Global Methanol Outlook 2023: Growth and Decarbonization

Prepared for the:

2023 Canadian Petrochemical Summit
June 7th, 2023

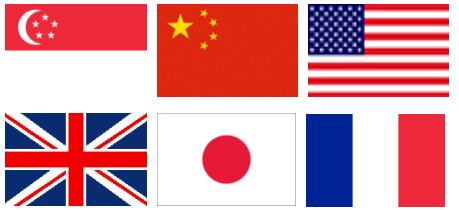
By:
Mark Berggren
Managing Director (MMSA)

INDEPENDENT. OBJECTIVE. GLOBAL METHANOL ADVISORS

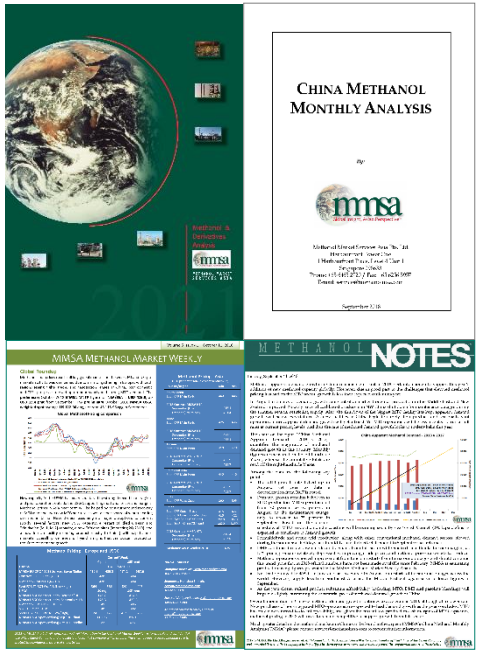
Methanol Market Services Asia Pte. Ltd.
60 Paya Lebar Road
Level 8 Unit 13, Paya Lebar Square
Singapore 409051
Phone: +65 9021 6275
E-mail: services@methanolmsa.com

MMSA – Global Insight, Asian Perspective™

INDEPENDENT. OBJECTIVE. GLOBAL METHANOL ADVISORS



- **20th Year of Operation – Globally present**
  - Employee owned, independent advisors
  - 172+ years of combined methanol industry experience: Singapore, Shanghai, Tokyo, UK, France, Houston, Seattle
- **Multi-Client Services**
  - **Methanol & Derivative Analysis**
    - Methanol, Formaldehyde, Acetic Acid, MTBE, MMA, Energy Use globally– 700+ pages; updated quarterly
  - **Methanol Notes™**
    - One-page topics of relevance, weekly since 2005
  - **MMSA Weekly Methanol Analysis**
    - Global market analysis and price assessment every Friday Singapore time – limited to 8 pages
  - **China Monthly Methanol Analysis (CMMA)**
    - Quantitative analysis of world's largest methanol market – Feedstocks, Costs, Affordability, MTO, S/D, Pricing
  - **Methanol Ship Tracking**
    - Daily monitoring of 400+ methanol carrying vessels (and growing)
  - **MTO Business Analysis**
    - Monthly assessment of profitability of 24+ CTO and MTO facilities in China
- **Project Services**
  - Market and Technical Due Diligence Support, Bankable Project Assessments, Valuation, other custom-made, proprietary efforts
  - Methanol (including **"low carbon" meOH**), Acetic Acid, Formaldehyde, MMA, MTBE



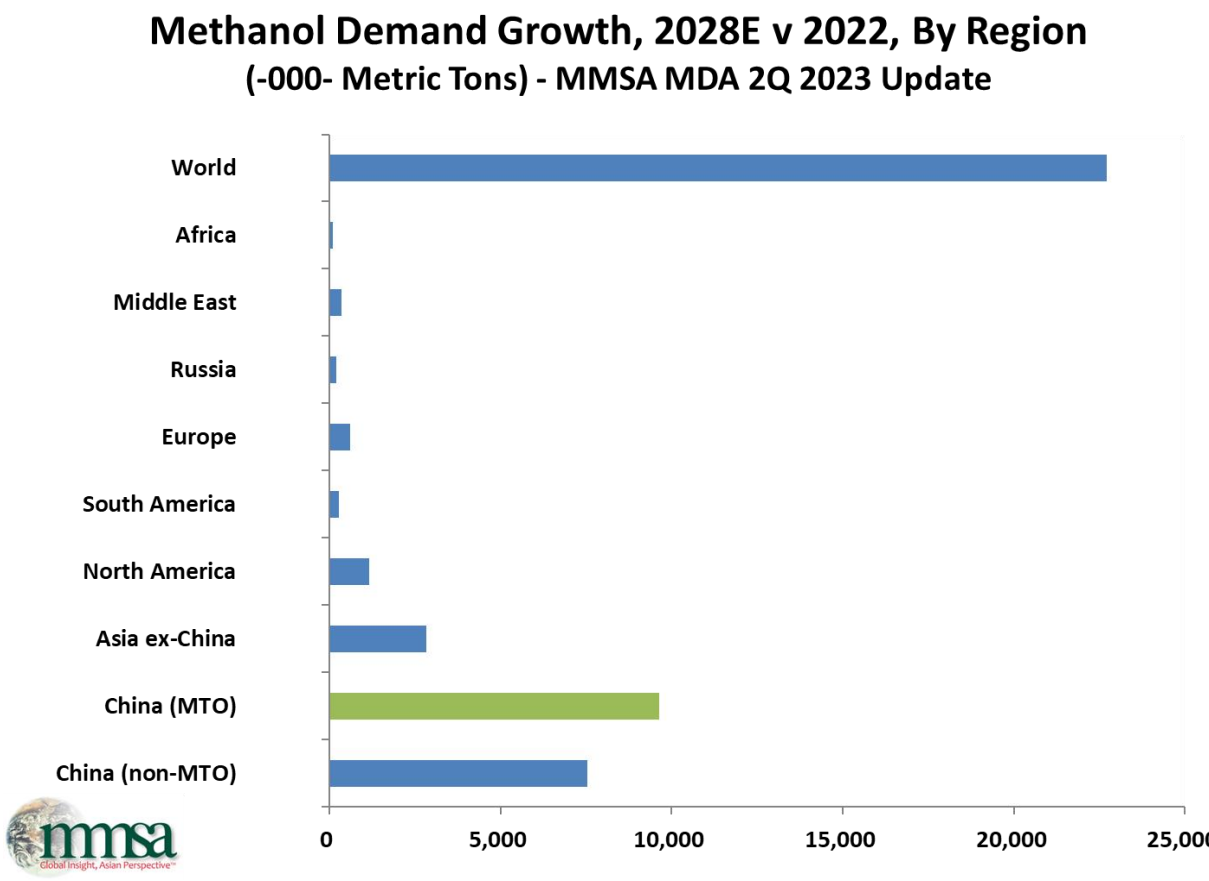
- **MMSA IMPCA International Methanol Conference: November 2 – 3, 2022 - Singapore**
- **MMSA IMPCA Methanol Forum: Nov 30th – Dec 1st, 2022 – Frankfurt**

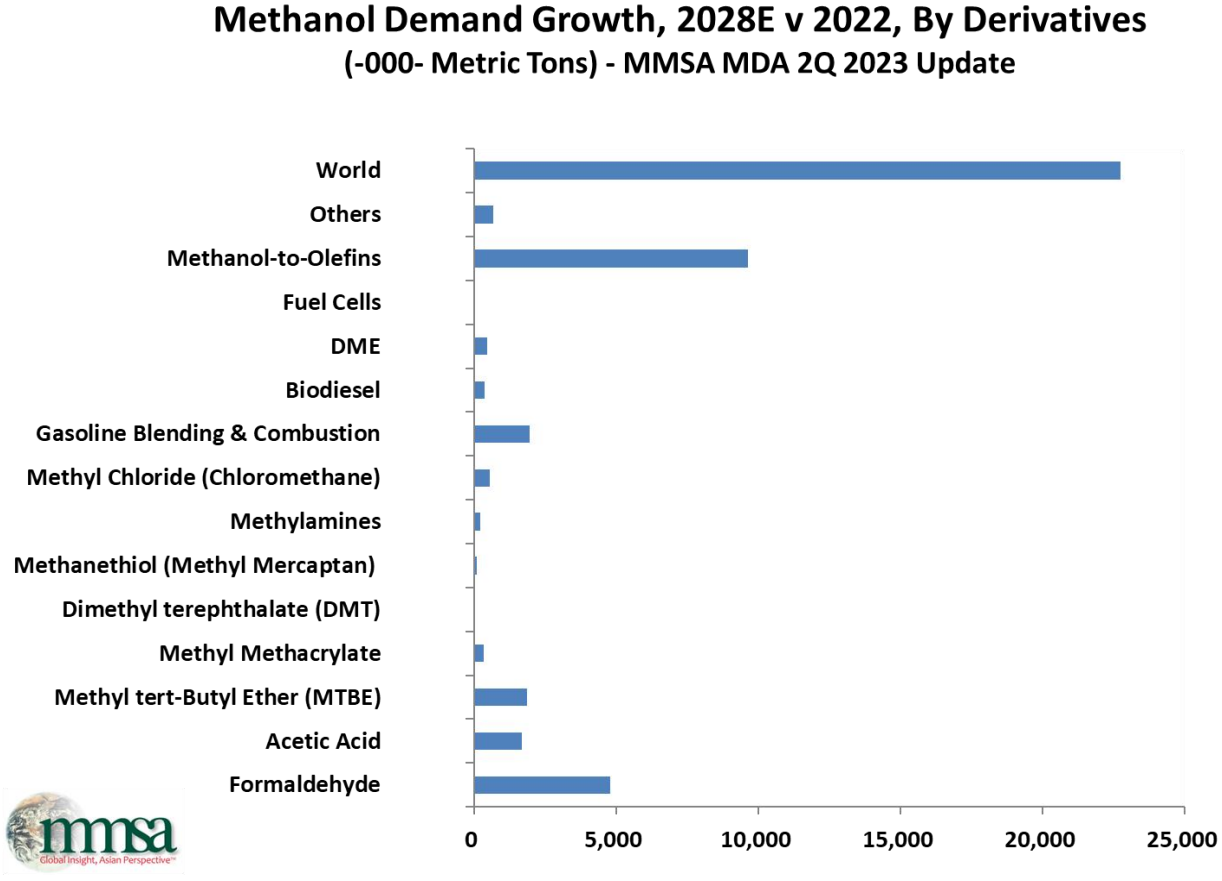
Today's Important Points, Numbers

- Conventional methanol uses will drive GDP-multiple demand growth
  - 108.7 million mtpa demand expected in 2023E, CAGR 3.4% '23E-'28E
  - Methanol's remarkable versatility in use has, will secure its future.
    - At the trailhead of seemingly unending value pathways
- Must reinvest in conventional methanol to support demand growth long term
  - Next plants will be more efficient; current assets will be revamped to lower carbon intensity
    - Coal based methanol is a clear opportunity for industry CI improvement; must engage, work with China (worried about energy security)
- Conventional methanol pricing and margins will support reinvestment
  - 2023E large buyer pricing USD 315 – 350 pmt depending on region. To USD 410 – 460 by 2028E
  - Margins are higher for gas-based operators than coal-based ones
- "Low carbon" methanol – highly varied with many species, costs, target markets, and values
  - Low carbon market about 1/400th (.25%) the size of conventional methanol market
    - Exciting developments in marine fuels will face challenges from supply

