Engineers India Limited

इंजीनियर्स इंडिया लिमिटेड
(भारत सरकार का उपक्रम)
ENGINEERS INDIA LIMITED
(A Govt. of India Undertaking)

METHANOL ECONOMY

LKMT Workshop on "Petrochemicals – Beyond Bulk Products"

13th -15th October, 2017, New Delhi

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Need for Alternate Energy Sources

Increasing world population

Increase in standard of living

Increase in carbon dioxide content of the atmosphere Greenhouse effect (Global warming). 401 ppm

•Methanol, Hydrogen & Ethanol could be sources of stored energy like fossil fuels but reducing our dependence on the same.

• Also potentially CO2 can be converted from a global-warming liability into a raw material for Methanol.

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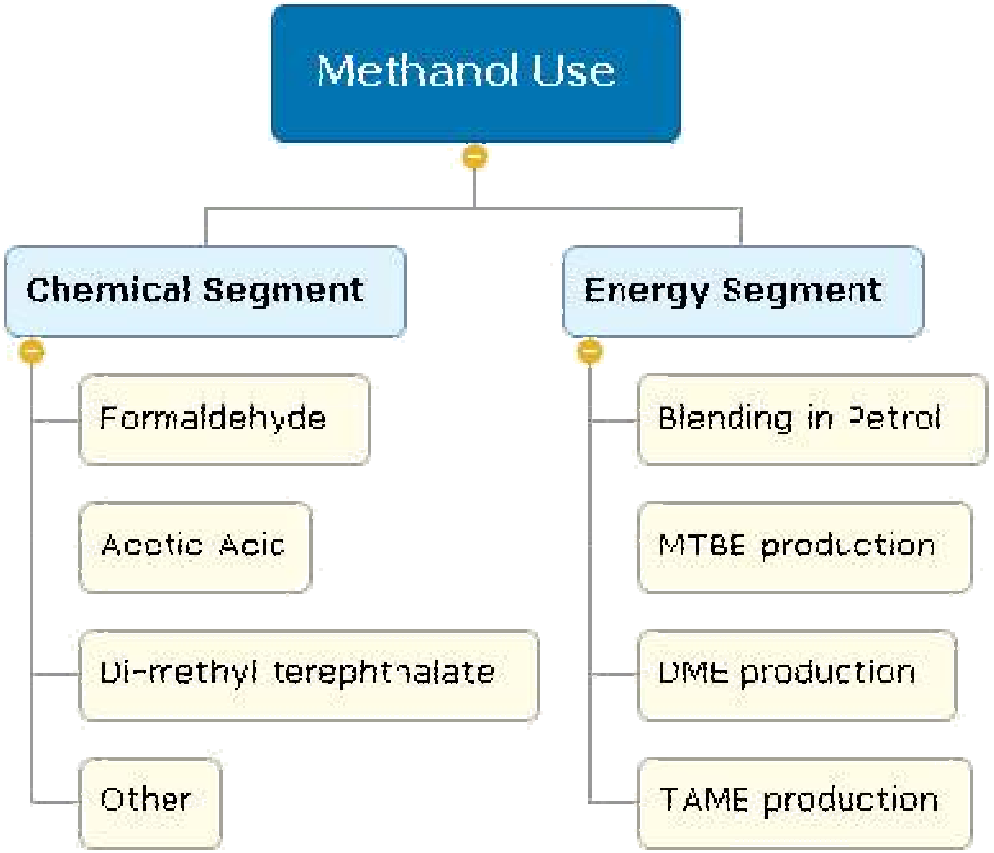
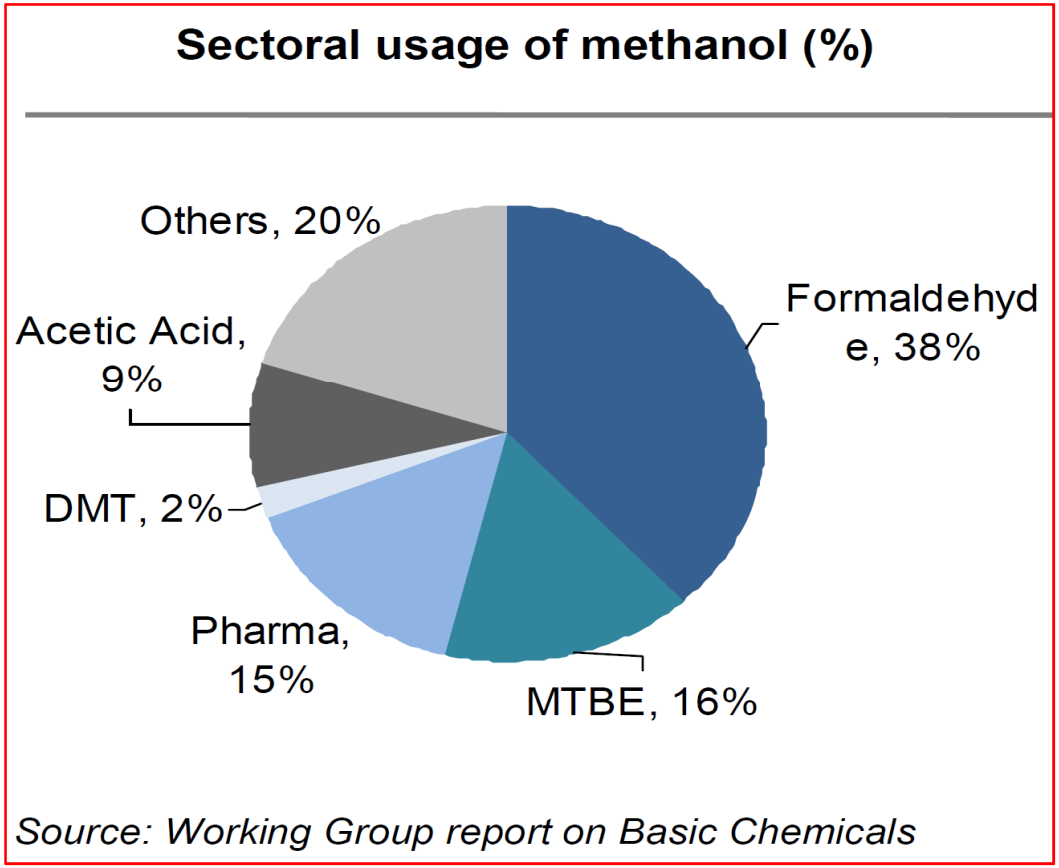
Methanol: Usage

- Starting point for the synthesis of a wide range of industrial Chemicals
- Source as an alternative fuel

