Global Chlor-alkali Market Outlook

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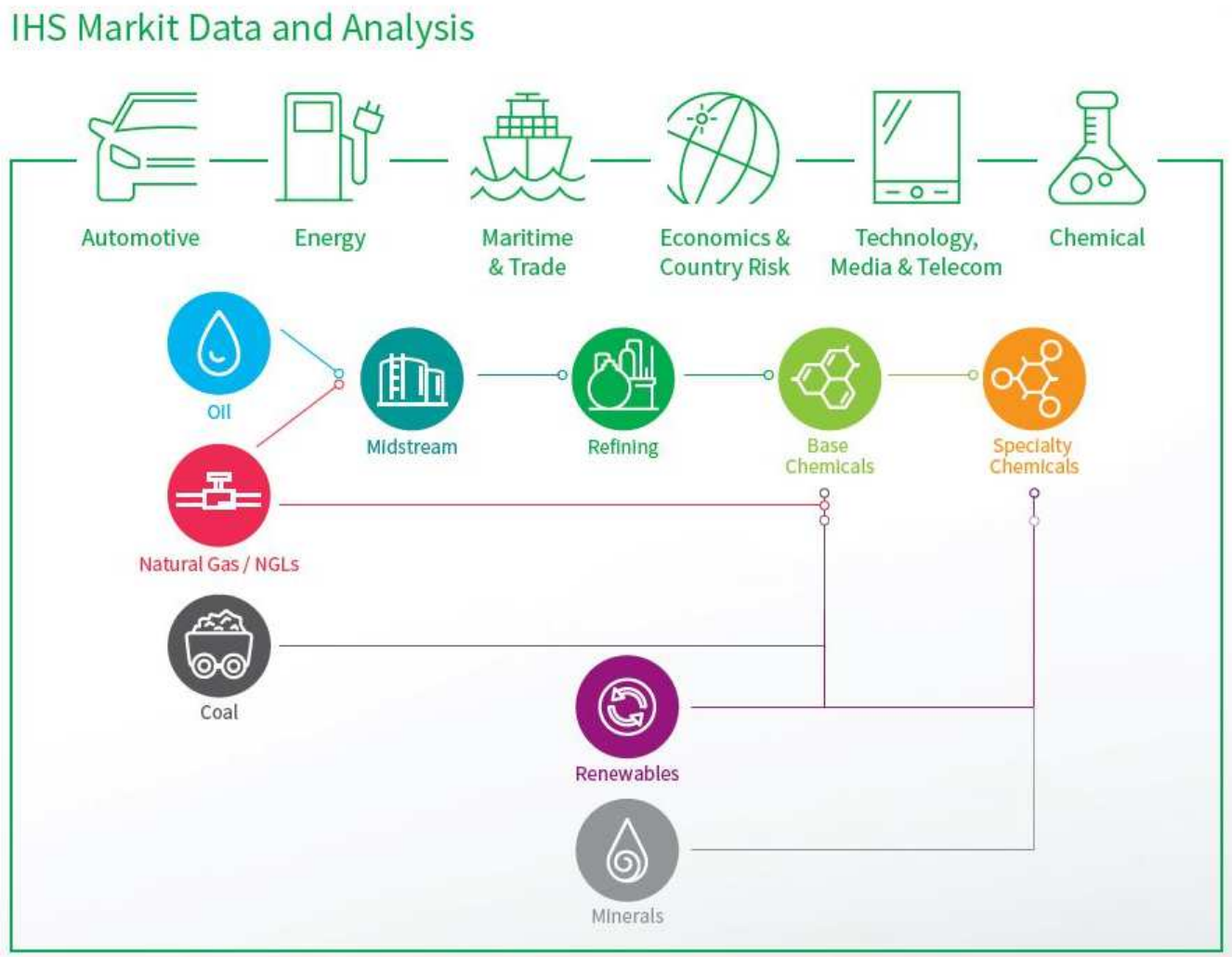