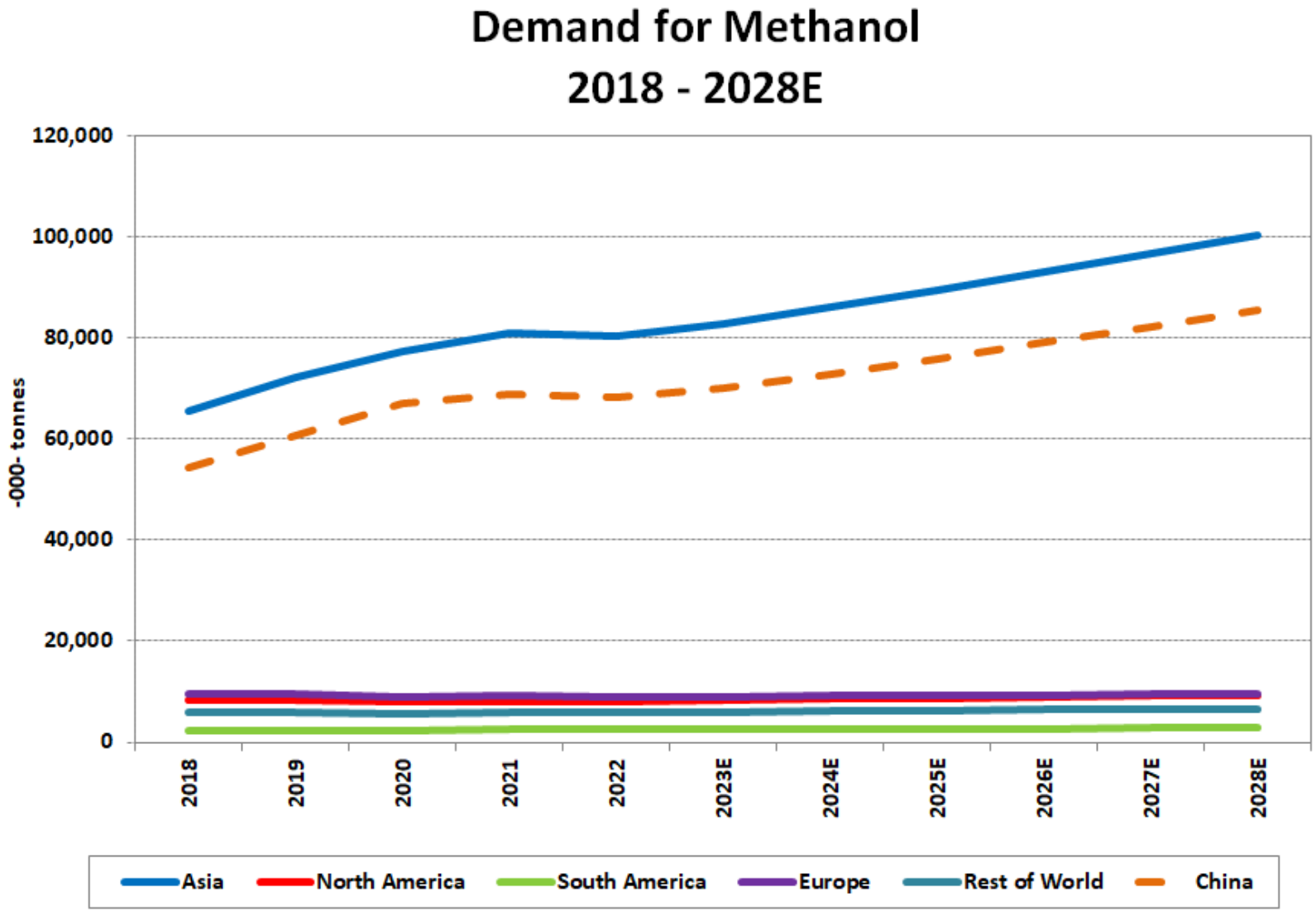
Conventional methanol demand to grow 22.7M mt from ‘22 to ‘28E on additional China, MTO, and formaldehyde needs

INDEPENDENT. OBJECTIVE. GLOBAL METHANOL ADVISORS



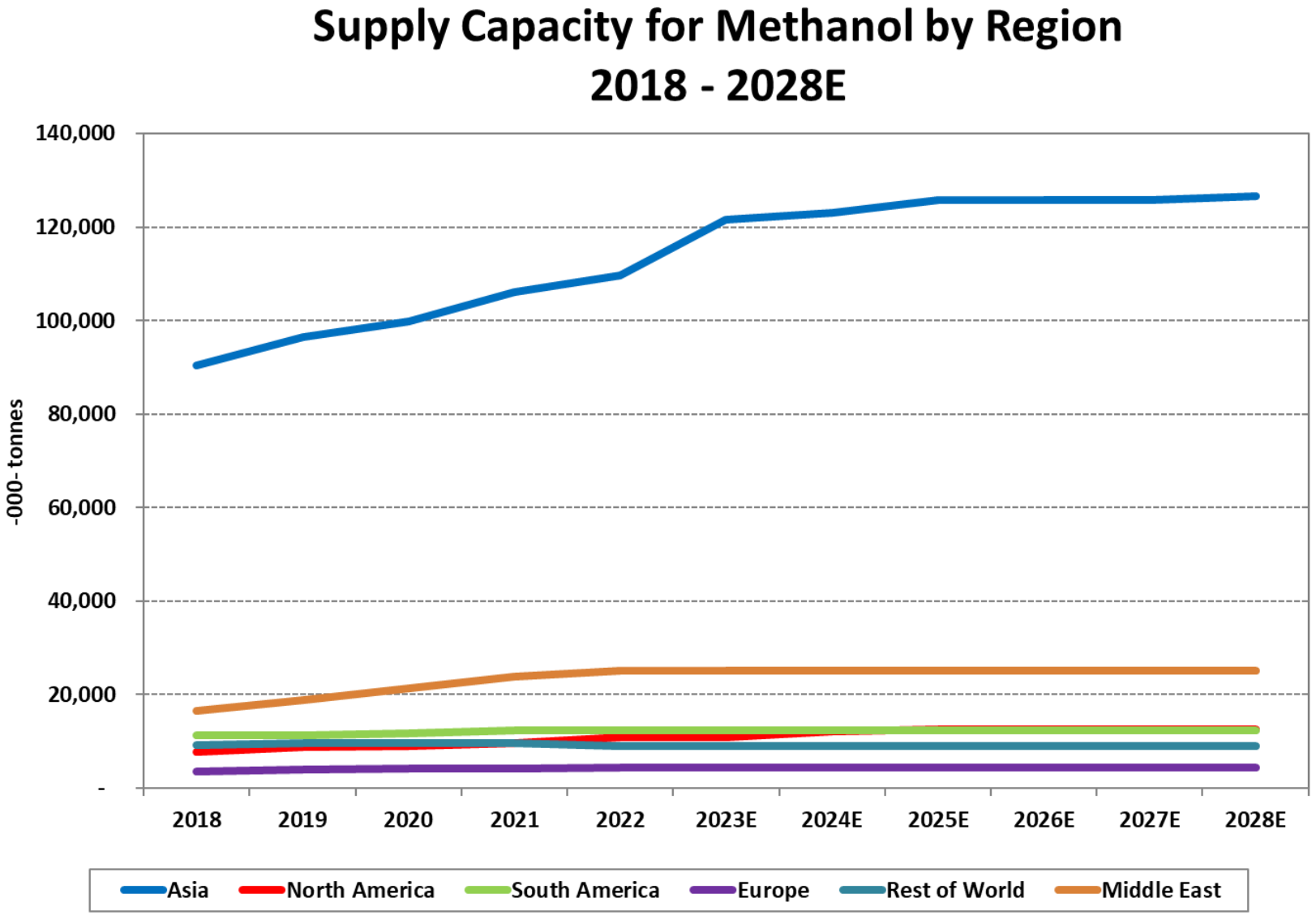


Loss of MTO demand leads to global contraction in 2022, return to slower-yet-GDP multiple growth by 2028

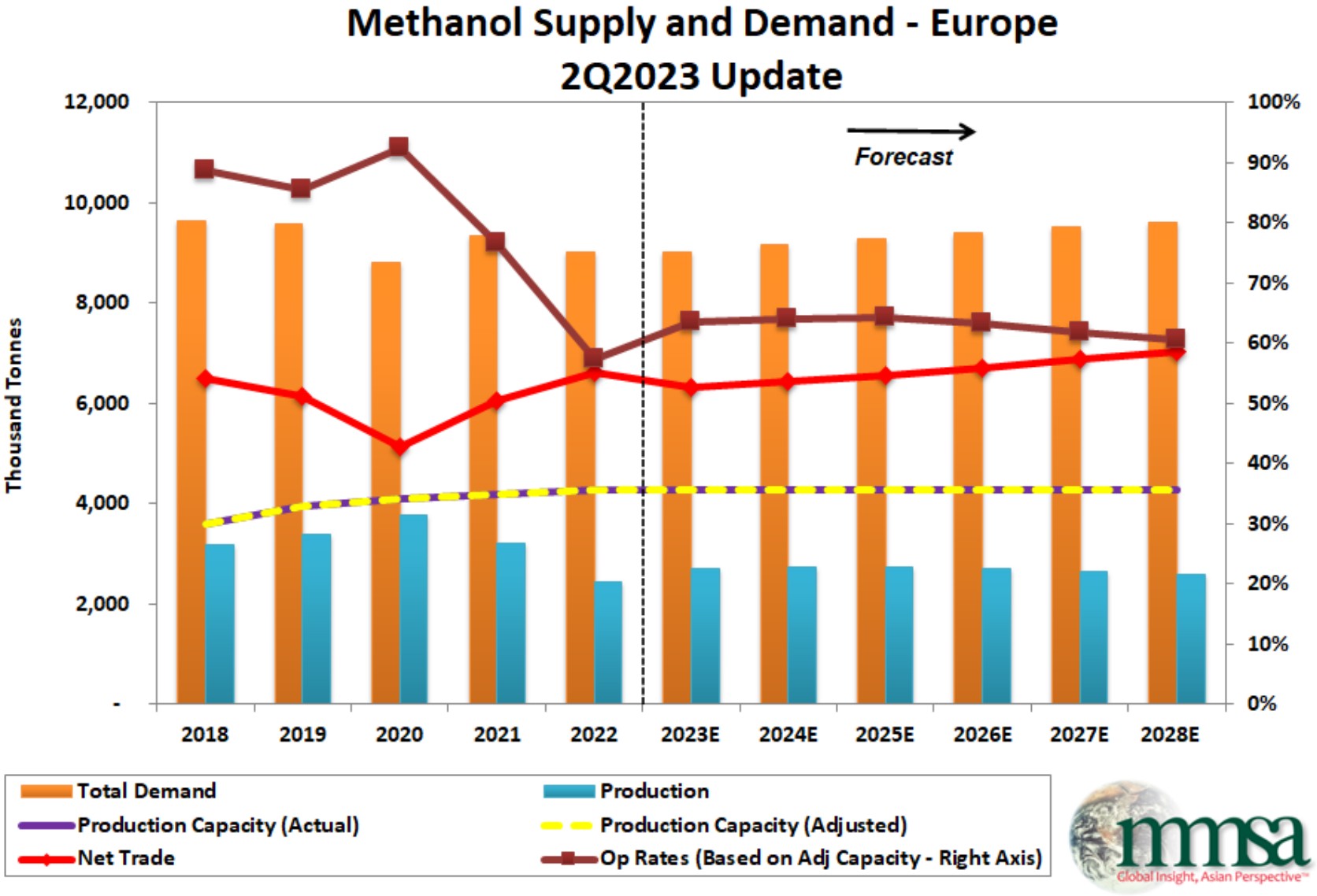


Conventional methanol supply

- In current environment, global methanol capacity announcements outside China have slowed
- China investments not clear either
- Must reinvest in conventional methanol to support demand growth long term
- From North America, Middle East, China (coal based unless access to natural gas improves)
- Must reinvest in conventional methanol to support demand growth long term
  - Next plants will be more efficient; current assets will be revamped to lower carbon intensity

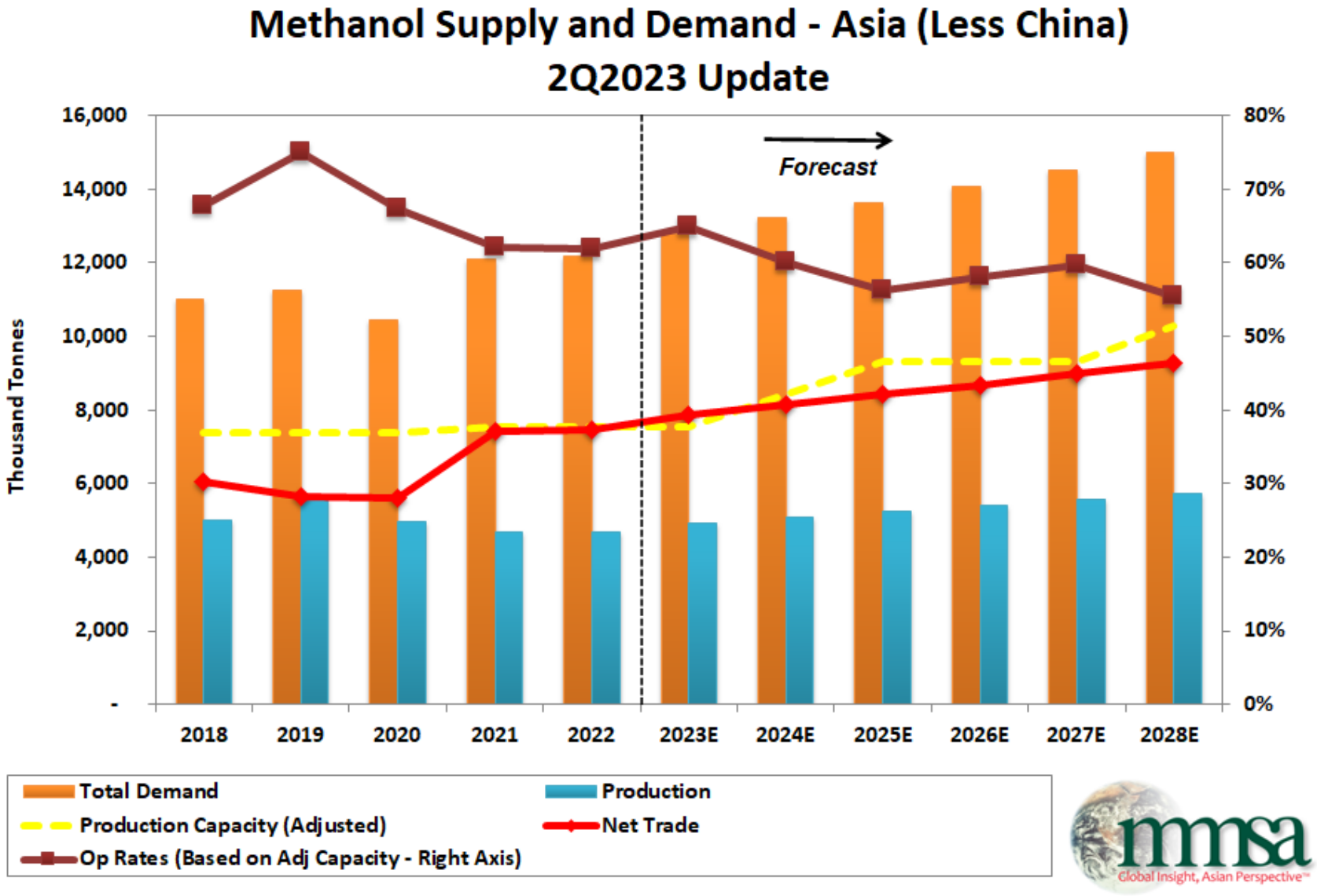


European demand to slowly recover, with imports supplanting local production; war on continent keeps uncertainty high