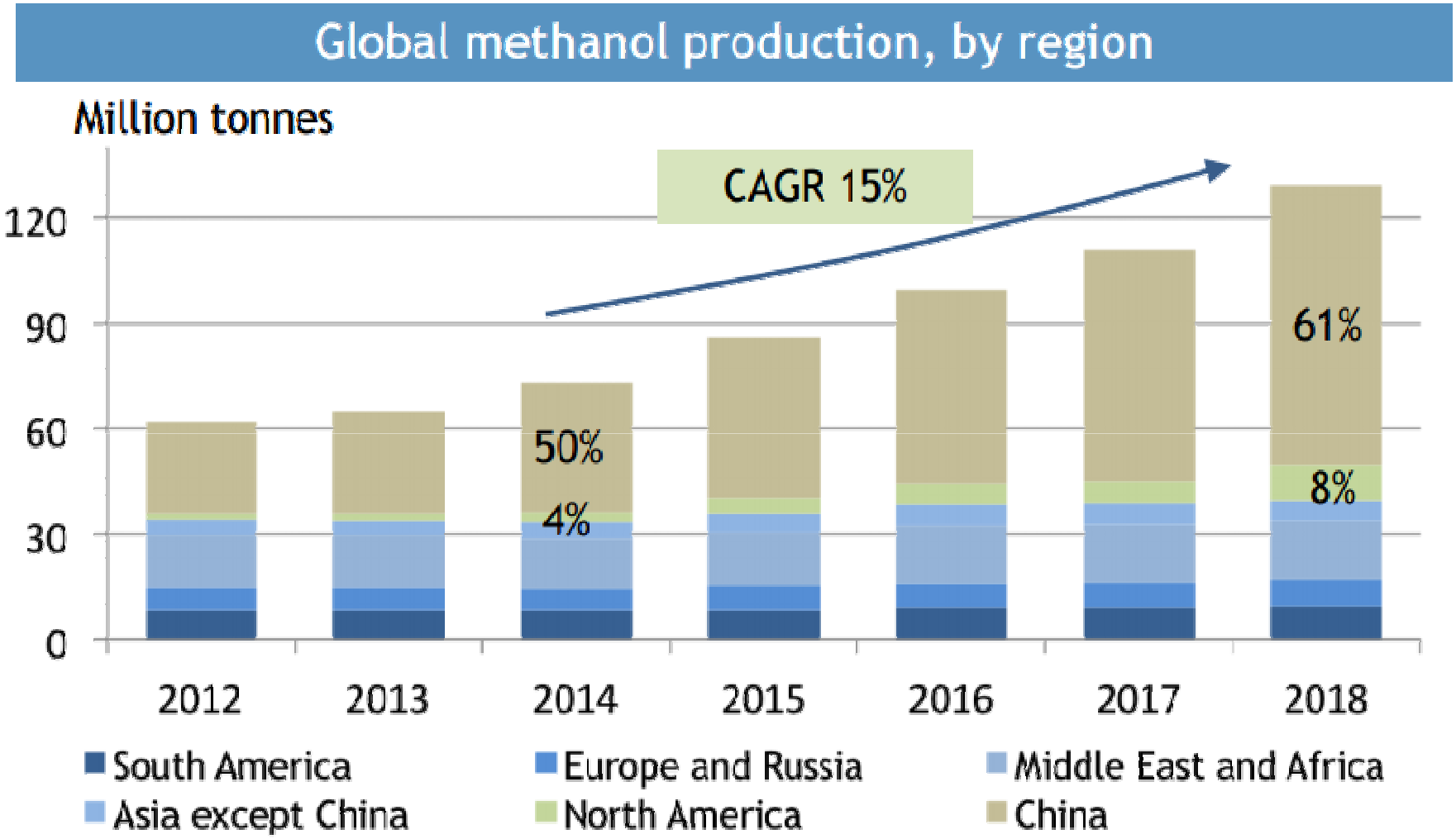




Source: Working Group report on Basic Chemicals

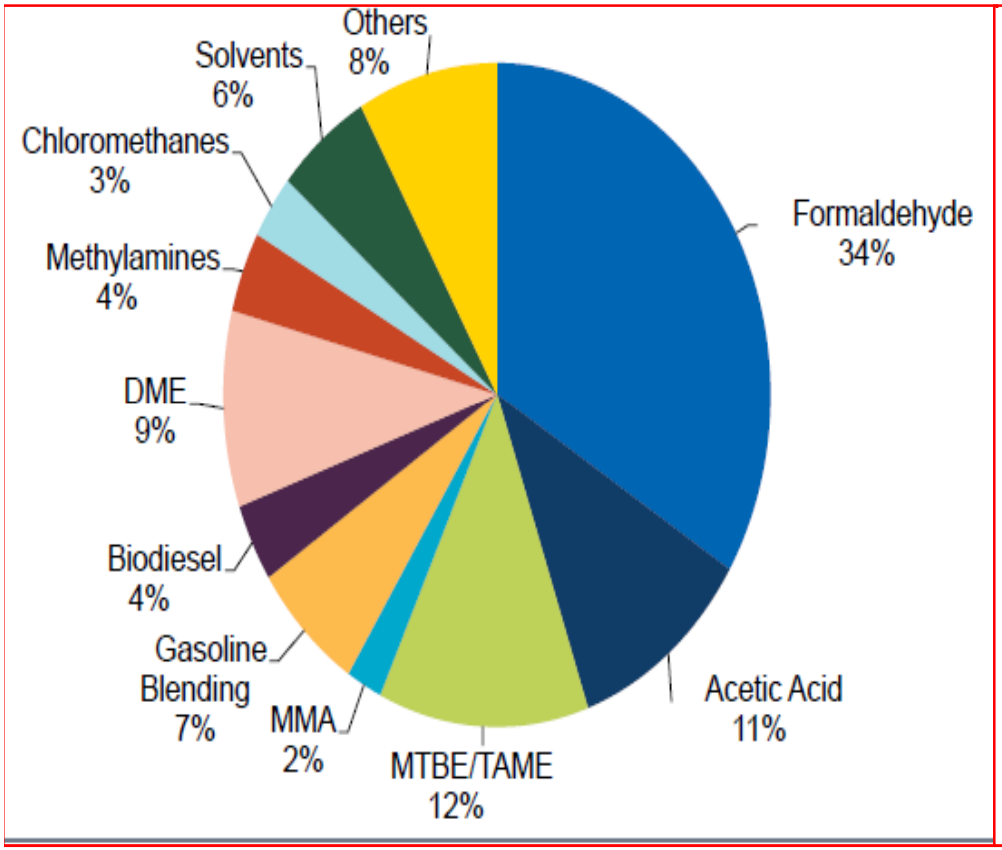
Other Use: Refrigerant, Pesticides, Paints, Tanning, Moulding Material

