middle Distillates	40%
Fuel Oils	20%

GTL-FT Barrel (vol%)

Naphtha	15-25%
Middle Distillates (Jet/Kero, Gas Oil/Diesel)	65-85%
Lubes/Wax	0-30%

Technologies – Gas-to-Liquids

Existing and planned capacity (FT-GTL)

| Project Parameters			Plant Location		Announced Technology Parameters		
Operator	Status	Operational Year	Name / Locality	Country	Nameplate Capacity	Million US$	$/bd
Shell	Operating	1993	Bintulu	Malaysia	12,000	$1,500	$125,000
Sasol	Operating	1994	Sasolburg	South Africa	5,600	ND	ND
Shell	Operating	2006	Bintulu	Malaysia	2,700	ND	ND
Sasol / Chevron[1]	Operating	2006	Oryx	Qatar	34,000	$1,500	$44,118
Shell[2]	Operating	2011	Pearl	Qatar	140,000	$20,000	$142,857
Chevron[3]	Construction	-	Escravos	Nigeria	34,000	$10,000	$294,118
Sasol	Proposed	2018	St Charles	USA	96,000	$14,000	$145.833
Calumet	Proposed	2014	Karns City	USA	1,000	ND	ND

First large Scale GTL facility

Technologies – Gas-to-Liquids

GTL based on Methanol synthesis

- Methane conversion to methanol
  - $CO + 2H_2 \rightarrow CH_3OH + energy$

- Two-step process:
  - Steam reforming to generate syngas.
  - High-temperature reaction of syngas to produce methanol.

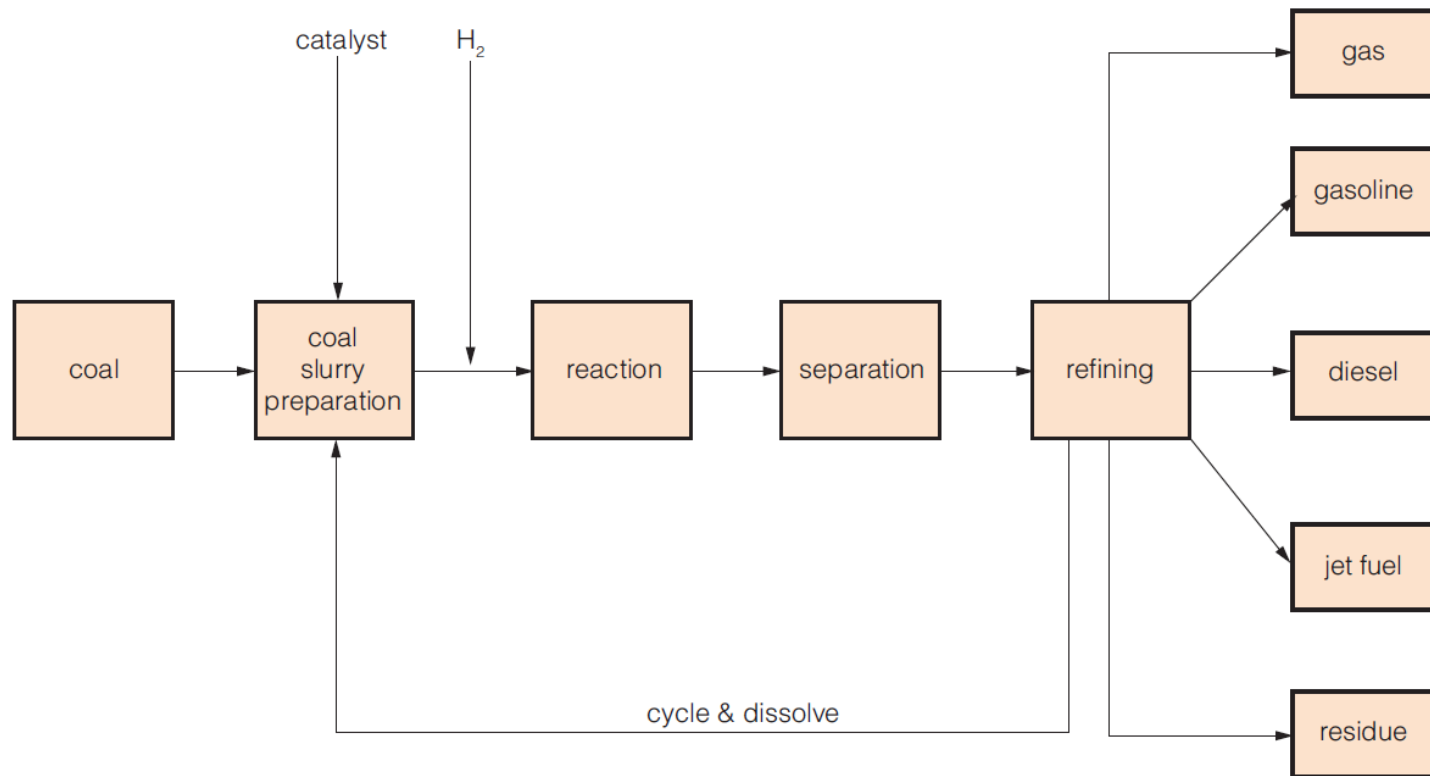- Methanol is then converted into Gasoline