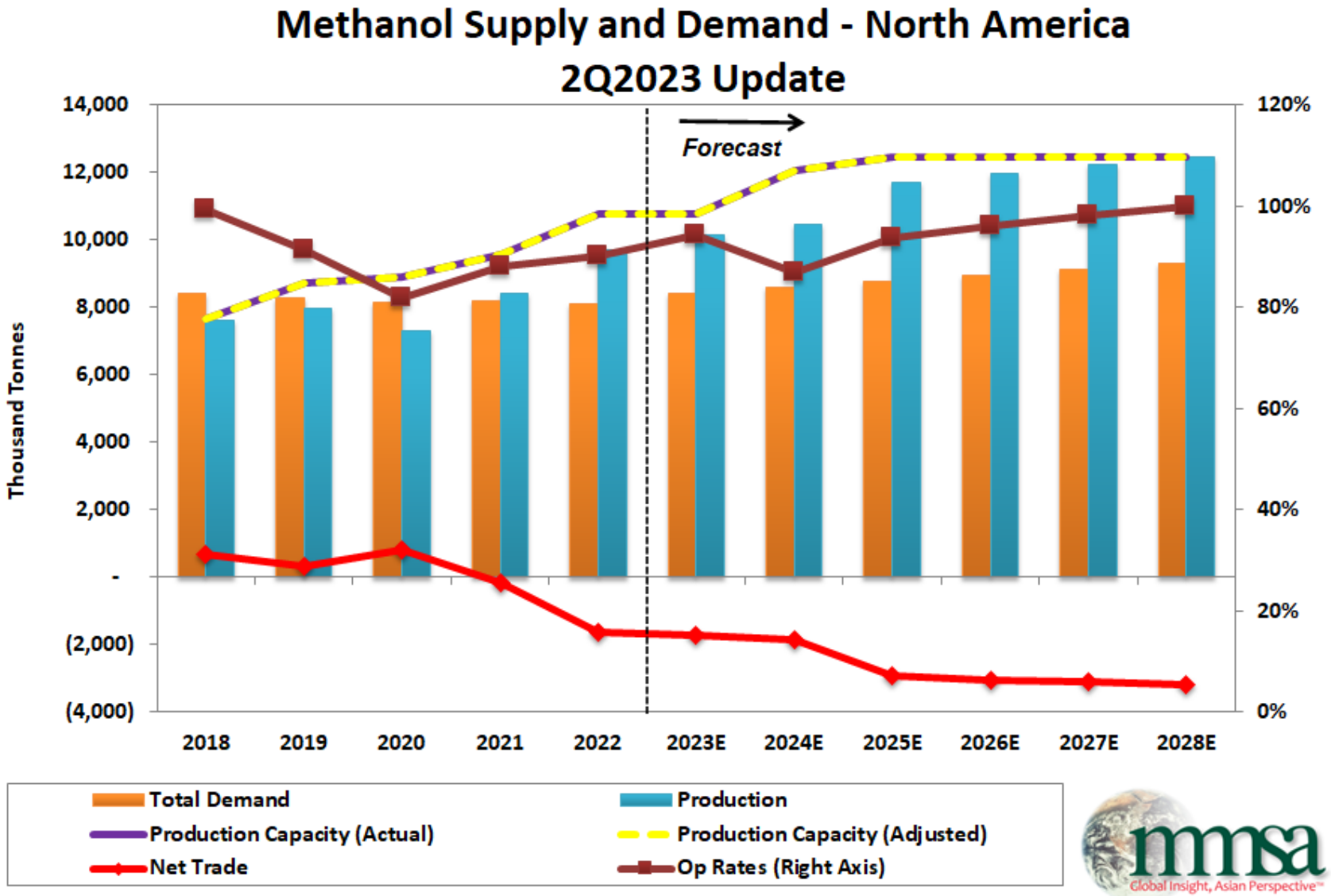
- Demand in most countries stunted by high energy costs, inflation, and war-related uncertainty
- Europe is the center of investment in low carbon solutions involving methanol – mostly from demand creation, although many projects being considered
- Region remains a "battleground" for overseas supply; typically, first choice for US exports

Broad Asia ex China next largest, highest growing region after China



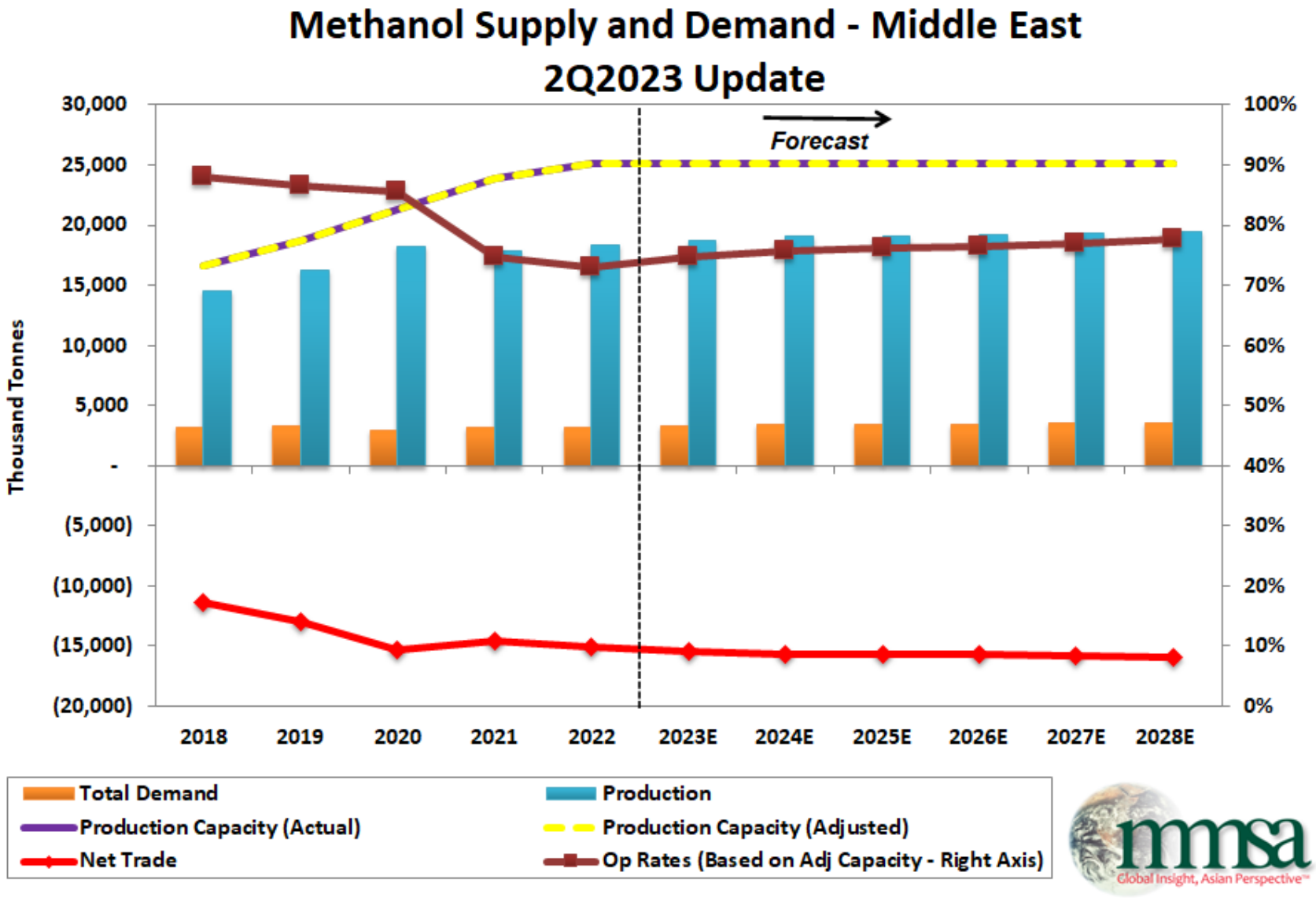
- Growth driven by India, traditional derivatives
- Japanese investment swings from China to SEA, India
- Biodiesel growth in Indonesia, Malaysia beginning to improve as vegoil supply improves
- Outside of biodiesel, local test projects to invest in methanol marine consumption continue
- Region less self sufficient than China due to higher overall feedstock cost
- Methanol production problems ongoing; to remain a major net importing region

North America rates can improve further; new production forces net exports in 2022



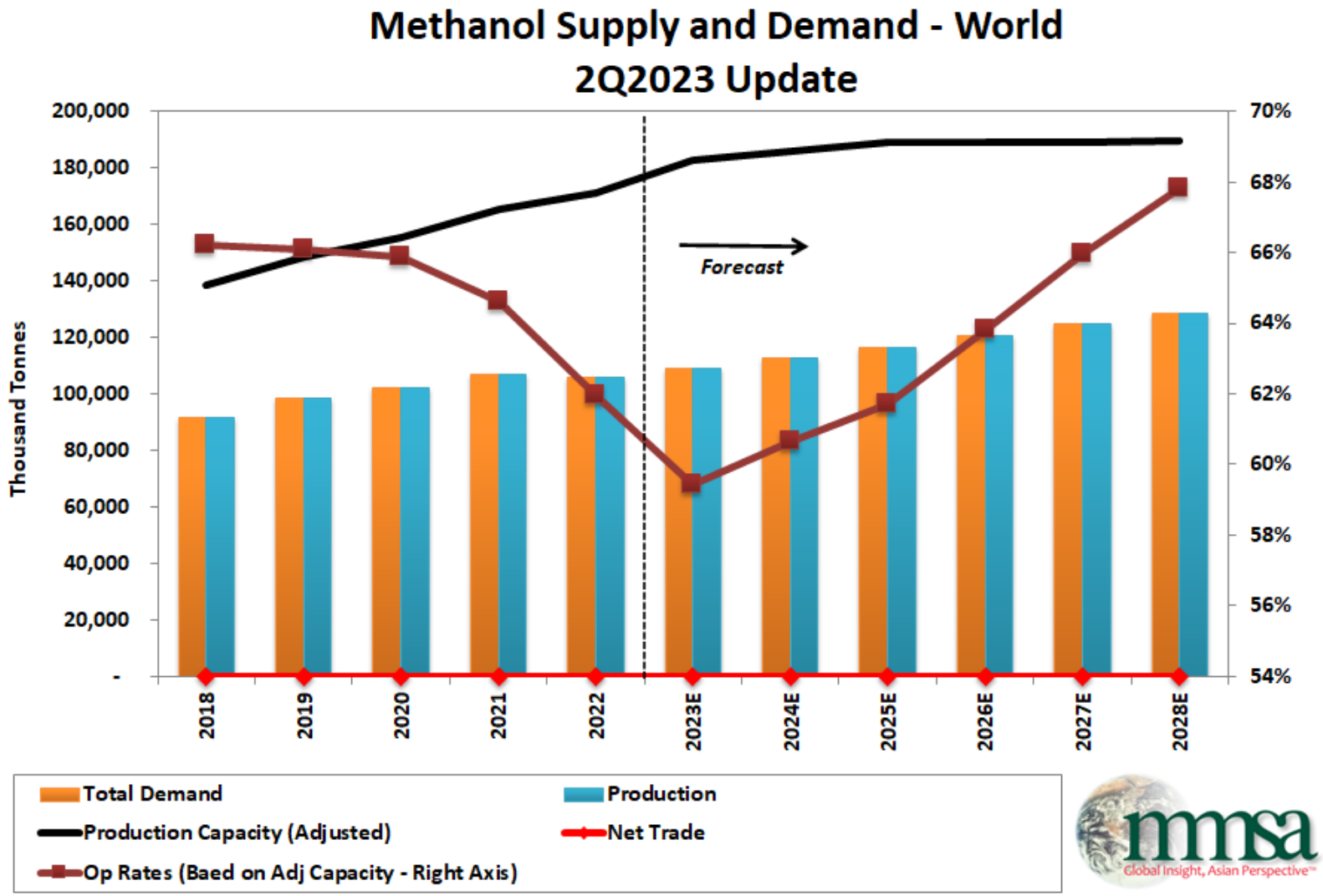
- Operating rates in USGC up this year as feedstock costs among lowest globally
- Methanex G-3 (1.7M mtpa early 2024), Fairway expansion (120K mtpa late 2024)
  - Best case new capacity 4.5 years
- Exports increasingly focused on Europe, with Far East and South America also targeted
- US – China remains "trade of last resort"
- Imports from Trinidad, EG shrink
- Downstream investment: Acetic Acid (Celanese), MMA (MRC), MDI (to be determined)