Methanol: Global Production

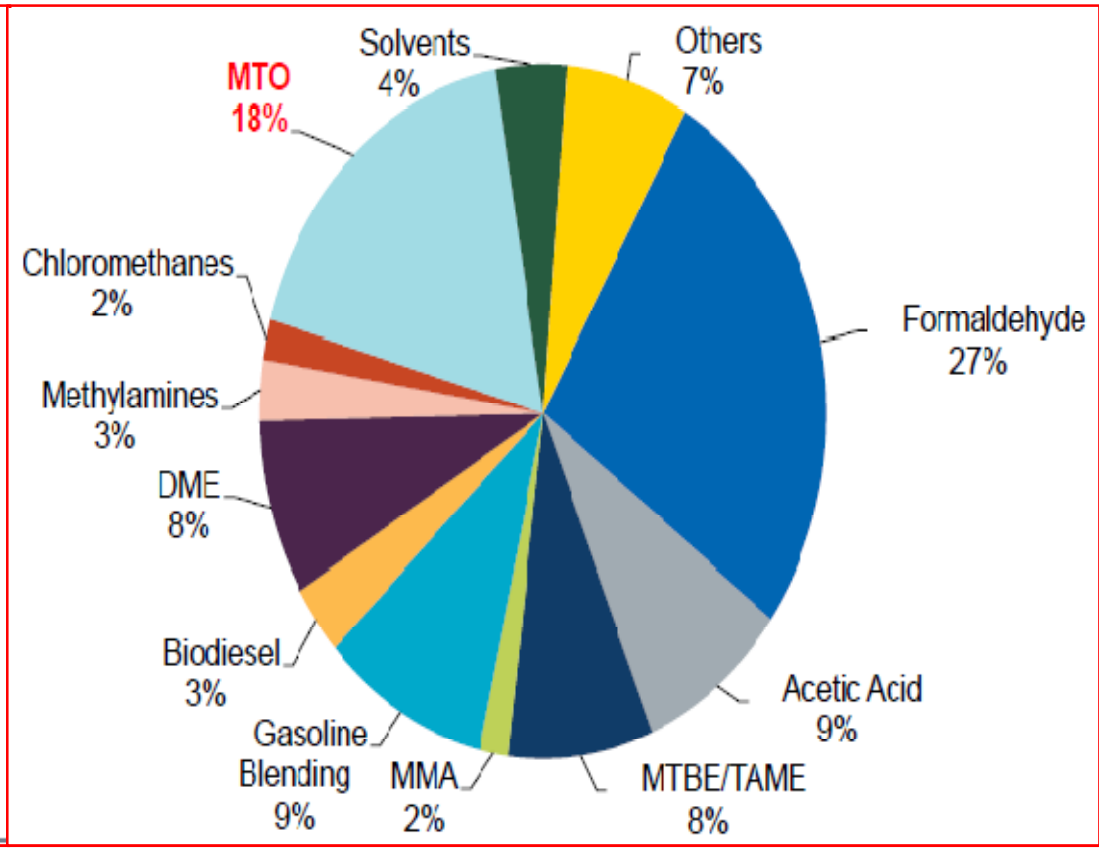


Global Methanol Demand by End Use

2010 Global Methanol Demand By End-Use



2015 Global Methanol Demand By End-Use



Methanol – Global & Indian Scenario

Net exporters: **Iran, Saudi Arabia**, Oman, South-east Asia producers

Net importers: China, Taiwan, South Korea, Singapore, **India**, EU and US

Indian market at a glance

- Consumption ≈ 2m tonnes/year (2014)
- Import: 1.4m-1.5m tonnes/year (2014)
- 70-80% imports are Iranian origin
- Five local producers

Major Methanol Plants

- Gujarat Narmada Valley Fertilizers & Chemicals Limited. (GNFC)
- Deepak Fertilizers, Taloja
- RCF in Mumbai
- NFL in Nangal
- Assam Petrochemicals

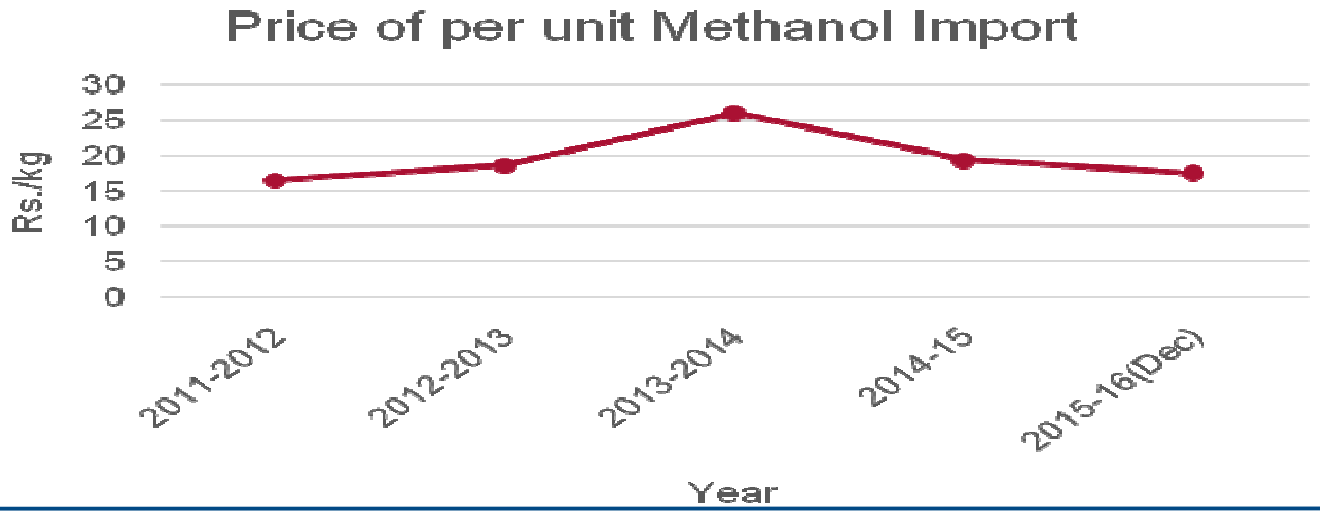
Feed for Methanol Production:

Primarily produced in India from natural gas/naphtha

Majority is imported

Methanol Statistics- India

Year	Installed Capacity(MMTPA)	Production(MMTPA)	Capacity Utilization (%)	Net Import		Consumption (MMTPA)
				MMTPA	Crore	
2015-16	0.474	0.162	34.29	1.667	2771	1.83
2014-15	0.474	0.210	44.24	1.592	3078	1.80
2013-14	0.474	0.307	64.76	1.223	3192	1.53
2012-13	0.474	0.255	53.79	1.214	2600	1.47