Technologies – Coal-to-Liquids

Overview of CTL technologies
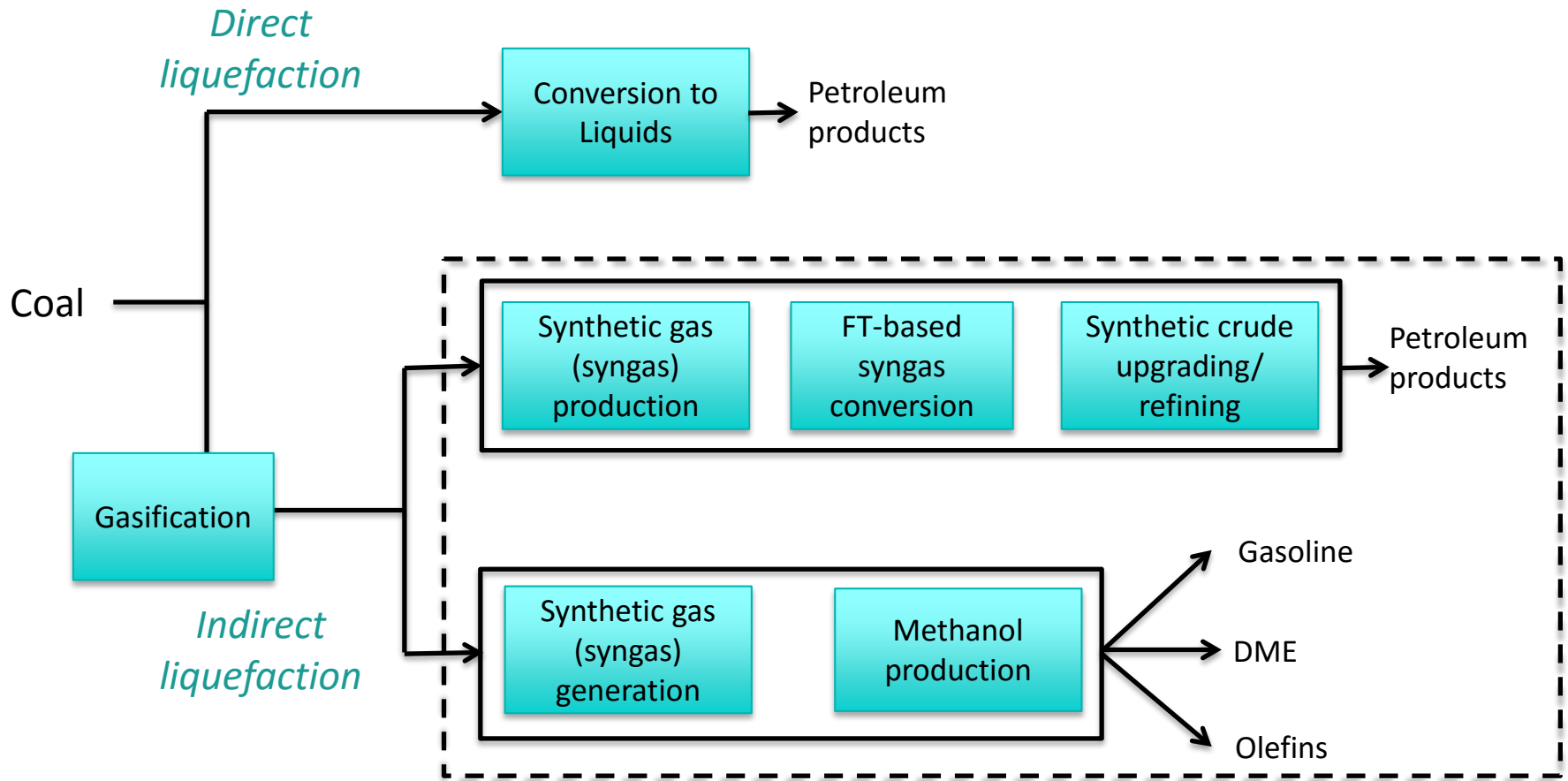
Technologies – Coal-to-Liquids