Middle East to remain exporter, with Iran molecules limited to Indian and Chinese consumers



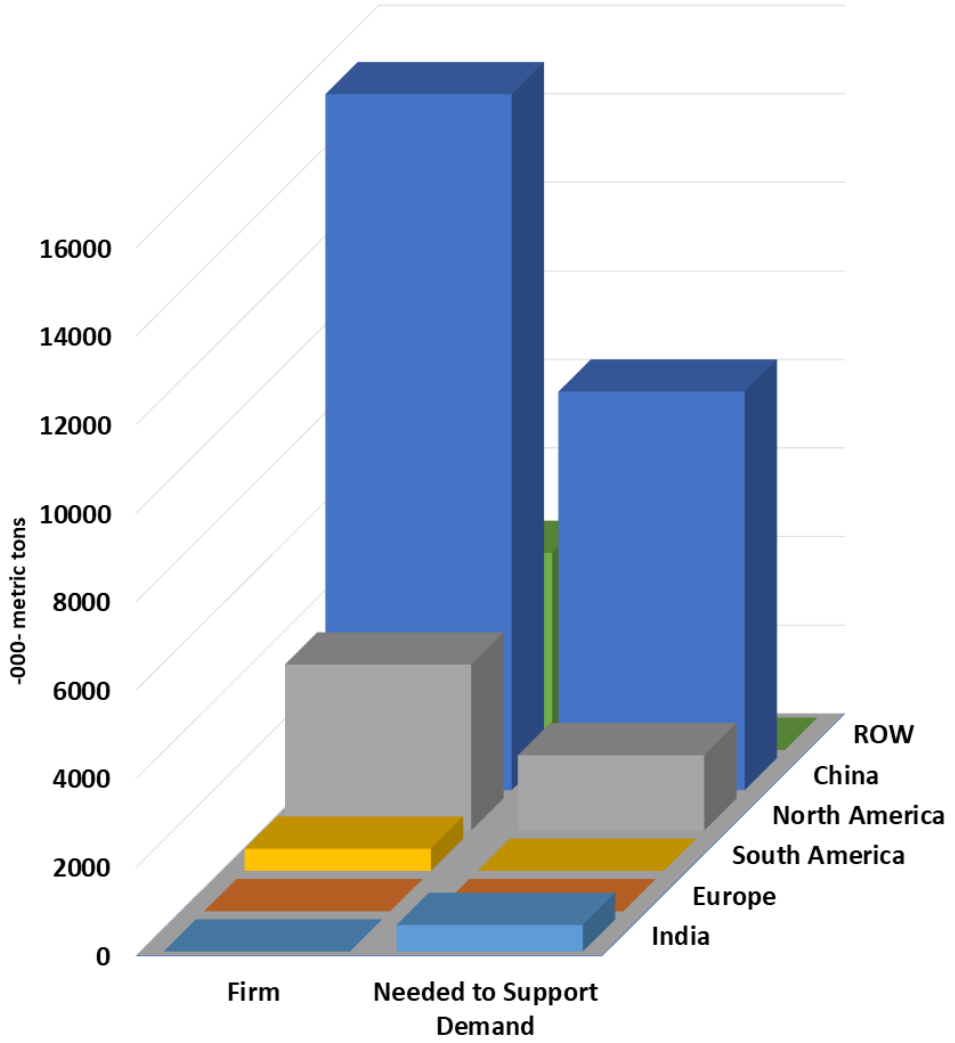
- Tumultuous time for Iran – feedstock limited and higher cost; low operational rates in massively expanded fleet of production
- No projects outside Iran in forecast; current Iran assets have had poor operational record (see MMWA)
- Iranian continues to have limited access to global markets, mostly at the fate of Chinese MTO producers
- Russia becomes direct competitor to Iran

Nameplate operating rates to remain challenged near term, both nameplate and effective rates must increase in forecast



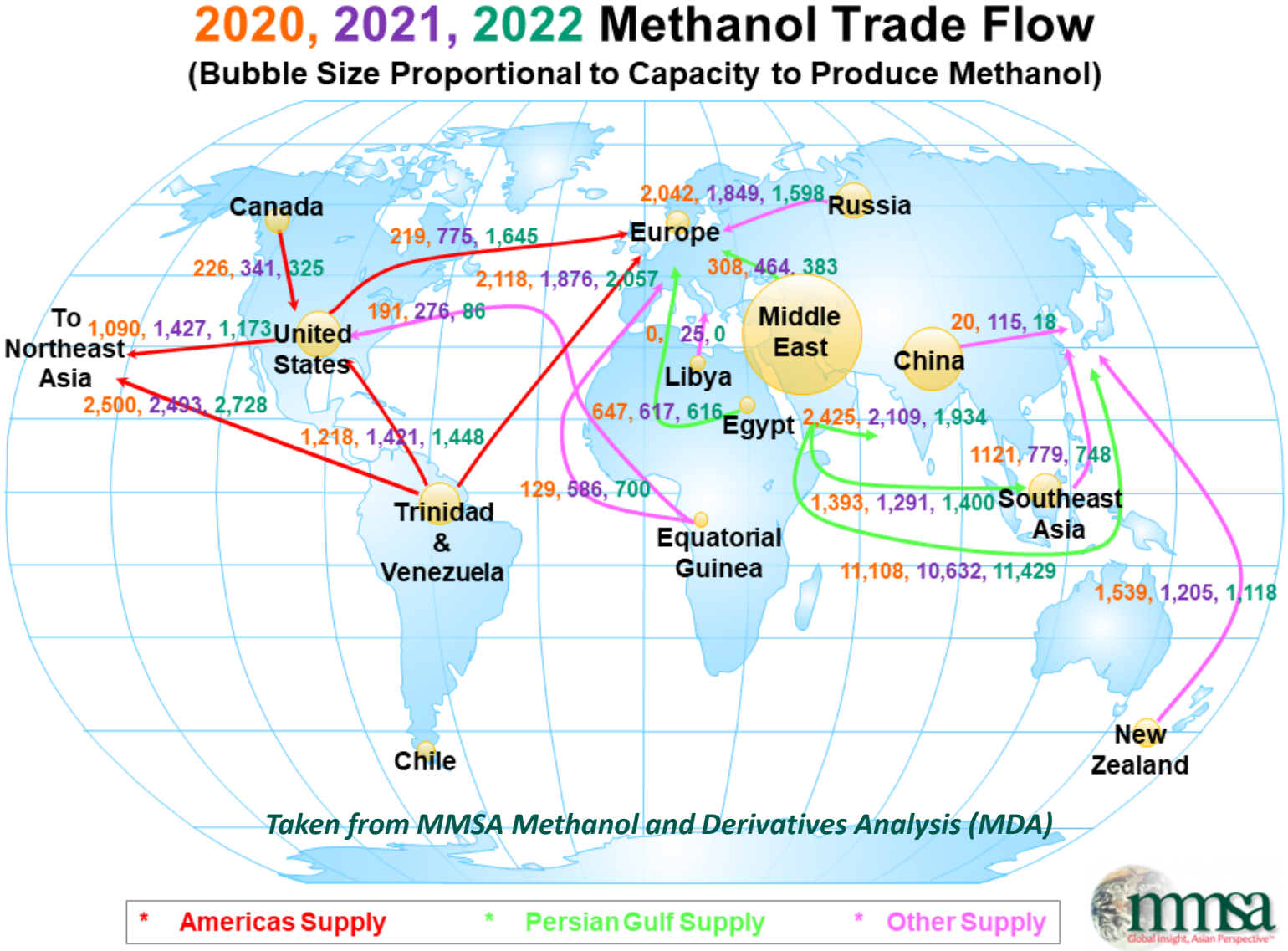
Despite grim current markets, more investment necessary, all will be more carbon efficient, China remains a paradox

Estimated Methanol Supply Growth, 2020-2031E

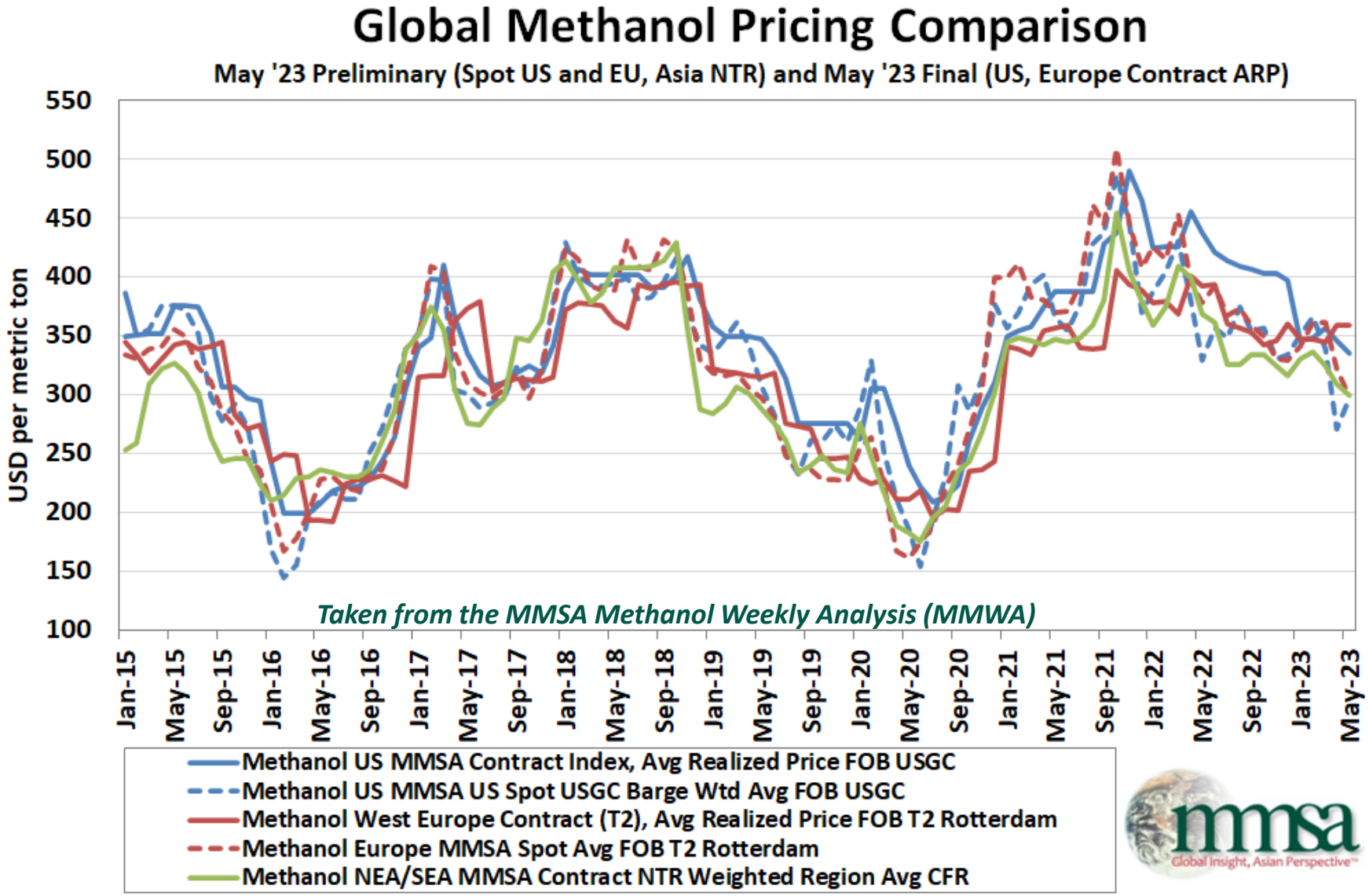


Middle East historical swing supplier, US Gulf and Caribbean surpluses clear out to Asia

