METHANOL SUPPLY & DEMAND
Outside China, methanol is typically produced from natural gas.

**World Total**
- 2018 ~ 122mn t nameplate capacity
- 52% from Natural Gas
- 35% from Heavy Liquids
- 12% from Coal
- 1% from Coking Gas

**Rest of World – ex China**
- 2018 ~ 55mn t nameplate capacity
- 97% from Natural Gas
- 3% from Coal
- <1% from Heavy Liquids

Source: Argus
Rest of world methanol production (excluding China) operates to best of abilities. Excess production from the rest of the world is exported to China.

China “generally” represents the high-cost methanol production bloc in the world and operates to meet China demand, less imports received from the rest of the world.

Industrial scale since 1923 (BASF)

Source: Argus
Methanol Production in Oman

Nameplate Capacity: 1.3 MMT/Year

Nameplate Capacity: 1.15 MMT/Year
China dominates global methanol industry demand – 54% in 2018

W Europe and N America compete for the 2nd and 3rd spots – top three accounting for 75% of total

Concentrated consumer base, ~30% of demand from top 25 consumers

- Main consumers are large, global chemical companies and China MTO producers: BASF,Momentive,Celanese,BP,Dow/Dow Corning, Lucite, Evonik, LyondellBasell, SABIC, Sinopec, Ningbo Fund, Jiangsu Sailboat, etc

Industry growth expected at 4.5% per year. The equivalent of 2 world scale methanol units

*Excludes China’s CTO sector
METHANOL

An essential ingredient of modern life

Energy/Fuel substitution markets - represent the fastest growing demand segment for methanol (~45% demand)

Chemical markets - essential ingredient used in countless industrial and consumer products (~55% demand)
WHERE IS METHANOL PRODUCED?

RENEWABLE PATHWAYS ARE RAPIDLY DEVELOPING

Source: The Methanol Institute and Qafqaz

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RENEWABLE METHANOL CIRCULAR ECONOMIES

Source: Carbon Recycling International
RENEWABLE/BIO METHANOL PROJECTS
EMERGING METHANOL ECONOMIES
China methanol production capability: 84.32 MMTs, mainly dedicated coal to methanol projects

New NG stock feed methanol project suspended, coking gas limited by steel industry

Advanced coal gasification and world scale methanol production

China: coal reserve rich country (115bln tons) with scarce crude (2bln tons) and NG reserves

Increasing concerns of energy security, mainly crude, over 70% oversea import

Methanol imports ~8 MMTs in recent years, import only ~11%

China Vehicle Population in 2018: 240 mln, consuming 100 MMTs gasoline and 140 MMTs diesel
CHINA’S POLICIES ON EMISSIONS AND AIR QUALITY

- Ten measures of Air Pollution Control
- Air Pollution Control Action Plan
  - Measures aimed to set limits to air pollution
  - Banned the burning of coal in urban areas with some coal-fired power plants shutting
  - Provide state/provincial support to new energy and energy-efficient technologies

Methanol became a cost-efficient alternative fuel as it can be domestically produced and has clean-burning properties.

Source: Global Carbon Project
China’s use of methanol in liquid fuels has grown rapidly since 2000.

Methanol became a cost-efficient alternative fuel as it can be domestically produced and has clean-burning properties.
INDIA’S ENERGY SECURITY CHALLENGES

- Government keen on cutting India’s oil import bill
  - India’s reliance on imported oil has grown to a multi-year high of 83.7% in 2018/19 due to consumption growth
- Natural gas imports also rising
  - Energy industry (23%) competes with fertilisers (28%), city gas distribution (CGD) entities (16%), refineries (12%), and petrochemicals (8%)
- Paris Agreement commitment: produce 40% of electricity from non-fossil fuel sources
- Need to bolster country’s long-term energy security as the world’s third largest energy consumer while increasing renewable sources in energy mix.

INDIA’S METHANOL POLICY ASPIRATIONS

• September 2015: NITI Aayog formed the Methanol Economy Expert Group

• 2018: Methanol M15 Guidelines published

• 2018: IRClass published Guidelines for Methanol Fueled Vessels

• 2019: Methanol economy roadmap proposed to Indian parliament

• Launching Projects:
  o M15 fuel blending (through ARAI)
  o Inland waterways (through IWAI)
  o Cook stoves (in Assam)
  o Remote power generation

• Looking into producing methanol from biomass/agricultural waste
METHANOL APPLICATIONS

- Land Transport Fuel
- Marine Fuel
- Industrial Boilers
- Fuel Cells
- Cookstoves
LAND TRANSPORT FUEL
Low-level gasoline blending (M15 – 25)
- No changes needed to vehicle
- ~75% of cars manufactured by international automakers are compatible with low-level blends
- Long history of M15 blending in China from 1980s
- Estimated 7 MMT of methanol consumed in M15 blends in China

High-level blending/methanol vehicles (>M85)
- Requires dedicated vehicles
- Few changes required to existing vehicle technologies
- Only in Chinese market, R&D started in late 1980s
- Geely has a 300,000/year production capacity for M100 cars
China