Direct Liquefaction

Technologies – Coal-to-Liquids

Direct Liquefaction

- **Direct conversion of coal**

- **Pulverised coal is treated at high temperature and pressure with a solvent**

- **The hydrogen/carbon ratio is increased by adding gaseous H_2 to the slurry of coal, with catalysts added to speed up the required reactions.**

- **Liquids produced need further upgrading to produce specification fuels such as gasoline/petrol and fuel oil.**

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Technologies – Coal-to-Liquids

Direct Coal Liquefaction (DCL)

- **The largest plant in the world at Erdos in the Inner Mongolia Autonomous Region operated by the Chinese company Shenhua Group**
  - **1st phase: 3 production lines => 3.2 Mt oil products**
  - **2nd phase: +2 production lines => 5.3 Mt oil products**
  - **Objective = product capacity of 21 Mt in 2020**

Expected product slate from each production line of the Shenhua DCL demonstration unit

Product	Annual production level, t
LPG	70,000
Naptha	321,000
Diesel	621,000
Liquid Ammonia	12,000
Sulphur	41,000
Phenol	3,000
Total	1068,000

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GTL-CTL – JODI Reporting

Reporting inputs/outputs for integrated processes

- **Gas-to-Liquids – JODI Gas**

JOINT ORGANISATIONS DATA INITIATIVE GAS QUESTIONNAIRE

Country _____
Month _____
Year _____

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Joint Organisations Data Initiative

	Natural Gas million m³ (at 15°C, 760 mm hg)	Natural Gas Terajoules	Natural Gas 1000 tonnes
	A	B	C
Production			
Receipts from Other Sources			
Imports			
LNG			
Pipeline			
Exports			
LNG			
Pipeline			
Stock Change			
Gross Inland Deliveries (Calculated)	0	0	
Statistical Difference (Calculated)	0	0	
Gross Inland Deliveries (Observed)			
of which: Electricity and Heat Generation			
Closing stocks			

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BETTER DATA
BETTER DECISIONS

GTL-CTL – JODI Reporting

Reporting inputs/outputs for integrated processes

- **Gas-to-Liquids/Coal-to-Liquids – JODI Oil**

	Crude oil	NGL	Other	Total (1)+(2)+(3)
	(1)	(2)	(3)	(4)
+ Production	0	0	0	0
+ From other sources			0	0
+ Imports	0	0	0	0
- Exports	0	0	0	0
+ Products transferred /Backflows			0	0
- Direct use	0	0	0	0
- Stock change	0	0	0	0
- Statistical difference	0	0	0	0
= Refinery intake	0	0	0	0
Closing stocks	0	0	0	0

	Petroleum Products								
	LPG	Naphtha	Gasoline	Total kerosene	Of which: Jet kerosene	Gas/ diesel oil	Fuel oil	Other products	Total products
	-5	-6	-7	-8	-9	-10	-11	-12	-13
+ Refinery output	0	0	0	0	0	0	0	0	0
+ Receipts	0	0	0	0	0	0	0	0	0
+ Imports	0	0	0	0	0	0	0	0	0
- Exports	0	0	0	0	0	0	0	0	0
- Products transferred	0	0	0	0	0	0	0	0	0
+ Interproduct transfers	0	0	0	0	0	0	0	0	0
- Stock change	0	0	0	0	0	0	0	0	0
- Statistical difference	0	0	0	0	0	0	0	0	0
= Demand	0	0	0	0	0	0	0	0	0
Closing stocks	0	0	0	0	0	0	0	0	0

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