Overview

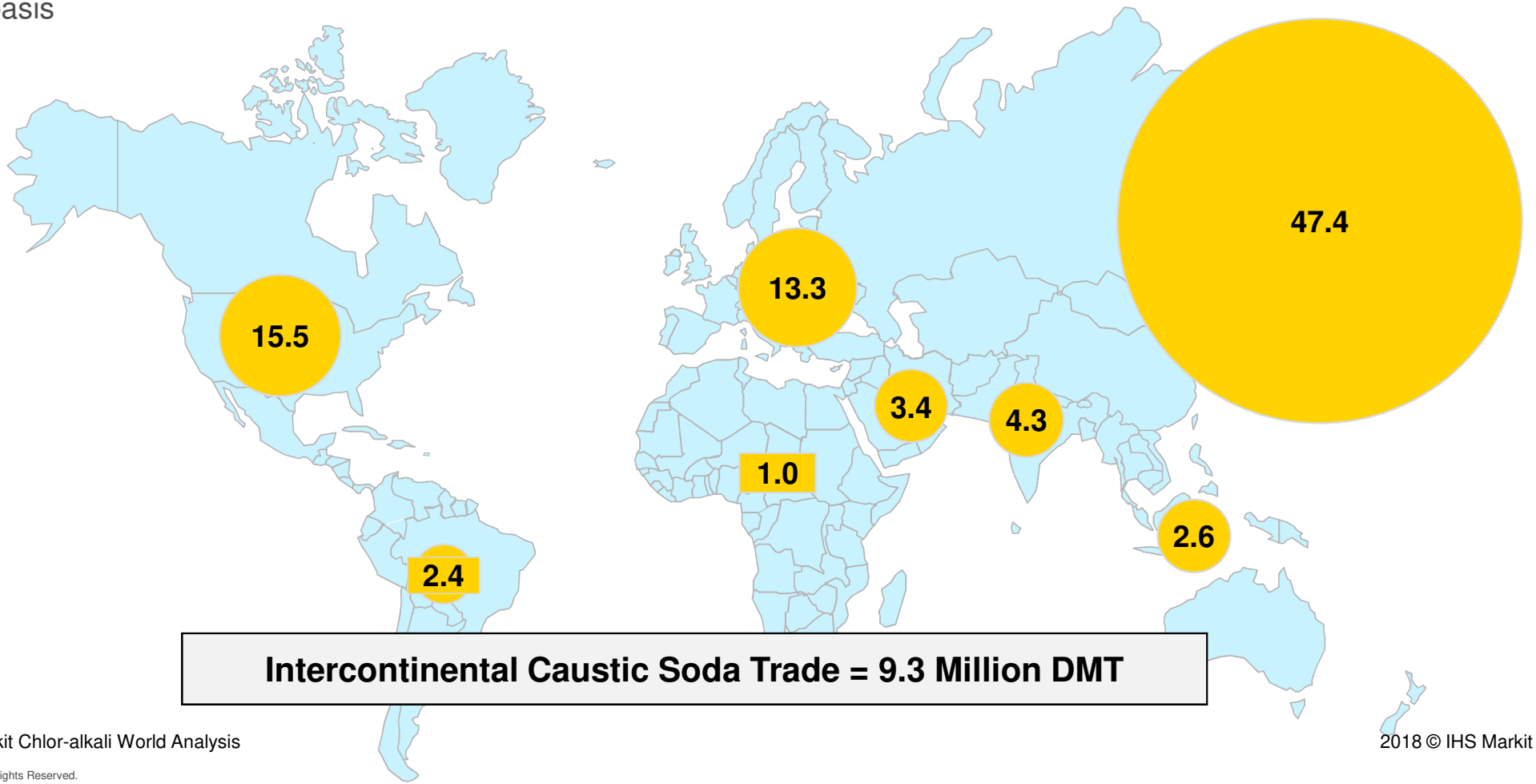
The big picture

Chlor-alkali Market Outlook

…strong demand growth combined with lack of capacity expansions will drive higher asset utilization and increased profitability through 2023.