- Methanol trade flow evolution continues
  - Europe increasing imports
  - US a net exporter, tilting to Europe
  - Trinidad to Asia trade increasing
    - Trinidad exports dependent upon access to reasonably priced natural gas
  - Russia joins Iran as supplier to China, India, expanding also into Turkey
  - US exports to expand further



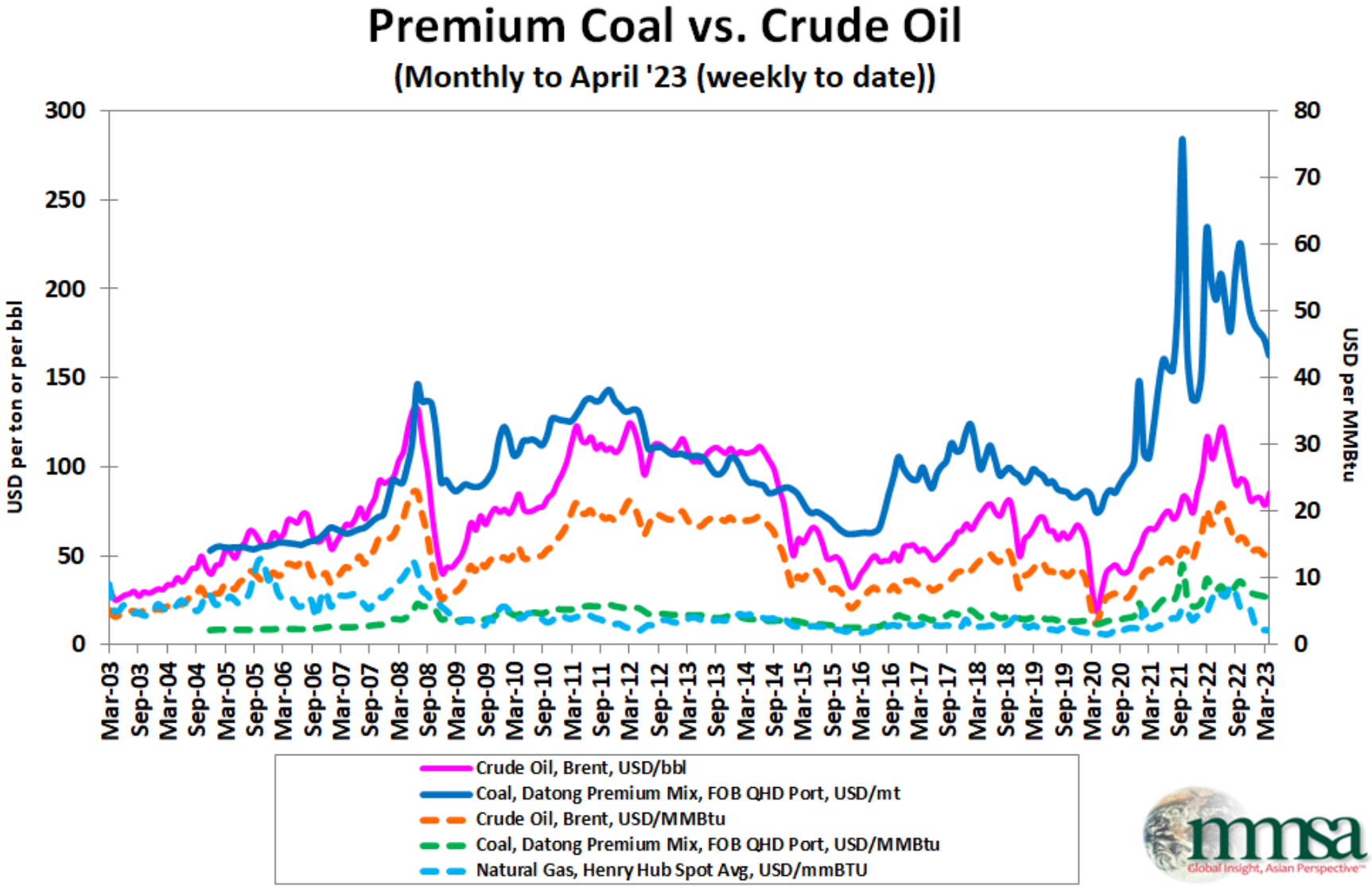
Regional methanol price differences narrow, fall with pressure from China. Margins high in USGC, low for some China, Iran



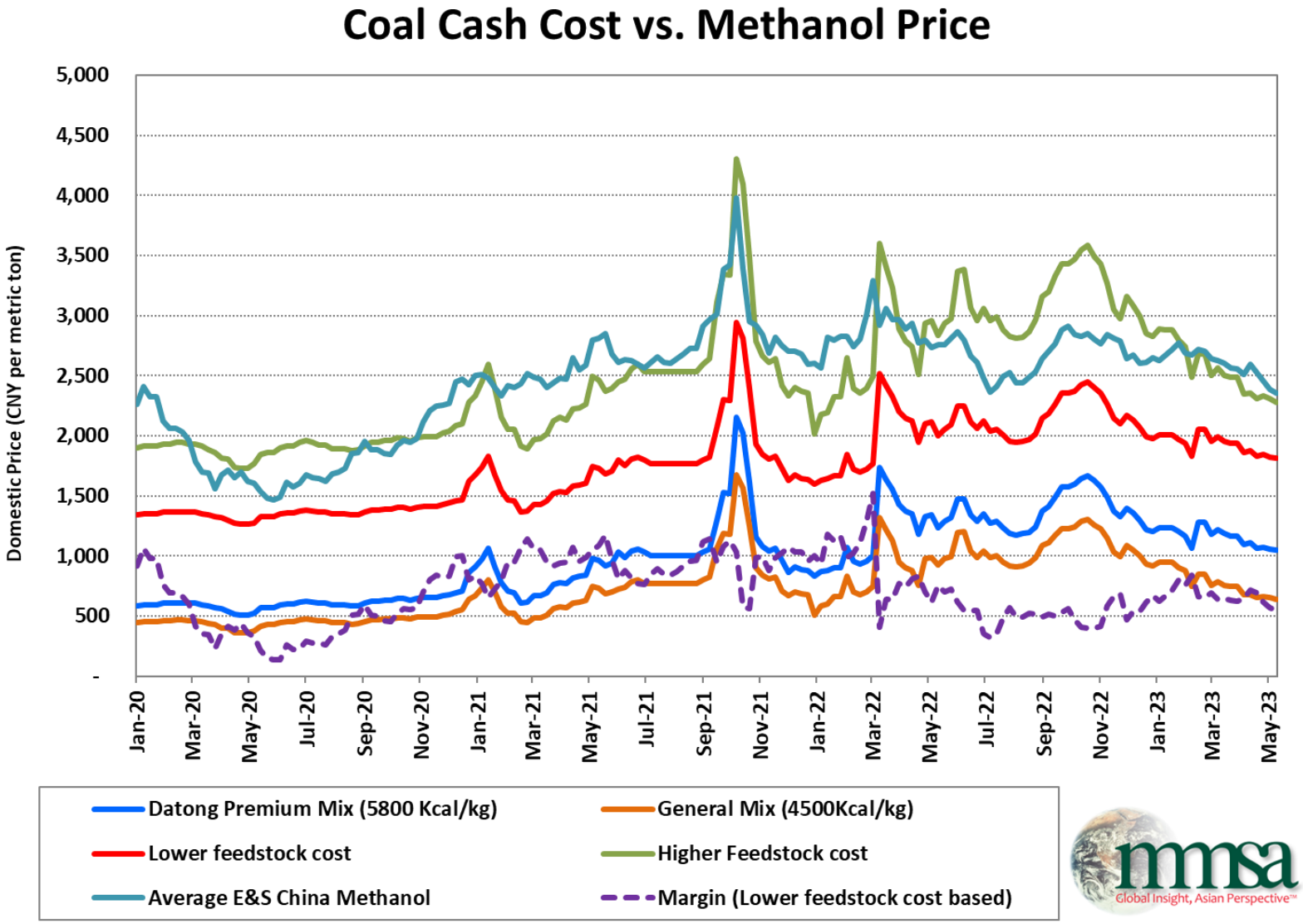
Conventional methanol pricing and margins will support reinvestment

- Prices limited on high side by derivative affordability
  - MTO remains the “marginal buyer” of product; very heavy ceiling
  - Marine fuels’ affordability must be watched
- Prices limited on low side by marginal cost of supply
  - Firmly located in China, based on coal feed
- Methanol affordability into MTO continues to limit methanol price upside
- Eventually, margins return near reinvestment levels although China must return to steady state
- Prices are connected globally – optional molecules moving from Middle East to Americas
- US, EU prices to remain at premium relative to China
  - China demand, tariffs are preventing more significant US – China trade patterns emerge

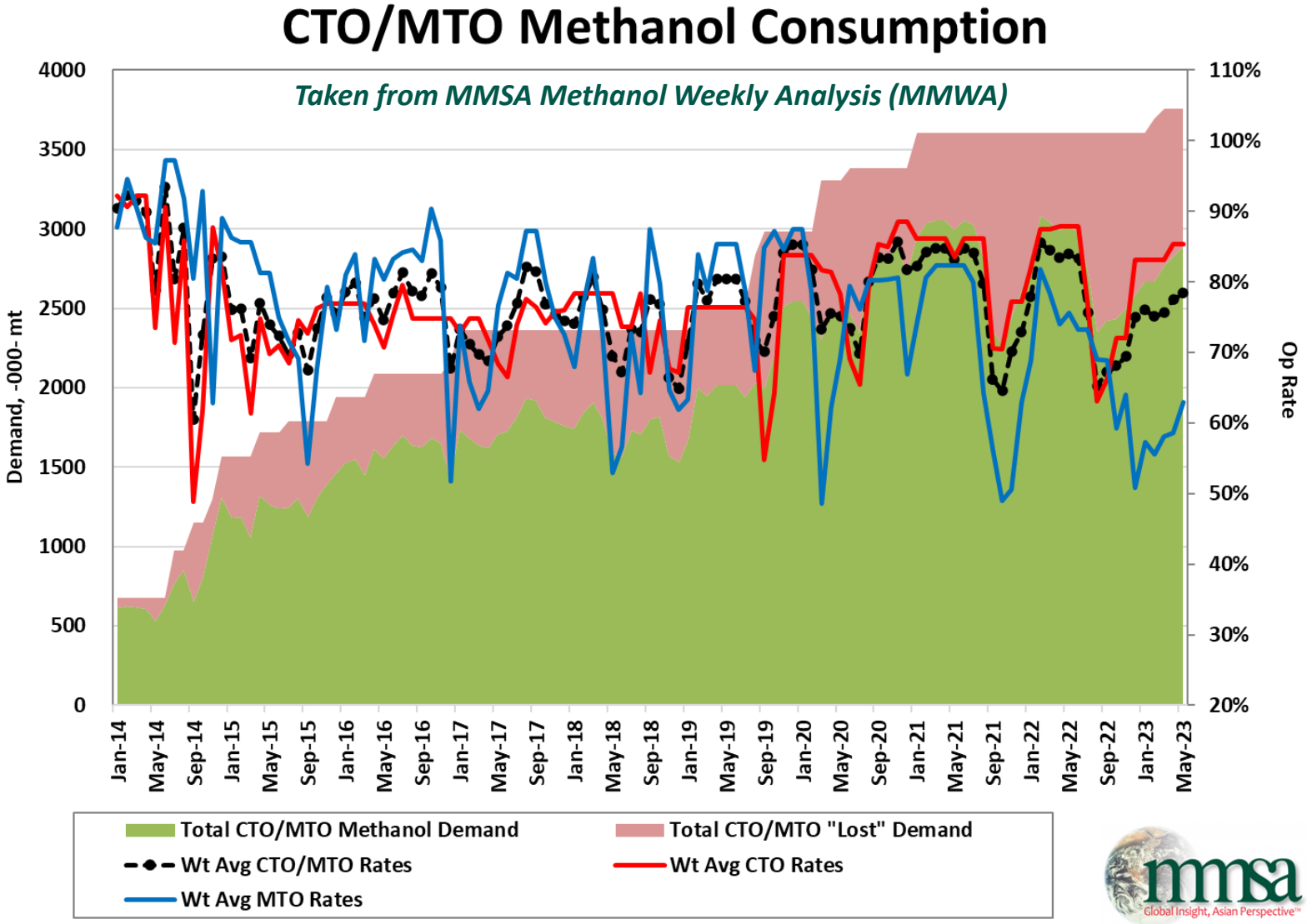
Coal prices fly up; spread between coal and refined products on cost / unit energy basis limits “old China” methanol opportunities