** Department of Chemical and Petrochemical*

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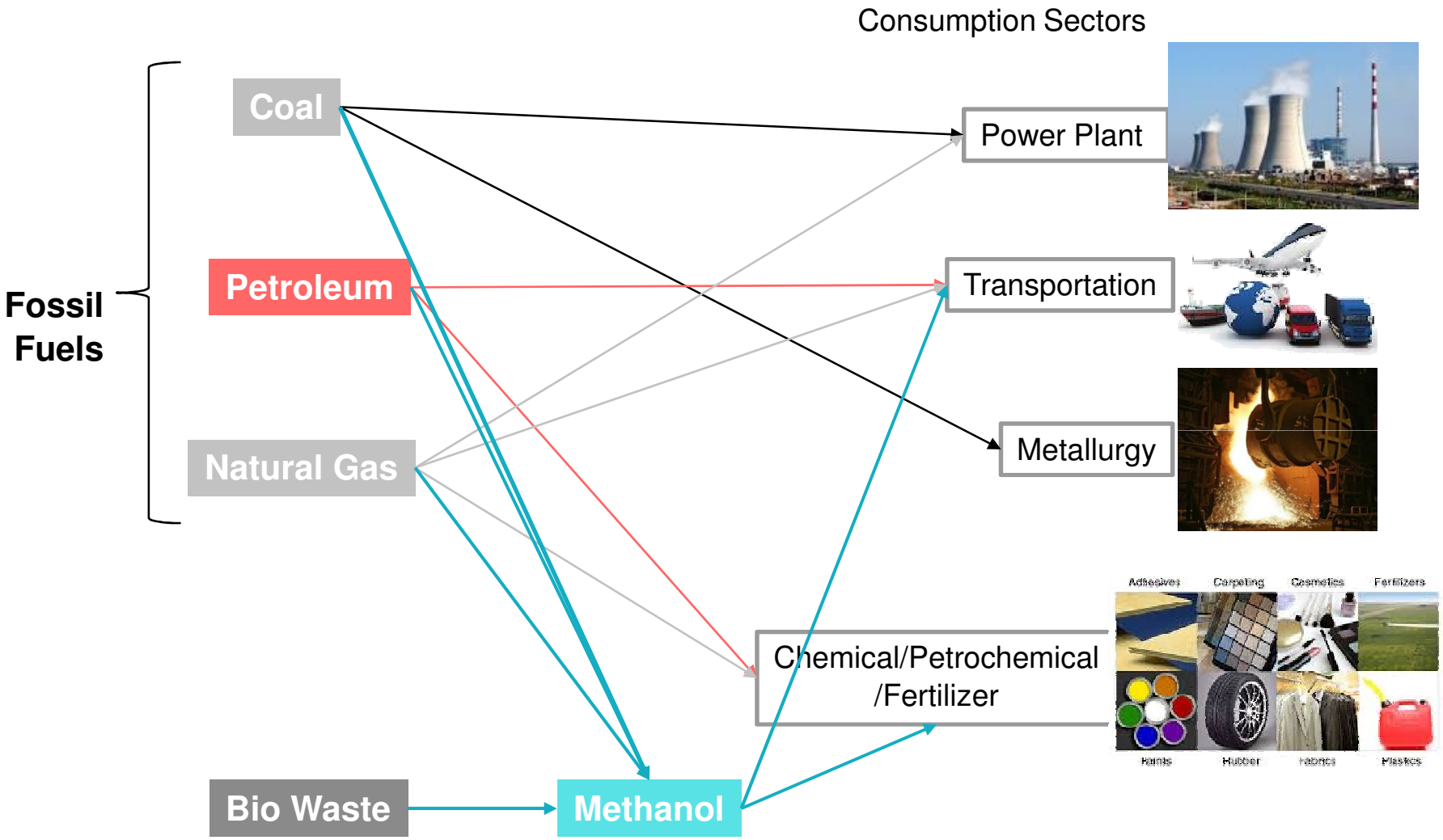
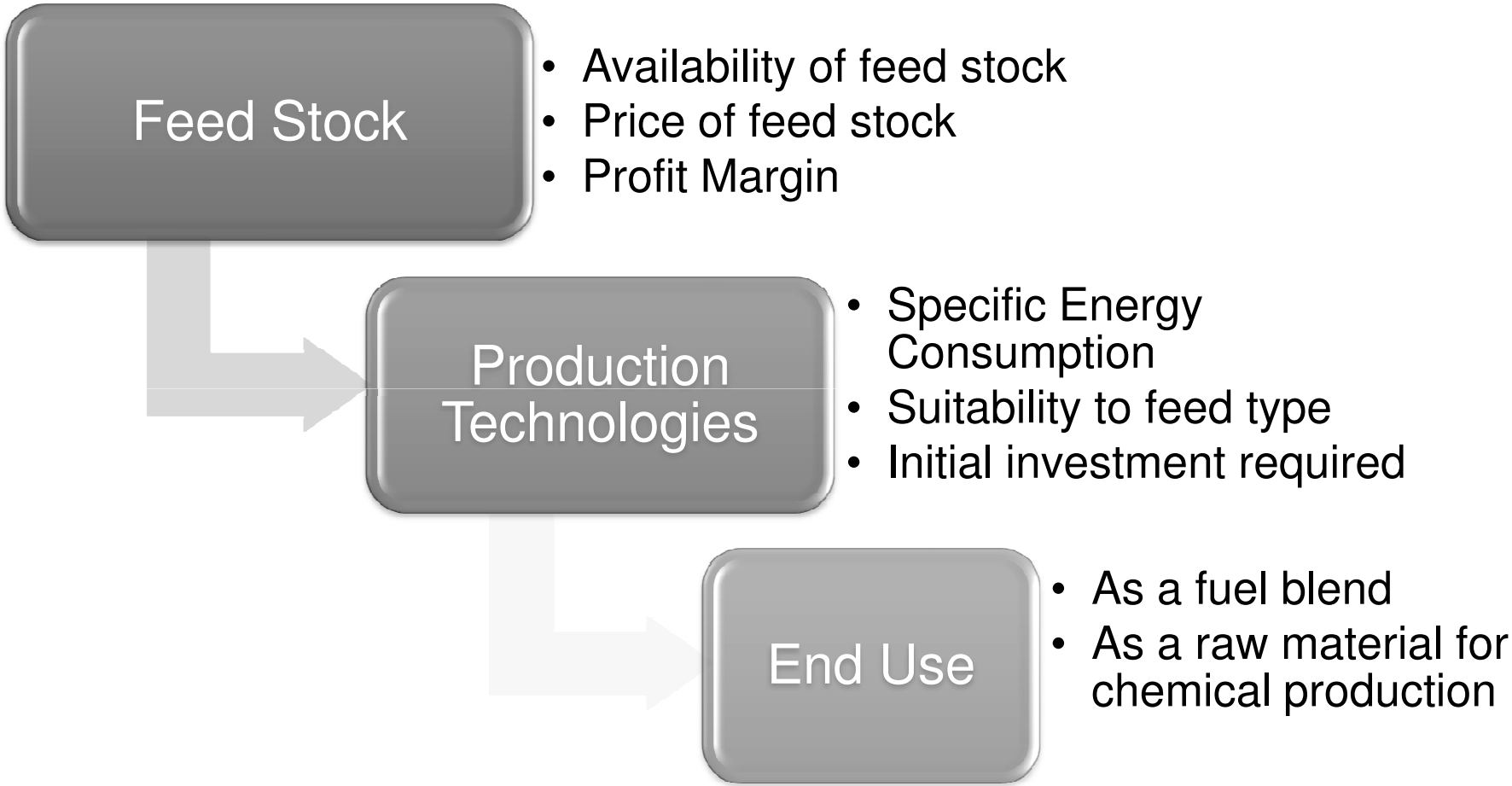
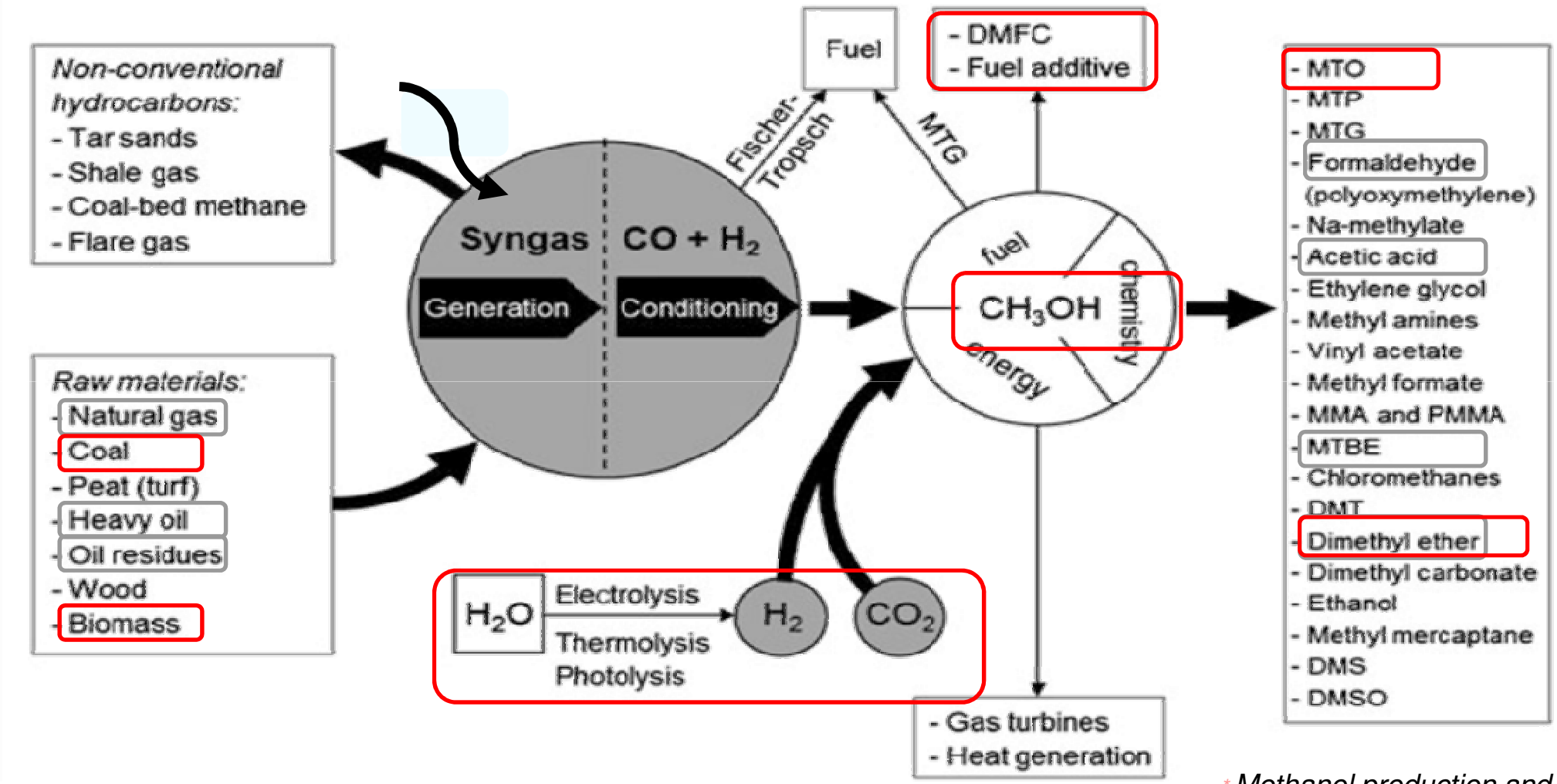
Methanol Economy