- Long history of methanol-gasoline blends in the lower levels
- Methanol commonly found in gasoline across the country
- 8 Ministries published a policy paper in 2019 to promote M100 cars
- 5-year projection (from 2019): 50,000 M100 cars, trucks, and buses consuming >500k MT/year
Iceland and UK
- Carbon Recycling International (CRI) trials 100% renewable methanol on Geely Emgrand 7 in Iceland
- CRI exported RM to UK for M3 blending
  - Compliant with EN228 which has 3% methanol content ceiling
Italy
- Eni and Fiat Chrysler Automobiles (FCA) collaborated on A20 fuel (M15 + E5)
- Trialed on 5 Fiat 500 cars used for car sharing in 2018
- Compliant with Euro 6 standard and 3% reduction of tailpipe emissions
India
- Methanol M15 guidelines published in 2018
- Launched M15 research project with Automotive Research Association of India (ARAI)
- M15 research results positive:
  - Lower emissions from vehicles
  - Compliant with cars (not 2/3-wheelers) with minor modifications to some components
- Waiting on government funds to launch field trials
- Stakeholders keen on methanol as ethanol aspirations were largely unsuccessful
- Beyond Bharat Stage VI market will open up to new fuels due to cost
International Convention for the Prevention of Pollution from Ships (MARPOL)

Annex VI Prevention of Air Pollution from Ships entered into force

ECAs first introduced with sulphur content limit of 1%

Global sulphur limit of 0.5%, effective January 2020

Sulphur content lowered to 0.1% in ECAS

Sulphur content

Global Sulphur Cap (outside ECAs)

- 2005: 4.50%
- 2012: 3.50%
- 2020: 0.50%

- 1973
- 2005
- 2010
- 2015
- 2016
- >2020
- ?
IMO Initial Strategy on the Reduction of GHG Emissions adopted at MEPC 72 (April 2018)

Level of ambition of Initial Strategy.

Carbon intensity of ships to decline through implementation of further phases of energy efficiency design index (EEDI) for new ships.

Reduce CO$_2$ emissions per transport work, as an average across international shipping by at least 40% by 2030, and 70% by 2050, compared to 2008.

Peak GHG emissions from international shipping ASAP, and reduce total annual GHG emissions by at least 50% by 2050 compared to 2008.
PROGRESSION OF GUIDELINES FOR METHANOL

- **2014**
  - CCC 1
    - Ethyl/methyl alcohol
    - Fuel cells
    - Low-flashpoint diesel

- **2015**
  - CCC 2
    - Ethyl/methyl alcohol
    - Fuel cells
    - Low-flashpoint diesel

- **2016**
  - CCC 3
    - Fuel cells
    - Ethyl/methyl alcohol
    - Low-flashpoint diesel

- **2017**
  - CCC 4
    - Fuel cells
    - Ethyl/methyl alcohol
    - Low-flashpoint diesel

- **2018**
  - CCC 5
    - Ethyl/methyl alcohol
    - Fuel cells
    - Low-flashpoint diesel

- **2019**
  - CCC 6
    - Ethyl/methyl alcohol
    - Fuel cells
    - Low-flashpoint diesel

- **2020**
  - MSC 101
    - Amendments
    - Referral to other sub-committees
  - MSC 102
    - Amendments
    - Approval
    - Adoption

Draft Interim Guidelines Validated

MSC 100
- Amendments
- Confirmation
- Referral to other sub-committees

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## Methanol Fuelled Vessels and Pilots

### Dual Fuel
- **Quantity**: 9 + 2
- **Type**: Chemical tankers, ROPAX ferry
- **Owner**: MOL, W-L, Marininvest, Methanex, Mitsui, OIL, NYK, Stena Line
- **Engine Type**: 2 stroke MAN, 4 stroke Wärtsila
- **Design**: new build, retrofit

### Fuel Cell
- **Quantity**: 1 + 2
- **Type**: Pilot boat, Tourist boat
- **Owner**: MI/SMA ScandiNaos, Innogy HTWG Konstanz
- **Engine Type**: high speed Scania, Weichai
- **Design**: retrofit

### Project | R&D
- **Quantity**: +4
- **Type**: Ferry
- **Owner**: Viking Line, SUMMETH/MARTEC, Lean Ships, Methaship, Billion Miles¹, FiTech², IWAI³, PCG Product Vessel⁴, NTU², GMM, Fastwater, Port of Rotterdam Barge, Jupiter, Paxell, Methanex Fishing⁵
- **Engine Type**: SI hybrid, dual fuel, etc.
- **Design**: new build & retrofit

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*All projects are based in the EU unless noted otherwise¹ China/SG, ²EU/China/SG, ³India, ⁴Malaysia, ⁵China*
Methanol classified as “not more dangerous” than other fuels such as gasoline or diesel – fuels largely familiar to most people
SAFER FOR THE ENVIRONMENT

LC50, LC = LETHAL CONCENTRATION FISH
Concentration in water, at which half the marine population died within the specified test duration

- Methanol$^1$: 15,400 (mg/l)
- Methane$^5$: 49,9 (mg/l)
- Heavy Fuel Oil$^3$: 79 (mg/l)
- Diesel$^4$: 65 (mg/l)
- Gasoline$^2$: 8,2 (mg/l)

Safer than Diesel by a factor of 240 times

$^1$ ECHA, European Chemicals Agency, registration dossier Methanol
$^2$ Petrobras/Statoil ASA, Safety Data Sheet, ECHA registration dossier Gasoline
$^3$ GKG/ A/S Dansk Shell, Safety Data Sheet
$^4$ ECHA, European Chemicals Agency, registration dossier Diesel
$^5$ ECHA, European Chemicals Agency, registration dossier Methane

Additional Source: Meyer-Werft
METHANOL IS WIDELY AVAILABLE AT PORTS

Methanol Fuel Availability at Ports
BROADLY, METHANOL IS...