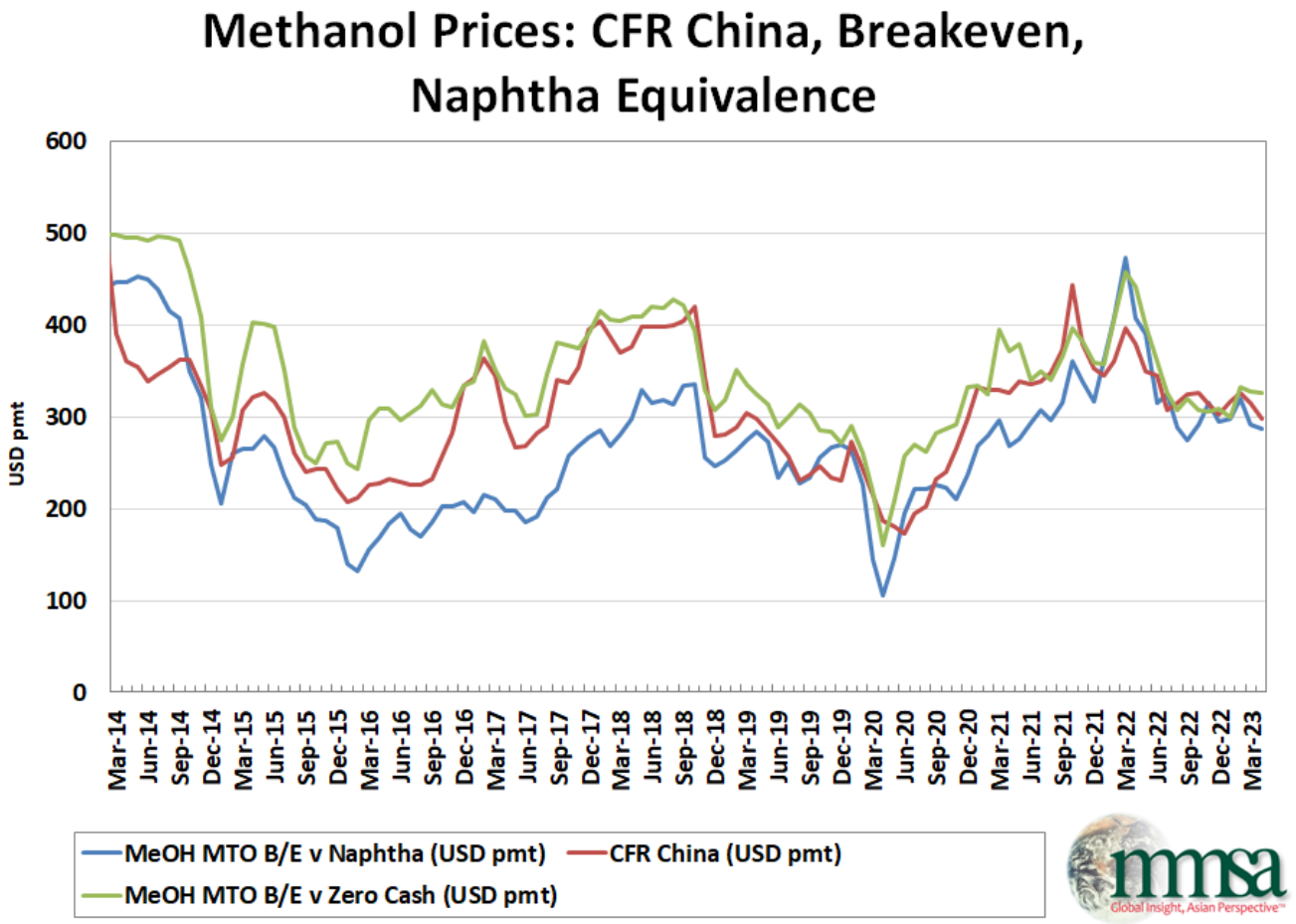
Chinese producer cash margins remain poor for high-cost China ops. Reinvestment continues as low-cost producers benefit.



MTO, CTO operations recover from lows. Much room for improvement.

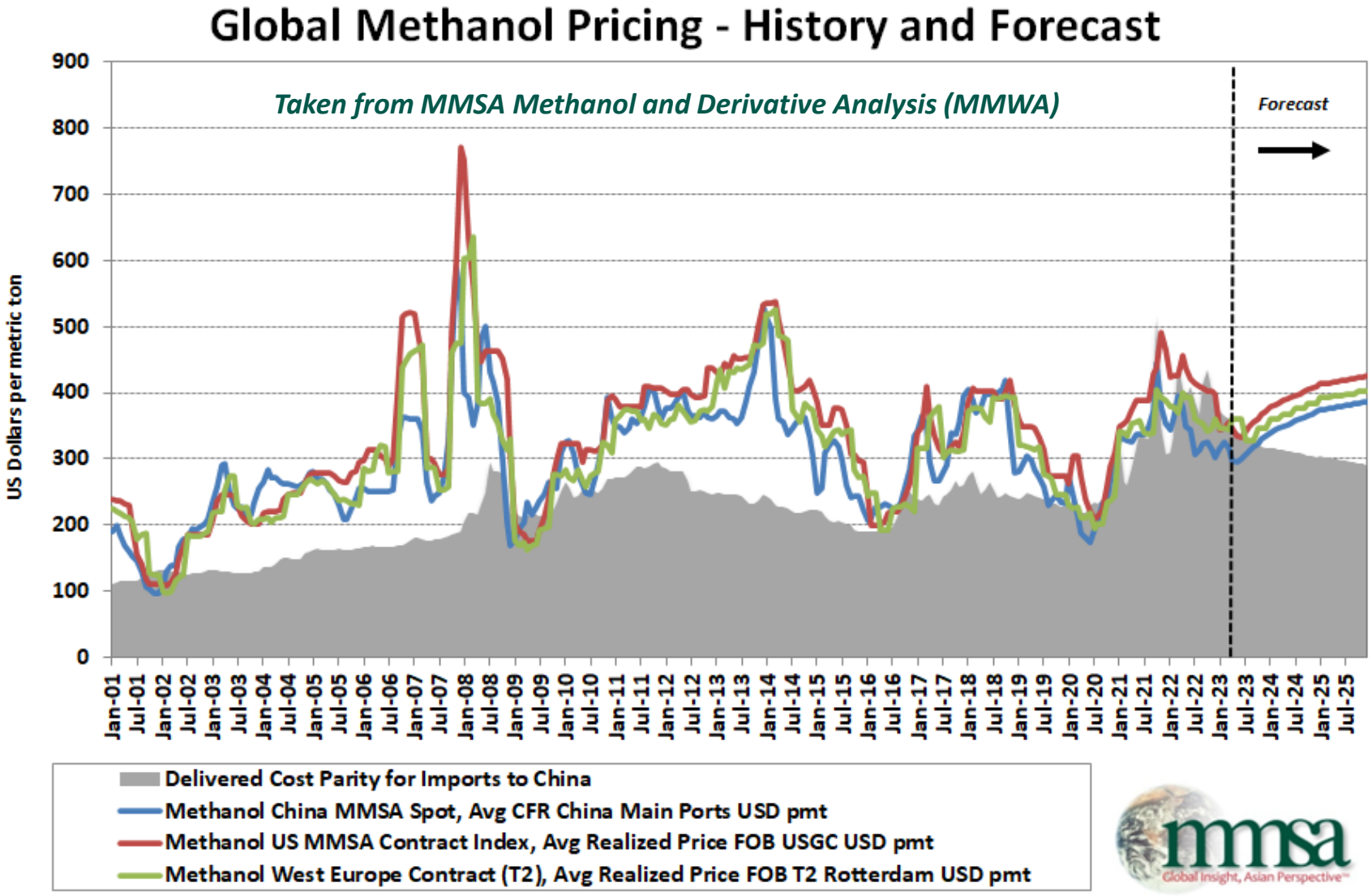


Methanol prices stuck between a rock (affordability) and a hard place (marginal production costs)



- MTO buyers strongly influence methanol prices, especially when Iran and Atlantic Basin production runs well
- Pace of recovery in China will dictate methanol price direction

Methanol prices to be contained at upper ends of affordability in China, USGC premium to persist, coal pricing to correct



“Low carbon” methanol – highly varied with many species, costs, target markets, and values

- Many process variants – from “tweaks” to radically new design
- Carbon intensity – varies greatly, must understand Life Cycle Analysis
- Feedstock availability a major limiting factor to growth – many competitive processes across product types
- Costs (opex, capex) – wide range
- Value – from causal to exciting

Lifecycle analysis (LCA) is basis for low carbon methanol valuation – adds GHG emissions from to creation through use

Well to Wake (or Wheel)

Well to Tank

Tank to Wake

Scope 3

Scope 1 and 2

Scope 3

Emissions Factors (g $CO2_e$ / MJ)

15 (25) **26** (150) **2** **69**

Conventional fossil-based methanol life-cycle analysis

112 (246)

Natural Gas

Coal

Marine gas oil LCA

INDEPENDENT. OBJECTIVE. GLOBAL METHANOL ADVISORS

Well to Wake (or Wheel)

Well to Tank

Tank to Wake

Scope 3

Scope 1 and 2

Scope 3

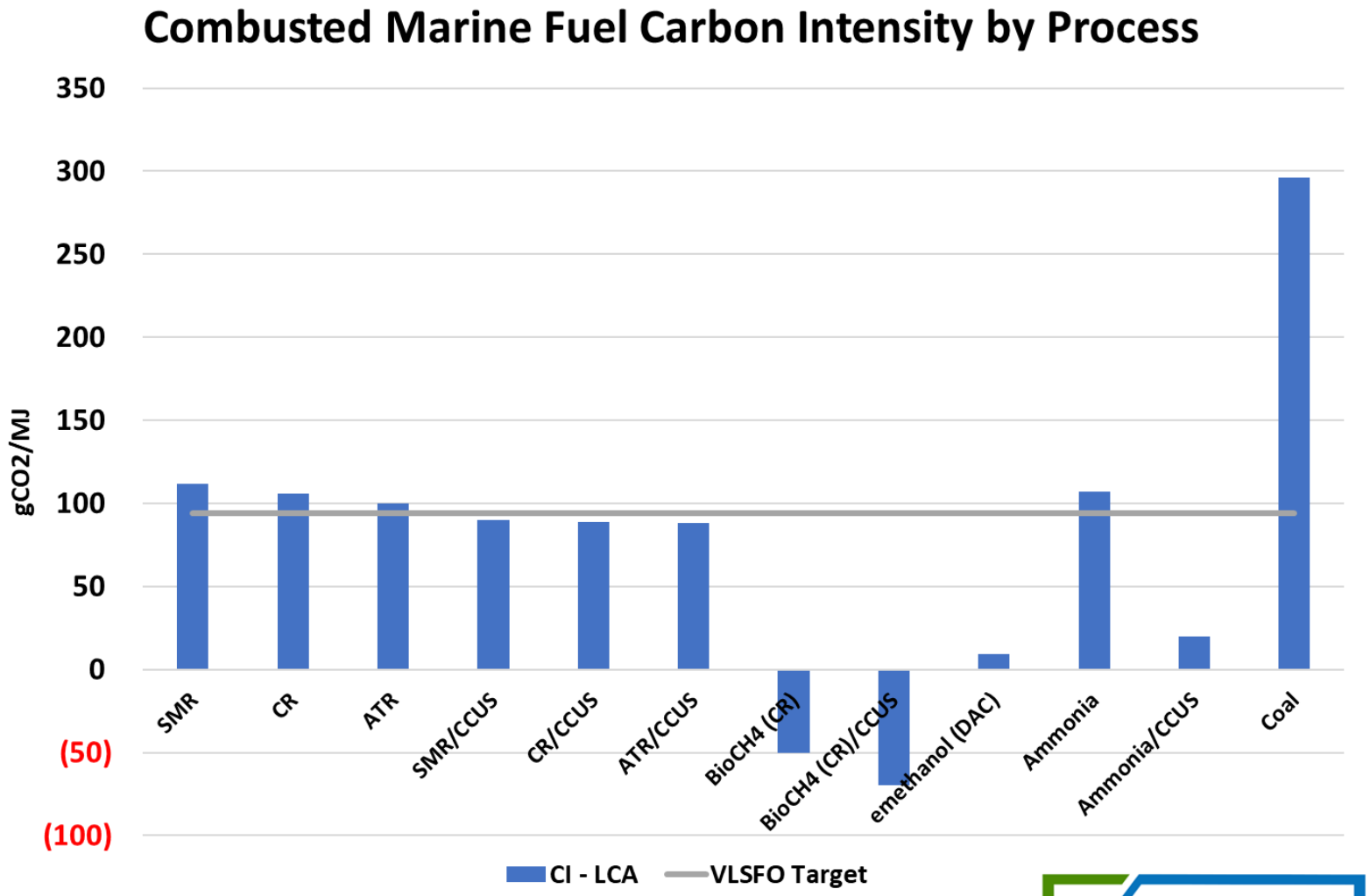
Emissions Factors (g CO2e / MJ)