Components of Methanol Economy

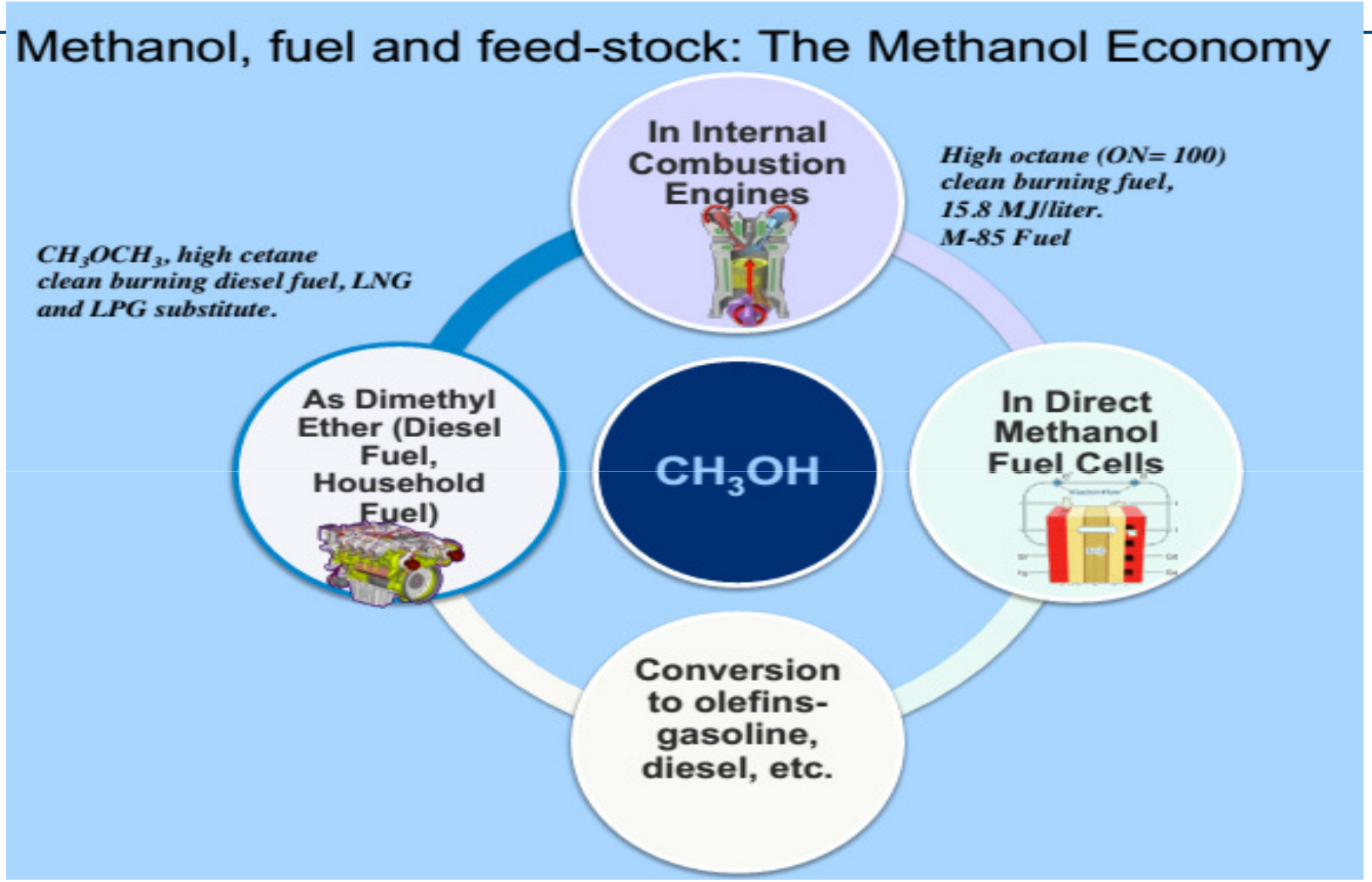


Methanol Economy: Product Portfolio



* *Methanol production and use*

Methanol, fuel and feed-stock: The Methanol Economy



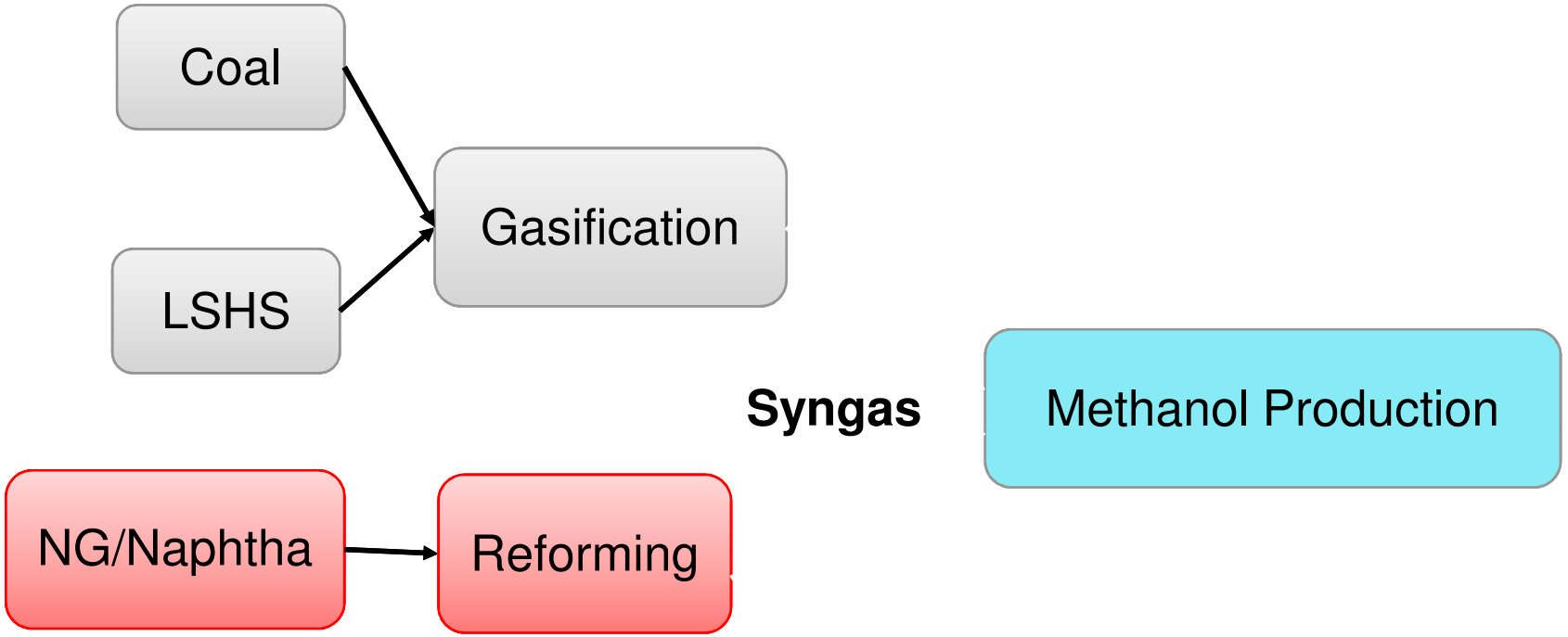
Methanol Economy…. *a fuel and feed-stock beyond oil and gas.*