- A cost effective and “future proof” fuel which can be produced from a variety of feedstocks – to include renewables
- One of the top 5 seaborne chemical commodities – safely handled for over 50 years
- A lower cost alternative for converting vessels, boilers and other power sources to methanol – minimal and economically viable without subsidies
- Widely available and alleviates many infrastructure and safety limitations both on land and at sea, trading within a narrower price range than competing fuels
- Not as well understood as a fuel, even though it has similar handling characteristics as distillate fuel
FUEL CELLS
Methanol can be produced efficiently from renewable electricity, providing a long term storage solution.

Physical characteristics make distribution and transport cost-efficient.

Can be converted to electricity in fuel cells on board vehicles with minimal emissions. No NOx, SOx, or PM. 80% reduction in CO2 emissions.

Compatible with existing distribution and refueling infrastructure.
2 types of methanol fuel cells

1. Direct Methanol Fuel Cell
   - Uses methanol without reforming
   - Methanol can react at the cell electrodes without reforming technology

2. Reformed Methanol Fuel Cell
   - Requires a reformer which converts methanol into hydrogen
   - Hydrogen is reacted in the fuel cell to produce power

Methanol (CH₃OH) is a better carrier of hydrogen than hydrogen.
- It is liquid at ambient temperature and pressure
- Has more hydrogen atoms in one molecule compared to H₂
FUEL CELL APPLICATIONS

Remote Power Generation
Telecom Towers
Security Installations
Military Applications
Range Extender in Automobiles
Propulsion for Marine Vessels
GLOBAL INDUSTRY GAINING TRACTION

Logos of various companies and organizations are displayed, indicating their involvement in the methanol industry.
HYBRID INNOVATION: AIWAYS/GUMPERT RG ‘NATHALIE’

AIWays: Gumpert RG Nathalie

Reformed Methanol Fuel Cell Electric Supercar

1,200 km Range

Top speed 300 km/h
INDUSTRIAL BOILERS
METHANOL FUELED INDUSTRIAL BOILERS

• Industrial boilers are widely used for heating and industrial stream
• Many cities in China prohibit the use of coal and diesel
• Capacity ranges from 1 to 20 steam tons/hour
• In continuous cycle on full load, one steam ton of capacity consumes 110 kg of methanol
• Methanol fuel is used neat or emulsified (typically to 25%)
• Standards developed with MI and Methanex support
• Currently close to 1500 units, consuming over 3M mtpa
• Forecasted to consume 5M mtpa by 2022
METHANOL FUELED CERAMIC KILNS

- China produces:
  - ~60% of world’s glass products
  - ~90% of all ceramics globally

- 0.5M mtpha market in Dehua alone
- Displacing LPG for safety
- More competitive than NG
**METHANOL FUELED CERAMIC KILNS**

- 3-yr pilot reference
- 4 MT/month average consumption with less air intake
- Underground storage with day tank buffer
- 3 to 6 cubic meters kiln capacity
- Retrofit kit includes:
  - Tank
  - Burners
  - Controls
  - CPU
  - Waste Heat Recovery
  - RMB 10,000 (USD$ 1,500)
- Higher achieved temperatures with methanol – to 1400°C
- Similar price but safer than LPG, which is registering on average of one explosion weekly – often with fatalities
METHANOL FUELLED TABACCO DRIERS

1 out of every 3 Cigarettes globally are consumed in China

- RMB1.7 trln profits + tax collected by government annually
  - Equal to military spending budget
  - More than Sinopec and CNOC combined contributions to state treasury
COOKSTOVES
METHANOL FUELED COOK STOVES

- Current market consuming over 5 M mtpa
- Forecast to reach 7-8 M mtpa by 2022
METHANOL FUELED COOK STOVES

• Single heating, stir fry, steaming

• Widely used in restaurants, central kitchens, mainly cost-driven

• Simple storage and transportation, filling the gap when NG supplied by pipeline is cost prohibitive

• Fuel: 100% methanol to methanol blends usually with water (to 40%)
SUMMARY

- Application design, whether retrofit or new build are simple, advantageous, practical and understandable – whether for ships, boilers, kilns, or cars

- Compelling emissions reduction properties in all cases

- Superior Life Cycle Analysis (LCA) advantage when combined with CCI technology or when renewably produced

- Infrastructure is a key enabler for methanol’s uptake as a fuel due to storage and handling being no more complicated than other liquid fuels

- More visibility over long-term pricing than competitive fuels
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