2018 Chlor-alkali capacity: Approximately 90 million metric tons

Chlorine basis



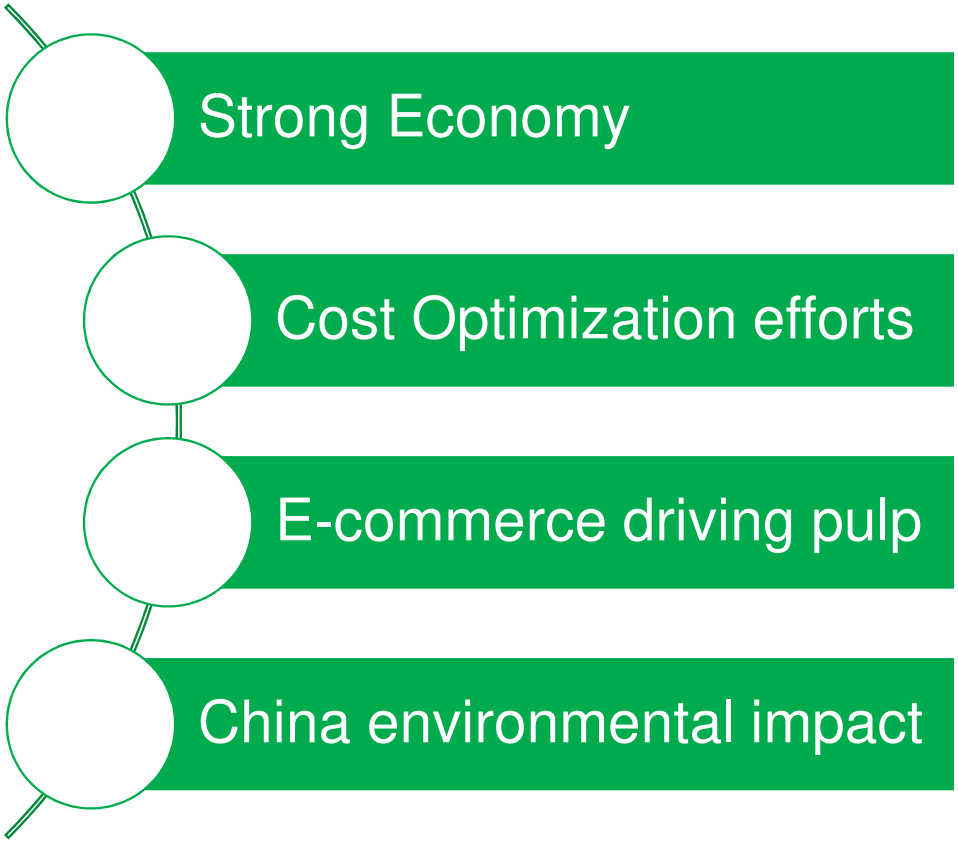
Source: IHS Markit Chlor-alkali World Analysis

What's changed since last year?

- **Chlor-Alkali capacity**
  - > Mercury-cell conversion is complete in Europe
  - > New capacity announcements emerging for Europe and US
- **Caustic soda**
  - > Prices moved higher, although excess product in regional spot markets has stalled upward momentum
  - > Alumina producers are optimizing bauxite vs. caustic price
  - > Limited uncontracted volume heightens spot market sensitivity
- **Chinese environmental policy expanded**
  - > Renewed inspections are impacting chlorine and caustic demand
  - > Chinese economy has cooled a bit
  - > Production from carbide-based PVC capacity is stalled … at least for now

Four key drivers support strong market conditions in the global caustic soda market