– replacing petroleum-based fuels and chemicals with methanol and methanol-derivatives – as a path to sustainable development

- Methanol is a “future proof” molecule that can be made from conventional fossil sources and emerging renewable feedstock.

- Expansion of energy markets for methanol builds demand for sustainably-sourced and locally-produced methanol
  - Methanol and DME fit well within most existing energy infrastructure
  - Methanol can be used in today’s internal combustion engines (blend)
  - DME can be burned in common house hold stoves and water heaters.
  - Likely be easier transition from oil and gas to methanol compared to transition to the Hydrogen Economy or to electric vehicles.
  - In principle, a relatively feasible and affordable path towards replacing oil.

Production Technology: Production Routes



Syngas Production Technologies

Steam Methane Reforming (SMR)
Most extensive industrial experience,, Oxygen not required, Lowest process temperature requirement

Heat Exchange Reforming
Compact overall size and footprint, Application flexibility offers additional options

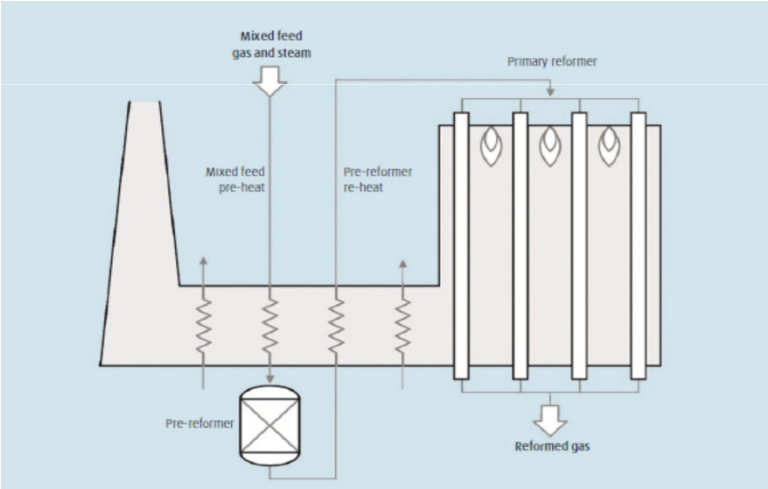
Two-step reforming : SMR followed by oxygen-blown secondary reforming.
Size of SMR is reduced, Low methane slip favors high purity syngas,

POX
Feedstock desulfurization not required, Absence of catalyst permits carbon formation and therefore, operation without steam, significantly lowering syngas CO2 content, Low methane slip,

ATR
Lower process temperature requirement than POX, Low methane slip, Syngas methane content can be tailored by adjusting reformer outlet temperature

Syngas Production: NG Reforming

	Feed	Temp. °C	Press. bar	Cat.	Note
Reforming	NG/Naphtha	900	30	Ni based	Requires HT/Lt Shift

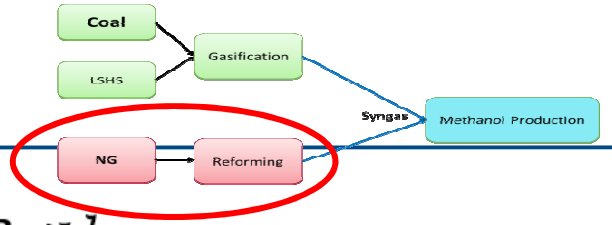


$$CH_4 + H_2O \rightleftharpoons CO + 3H_2 \qquad \Delta H_{298K} = 49.1\ \text{kcal mol}^{-1}$$

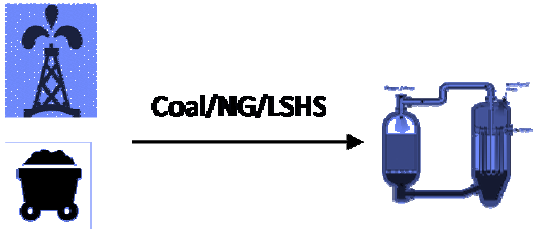
$$CO + H_2O \rightleftharpoons CO_2 + H_2 \qquad \Delta H_{298K} = -9.8\ \text{kcal mol}^{-1}$$

Stoichiometric ratio for MeOH Production:

$$\text{Required } \frac{H_2 - CO_2}{CO - CO_2} > 2$$

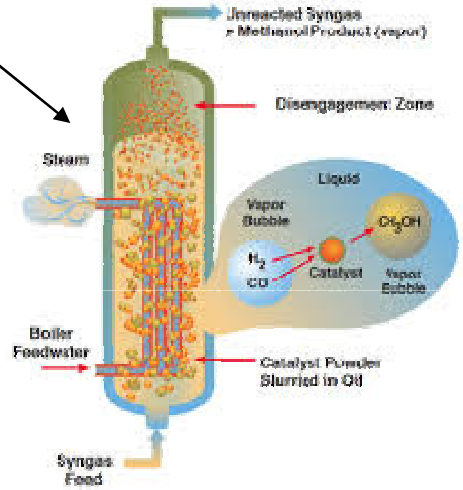


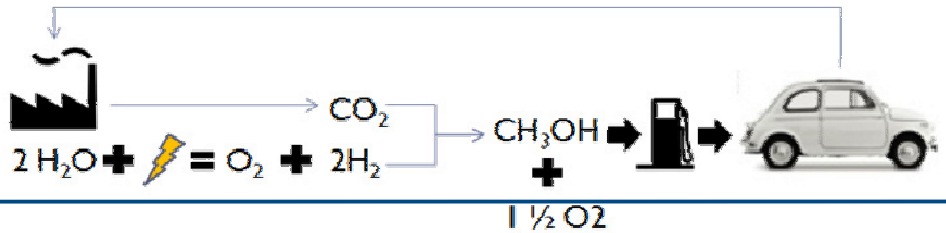
Methanol Production: Processes

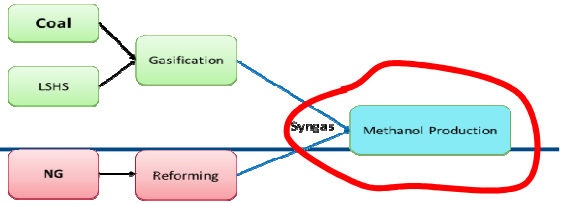


Production Processes

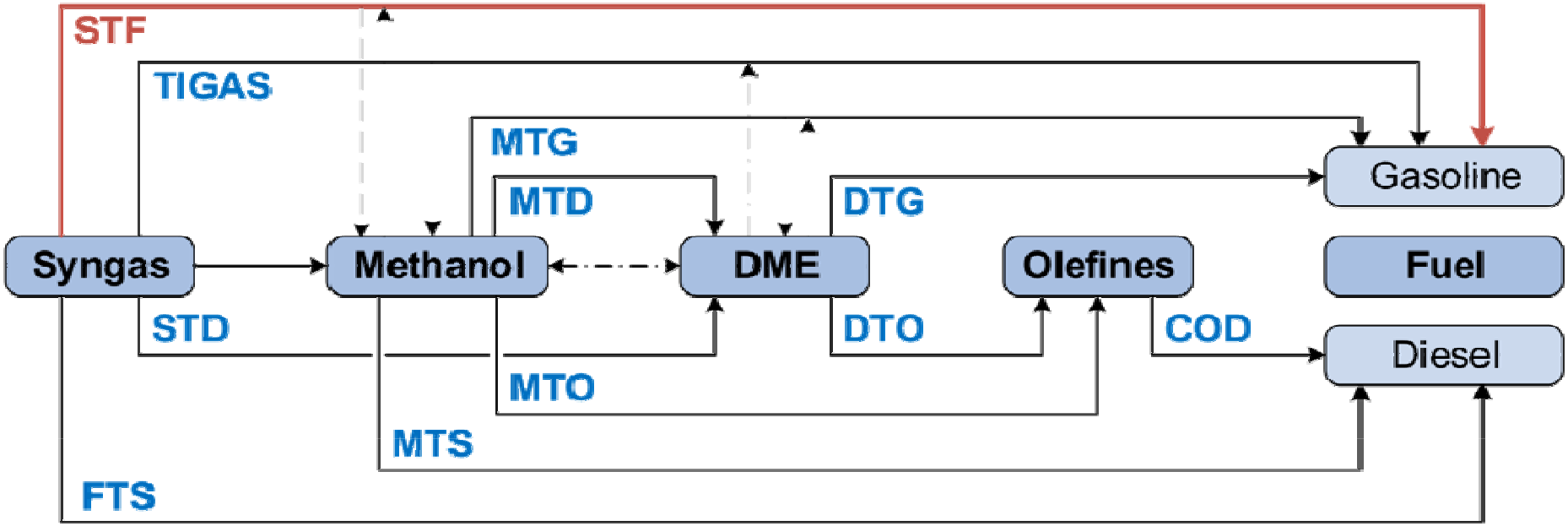
- Two Stage Methanol Production
- Single Stage (oxidative conversion) Methanol Production
- Catalytic hydrogenation of CO2







End Use: Methanol-based fuel production



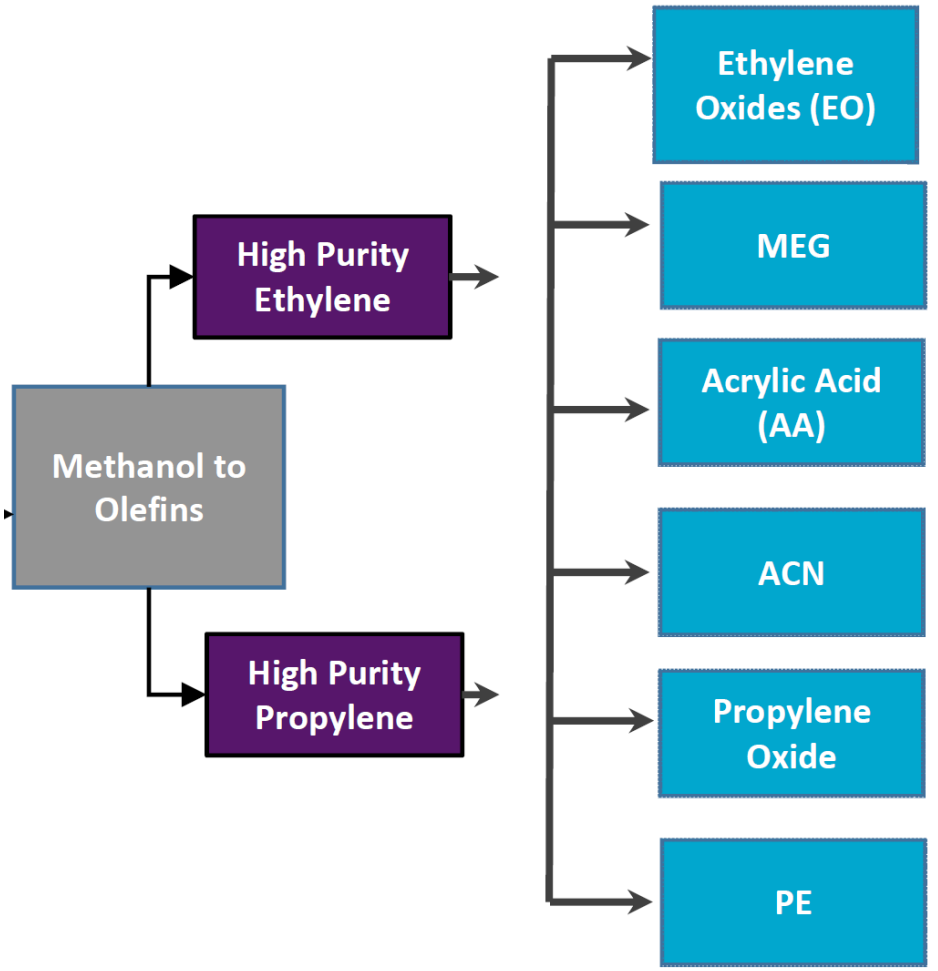
- TIGAS: Topsøe Integrated Gasoline Synthesis
- MTG: Methanol-to –Gasoline
- DTG: Dimethyl ether-to-Gasoline
- DTO: Dimethyl ether-to -Olefins
- **MTO: Methanol-to -Olefins**
- STF: Syngas -to -Fuel
- MTD: Methanol-to -Dimethyl ether
- STD: Syngas -to -Dimethyl ether
- COD: Conversion of Olefins to Distillates
- MTS: MtSynfuels

MTO

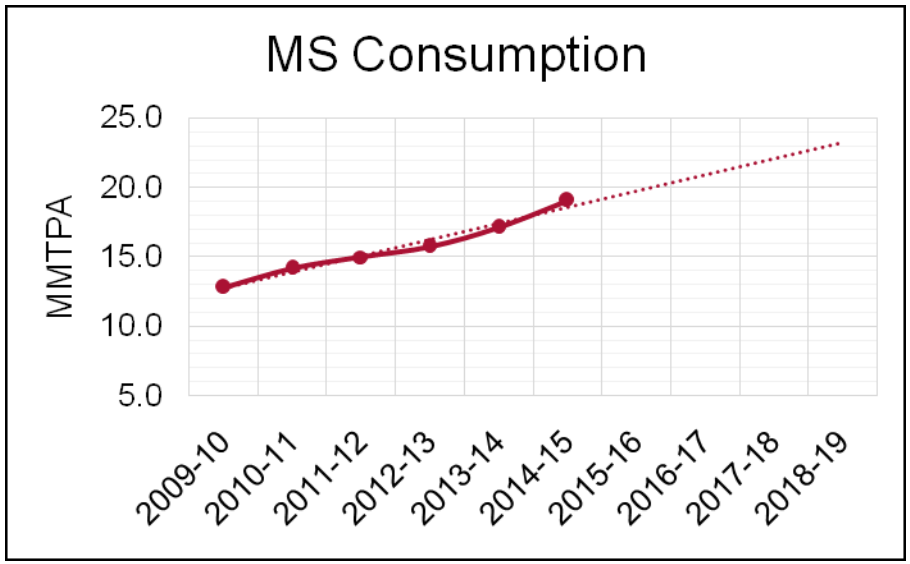
- MTO an alternative process to Naphtha cracking for olefins production (plastics)