6 **10** **3** **75**

94

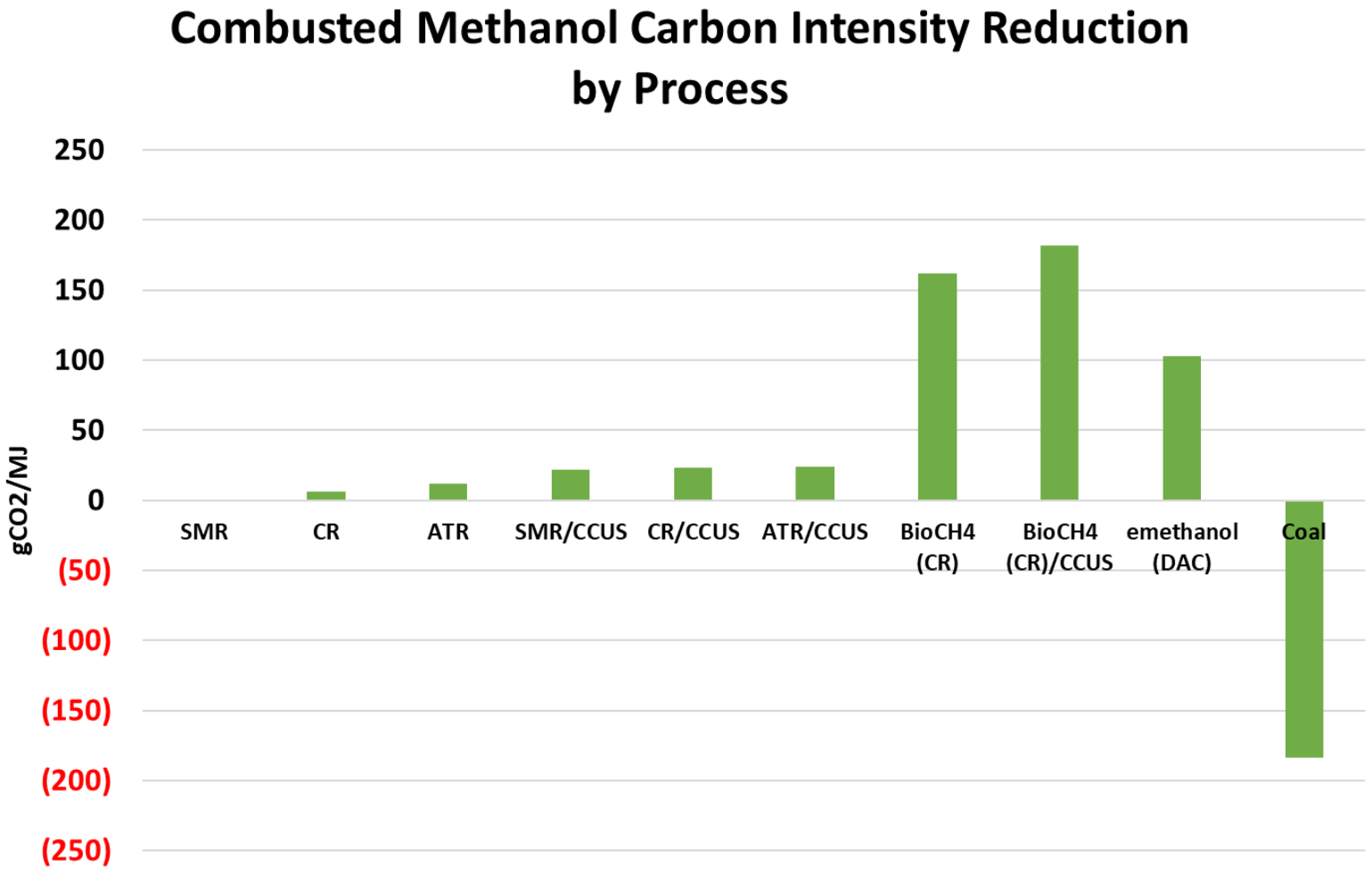
Processes to lower LCA Carbon Intensity (CI) exist…

- Wide range of possibilities
  - Typical SMR – 112 gCO2/MJ WTW LCA
- "Tweaks" by improving process efficiency (i.e. CR, ATR) insufficient to allow conventional methanol to help VLSFO users reduce their GHG footprint (although improved NOx, SOx)
- CCUS helps to an extent
- Biomethane "gold standard"
- Ammonia/CCUS offers promise with many hurdles
- Coal moves the industry toward elevated GHG wise



…with varying effectiveness

- Figures to the right can be improved
  - Scope 3 feedstock can be reduced by use of “responsibly sourced” natural gas
  - Scope 3 combustion use adds fixed 69 gCO2/MJ
    - Unavoidable unless biomethane, renewable (electrolytic) H2 used as feed
- Chemical uses also benefit
  - CO2 “buried” with long-lasting methanol derivatives
  - CO2 “avoidance” with methanol derivatives replacing (Scope 4)



MMSA models for carbon intensity of major commercial pathways allow for economic evaluation

- SMR – Middle East (see example, right)
- Combined Reformer – USGC
- ATR – USGC
- Coal Gasification – China
- MTO – China
- eMethanol – Europe
- Biomethane (small modular) – US Midwest delivered to USGC
- Biomass (woodchips) – US delivered Europe
- MTG – US Production Delivered Locally
- MeOH Reformer Fuel Cell – USGC power costs

Methanol - SMR Production

Middle East Production Delivered China

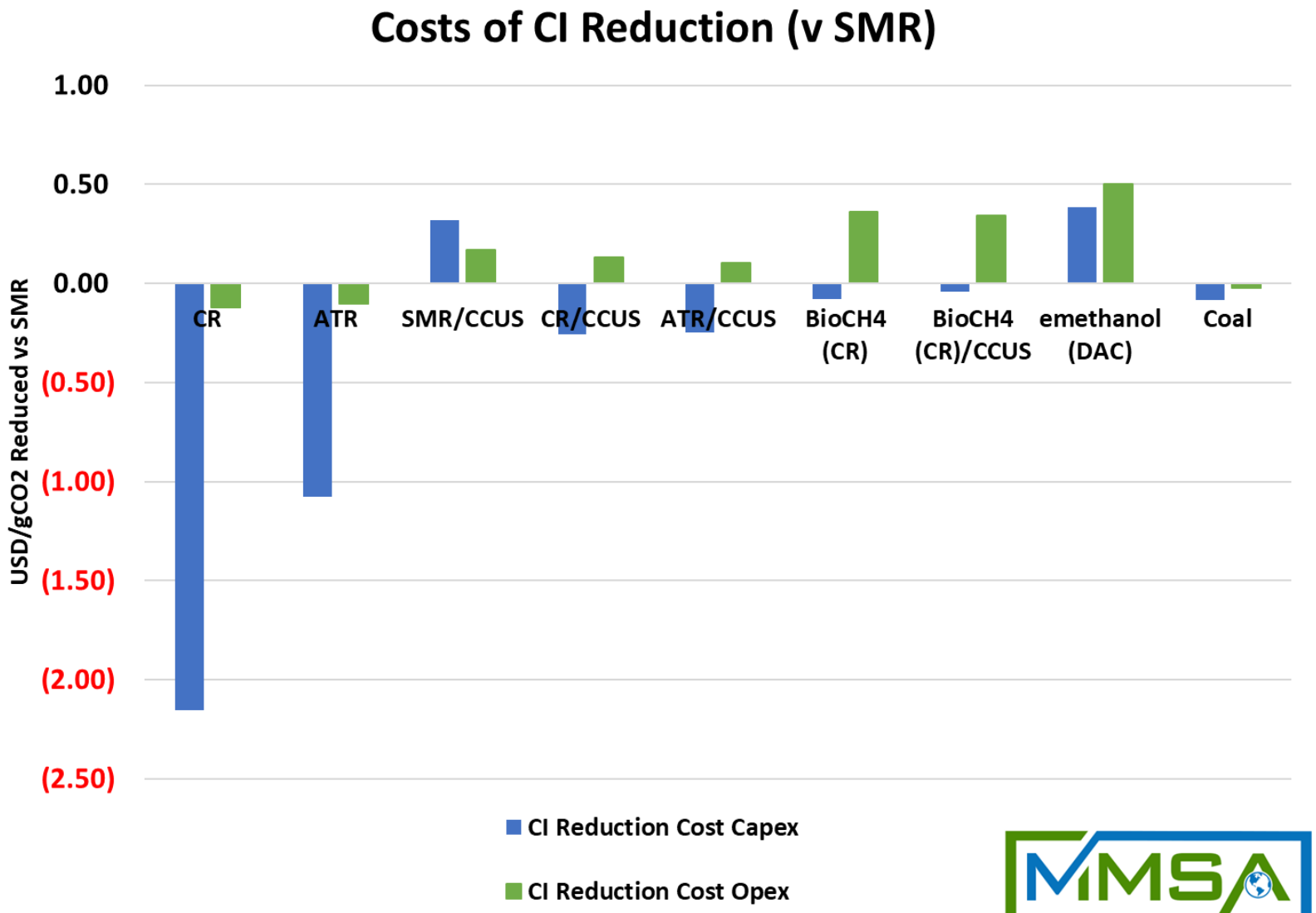
900	K mtpa unit	per mt methanol	
100	% utilization	Requirements	Cost USD
Variable Costs			
Feedstock	GJ_{LHV}	29.6	
Net Fuel (furnaces and boiler)	GJ_{LHV}	3.0	
Total	GJ_{LHV}	32.6	42.5
Electricity	kWh	38.6	2.6
Water Makeup	m^3	8.0	0.5
Catalyst			1.8
		Total Variable	**47.3**
Fixed Costs			
Plant fixed costs			22.8
Freight - ME to MP China			45.0
		Total Fixed	**67.8**
		Total Delivered Cost (China)	**115.1**
		Potential CO_2 tax cost add	**54.0**

GHG Emissions	Source	Scope	gm CO_{2e}/MJ
	Feed	3	9.0
	Direct	1	24.2
	Indirect	2	0.5
	Transport/Storage	3	2.5
	WTT - Total Well to (Customers) Tank		**36.2**

Econ Assumptions		
Natural Gas Price	1.25	USD/$MMBtu_{HHV}$
Electricity Cost	0.07	USD/kWh
Make Up Water	0.06	USD/m3
Fixed cost	2.0	% of TFI
Total Fixed Investment	1,025	M USD
Potential CO2 tax	**75**	**USD pmt CO_2**

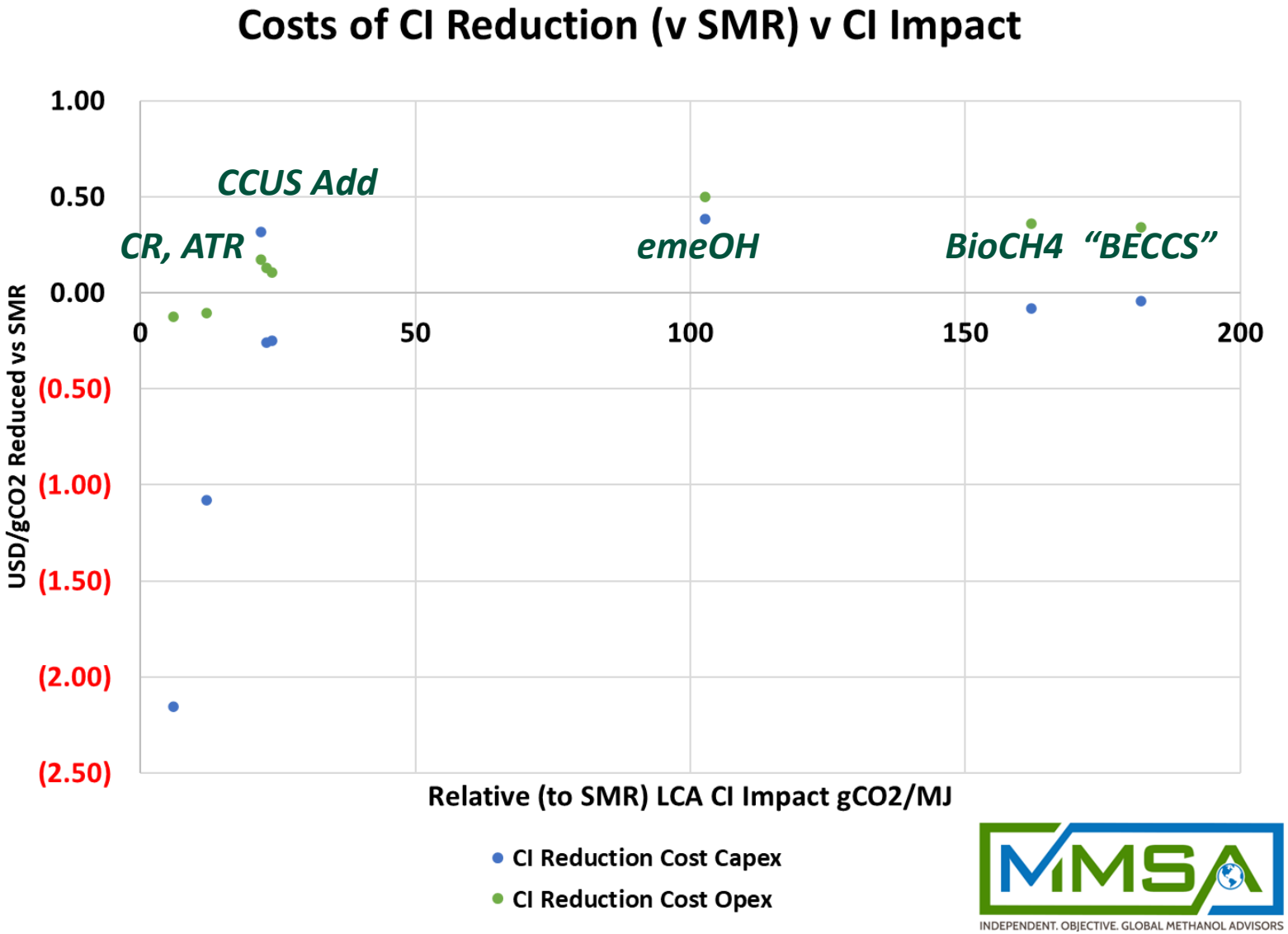
The transition to sustainable methanol will raise opex