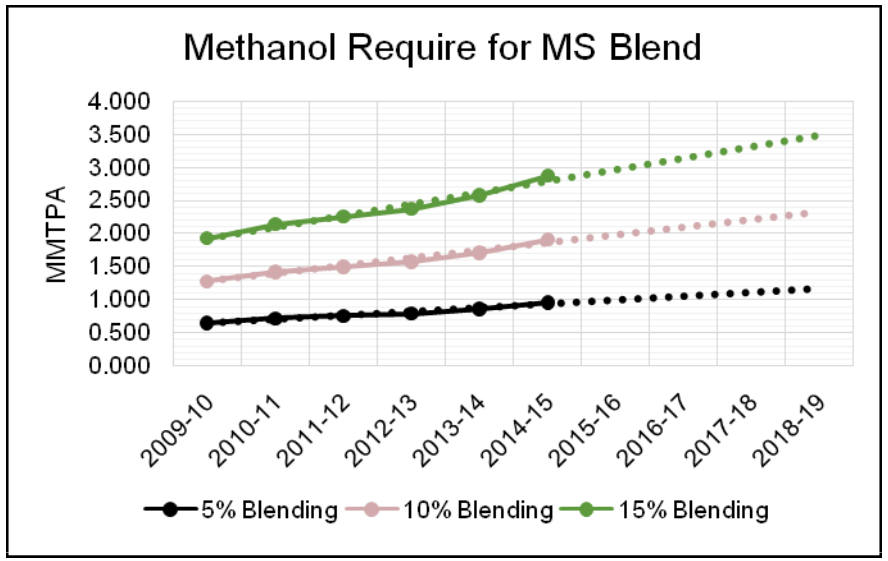
- Two main pathways
  - Upstream Integrated (CTO) – olefins produced directly from coal, methanol an intermediate step
  - Merchant (MTO/MTP) – methanol purchased from external suppliers

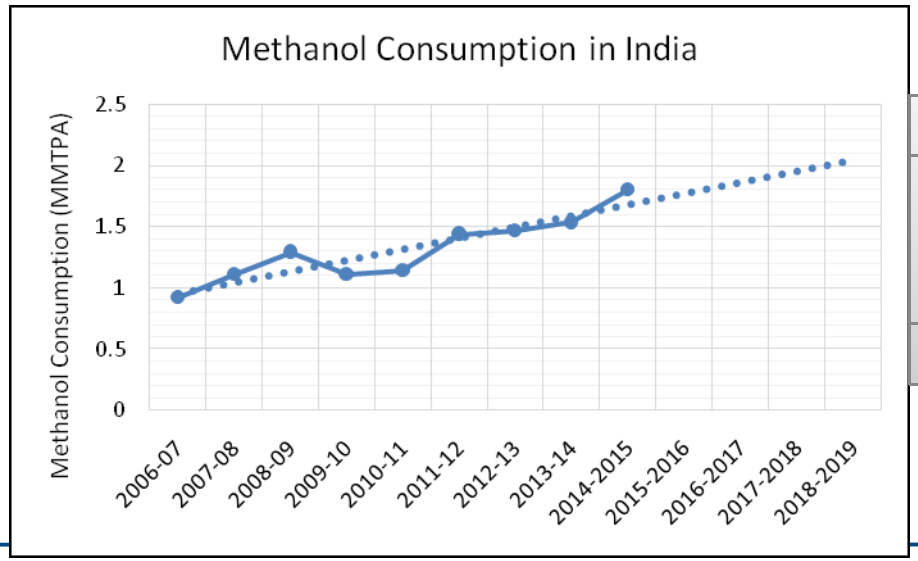
- China merchant MTO capacity is well established and still growing strongly



As Gasoline Blend







Projected Methanol required by 2018-19 in MMTPA(low CARG)						
For Chemicals	for Fuel Blend			Total Methanol Required		
	5%	10%	15%	5%	10%	15%
2	1.15	2.3	3.5	3.15	4.3	5.5

Based on data from PPAC & "Chemical and Petrochemical Statistics at a glance 201

End Use: Methanol as MS blend in India

- Methanol can be produced from verity of feed stocks like NG, Coal, Biomass
- Will reduce dependency on crude
- Indigenous technology for Coal to Syngas under development

Advantages as gasoline a blend:

- Octane No 100 (high compression ratio(9 to 11) possible-> high efficiency)
- Latent heat is 3.7 times of Petrol. Can be used in engine cooling
- Boiling point 64.7oC
- Can be used in IC engine after slight modification
- Reduced Nox emission, No C – C bond. No soot/particulate matter

End Use: Methanol as MS blend in India

- Can be blended with gasoline as an oxygenated additive
- Methanol as fuel for DMFC, which is most potential to replace conventional batteries (Methanol has higher no. of H atom than same vol. liq. Hydrogen)
- Requires dedicated Specification, Norms for India
- Requirement of indigenous technology for Methanol synthesis

•Disadvantages:

- Reacts with few plastic/polymers (corrosion inhibitors are added)
- Corrode some metals, including aluminium, zinc and magnesium, toxic
- Energy density ½ of gasoline

End Use: Methanol to DME

DME as LPG Substitute

– Burns like Natural Gas

Wobbe Index 52 (Natural gas 54)
Boiling point -25°C (Propane -42)
Vapour pressure 0.53 MPa (Propane 0.91)

– Handles like LPG

Completely miscible in LPG
Existing LPG infrastructure - Below 20 % DME.
For neat DME, minor changes in sealing materials and burner tip.

Same efficiency and emission as LPG from cooking stove to industrial boiler.

Methane DME Propane

Outstanding Diesel Alternative

– Clean-burning alternative to diesel

Cetane number 55-60 (Gas oil 40-55)
No smoke, no sulphur
NOx : ~ 90% reduction
CO2 : ~ 95% reduction

– Cost – Relatively moderate

(with very high conversion efficiency)

– Energy density

Lower than diesel (must be pressurized to be used in modified diesel engines)

Significant interest in this diesel substitute in Japan and other parts of Asia.

Today,150,000 t/y as aerosol propellant, plus 300,000 t/y for emerging fuel market

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In Summary …….. An opportunity for India

• An ambitious target of reducing **10% import dependence** of oil and gas by 2022 from 2014-15 levels. By Hon'ble PM of India announced

• Methanol can be used as an alternative transportation fuel thereby **reducing import dependence**.

• **Clean cooking fuels**
India Imports half of its LPG requirement. Thrust on LPG as a fuel will increase import dependence. **DME can be used as a substitute for LPG**.

• A large number of telecom towers, especially in rural areas run on Diesel for 16-20 hours, DME provides a substitute for replacing diesel in telecom towers.

• Biomass/MSW to methanol - A viable option for India- can be dovetailed with Swachh Bharat Mission.

• India's commitment on **Climate Change** at Paris COP21

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