- "Negative" costs in lowering incremental GHG emissions relative to SMR via investment in more efficient processes
- All others will see higher operational costs
- CR, ATR, CCUS cannot deliver "zero" or negative carbon
- Biomethane looks to be more cost effective on a capex basis
  - Yet biomethane availability longer term may be limited versus renewable H2, CO2



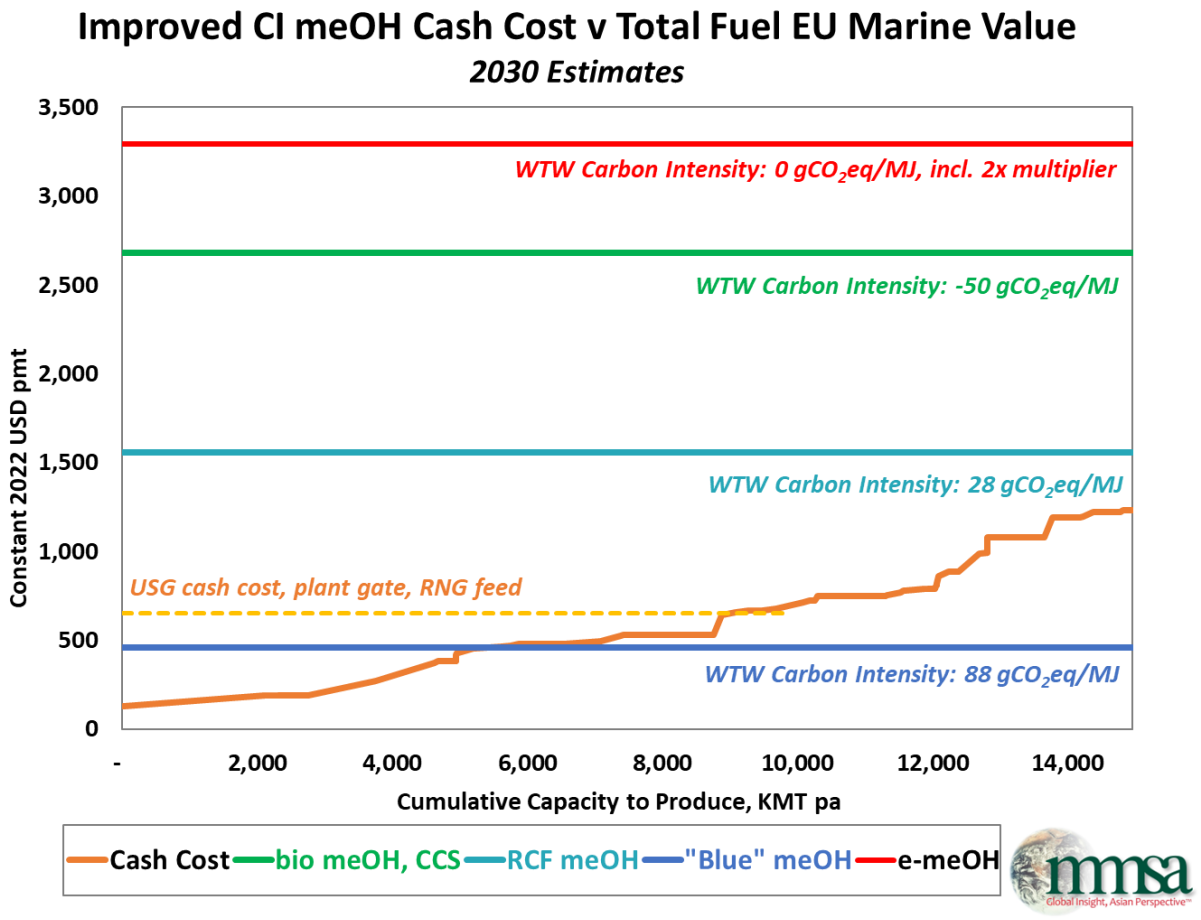
Methanol provides sustainable pathways for the energy transition

- First steps: select more efficient technologies (underway)
- CCUS provides the next steps (in planning)
- Biomethane provides the best in CI reduction when it can be afforded (underway, very limited due to high feedstock demand)
- Limitation in biomethane feedstocks will require investment in electrolytic methanol (underway, slow, small for now)
- How can we afford all of this?



EU will penalize non-compliant shippers, first with ETS requirements, then with penalties

- Between 1.2 – 1.8 m mtpa capacity to consume low carbon methanol by 2030 on order books
- EU Fuel Maritime sets out formulae for penalization of fleets
  - Begins 2025
  - Chart to the right shows estimates for “max affordability” of methanol (value of avoiding penalties – horizontal lines)
- Lower LCA score yields higher values
  - Values are not prices! They are ceilings
- Costs are floors – proper designs will yield value above cost



Low carbon methanol may rekindle previously sought after methanol markets

- Table at right developed in 2005
- At the time, demand for most of these applications was close to zero
- Only MTO has “fulfilled the dream”
- All sectors can lower carbon intensity via low carbon methanol
  - Marine Fuels poised to deliver – requires patience

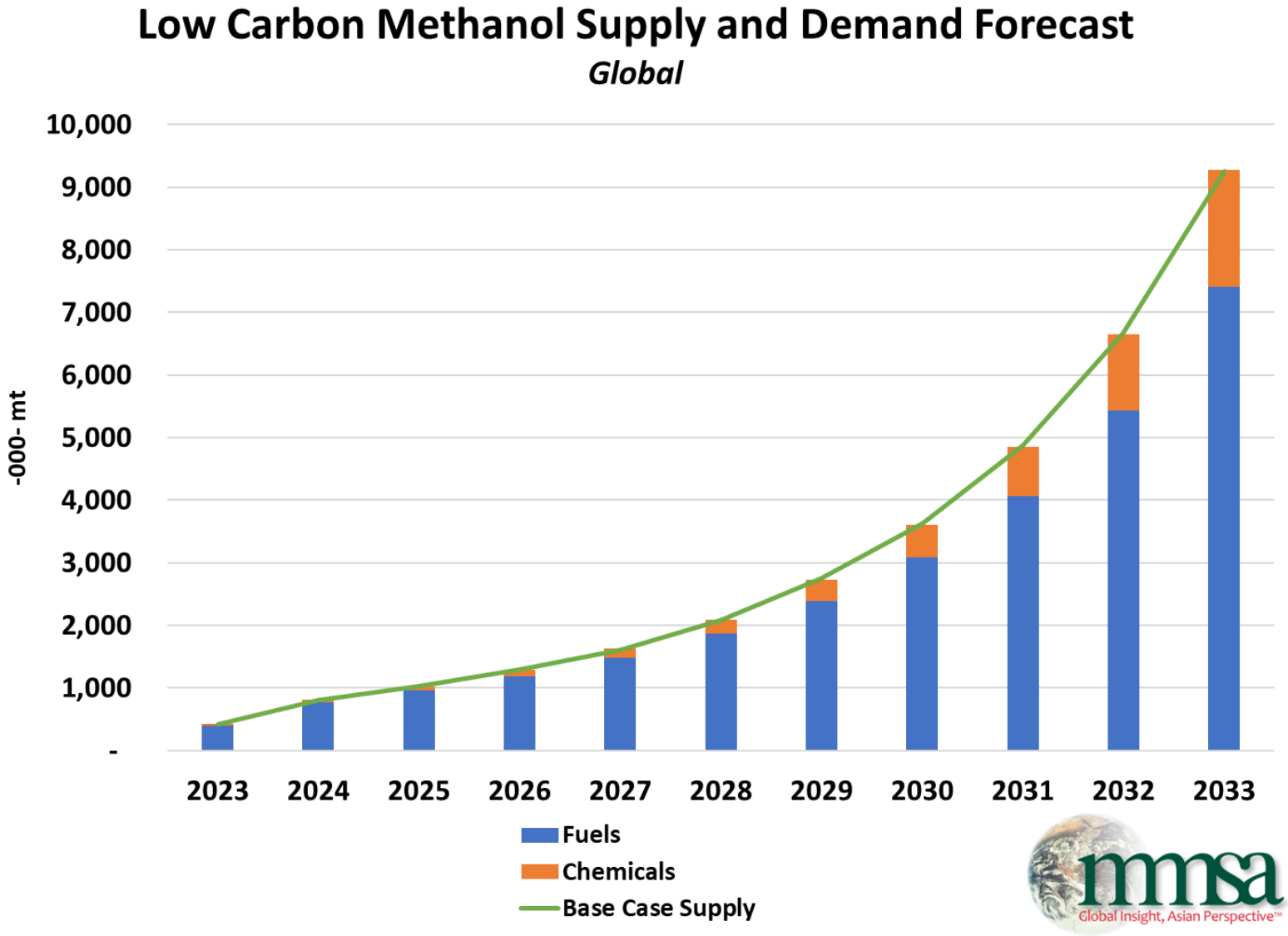
Developing Global Methanol Markets Summary

Application	Current Methanol Demand (2023E, -000- Tons)	Potential* Methanol Demand (-000- Tons)
Alternative Fuels		
Gasoline Blending & Combustion	11790	50,000 - 60,000
Biodiesel	3463	25,000 - 40,000
Dimethyl Ether (DME)	3266	10,000 - 15,000
Marine Fuels	195	10,000 - 20,000
Power Generation & Others	75	40,000 - 60,000
Fuel Cells	21	3,000 - 8,000
Methanol-to-Olefins	33652**	30,000 - 40,000
Methanol-to-Gasoline	500***	15,000 - 35,000

** Rough estimates of peak demand calculated as replacement percentage of existing global demand as a substitute*
*** 31 commercial-scale MTO plants commissioned in China as of April 2023 (18 integrated with meOH production, 13 merchant MTO buyers).*
**** Turkmengaz MTG plant commissioned in 2019, running sporadially*

MMSA base case scenario has pent-up low carbon methanol demand growth accelerating, limited by supply availability

- **Fuels** demand driven by marine, road transport use in Europe and US (marine)
  - SAF uses grow fast at smaller levels
- **Chemicals** demand driven by “specialty” olefins, formaldehyde chain products
- Supply largely from US biomethane, with support from CCUS and to a lesser extent Europe (eMethanol) and China (eMethanol)
- MMSA study has detailed breakdown



Today's Important Points, Numbers

- Conventional methanol uses will drive GDP-multiple demand growth
  - 108.7 million mtpa demand expected in 2023E, CAGR 3.4% '23E-'28E
  - Methanol's remarkable versatility in use has, will secure its future.
    - At the trailhead of seemingly unending value pathways
- Must reinvest in conventional methanol to support demand growth long term
  - Next plants will be more efficient; current assets will be revamped to lower carbon intensity
    - Coal based methanol is a clear opportunity for industry CI improvement; must engage, work with China (worried about energy security)
- Conventional methanol pricing and margins will support reinvestment
  - 2023E large buyer pricing USD 315 – 350 pmt depending on region. To USD 410 – 460 by 2028E
  - Margins are higher for gas-based operators than coal-based ones
- "Low carbon" methanol – highly varied with many species, costs, target markets, and values
  - Low carbon market about 1/400th (.25%) the size of conventional methanol market
    - Exciting developments in marine fuels will face challenges from supply

INDEPENDENT. OBJECTIVE. GLOBAL METHANOL ADVISORS