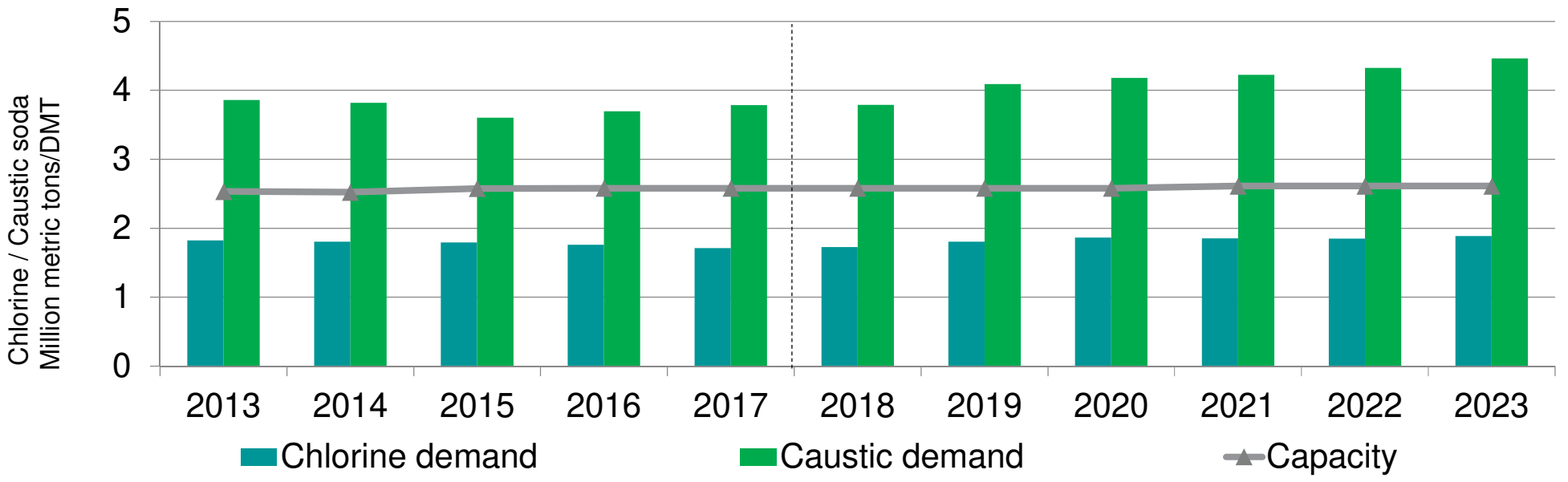
- Strong economic activity is supporting caustic demand in all segments
- Key consumption segments are exploring optimization alternatives for caustic soda cost mitigation
- E-commerce is changing the comparative structure of pulp consumption segments
- Chinese production and consumption dominates global market structure, magnifying impacts of changes underway in the domestic market



Americas

South America caustic and chlorine demand continue to diverge

SAM Chlorine and Caustic Soda Demand Forecast

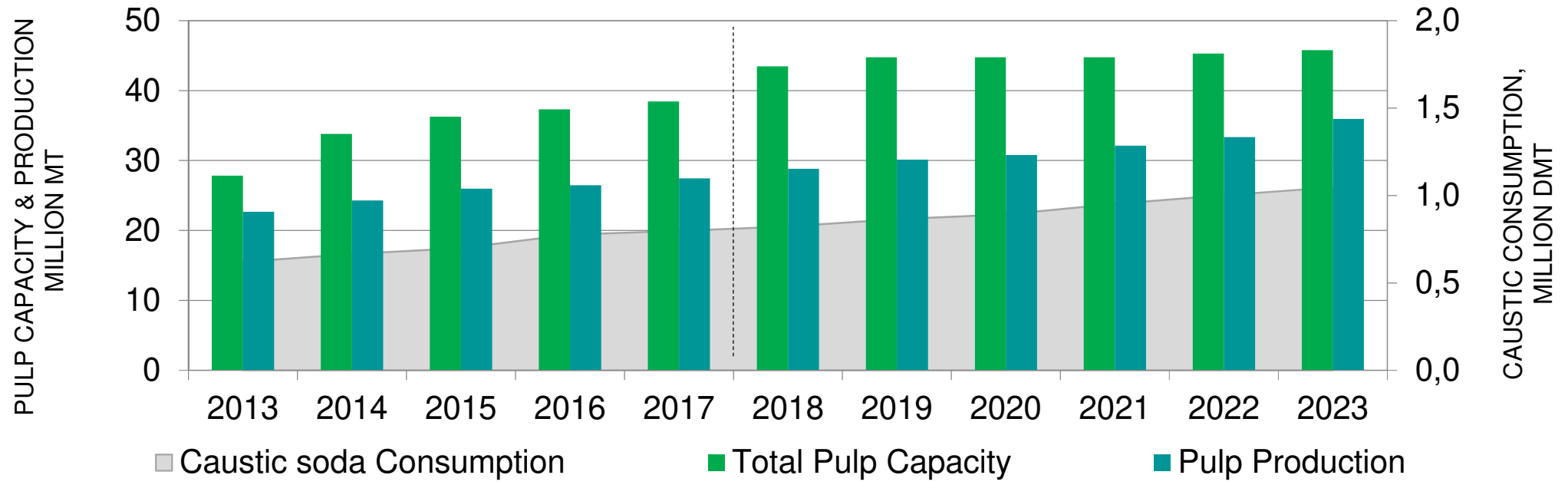


Source: IHS Markit World Analysis 2019

4.7% AAGR of SAM caustic demand for pulp production

- 5 year SAM caustic production AAGR = 1.8%, constrained by chlorine outlets

SAM Pulp Production & Caustic Demand

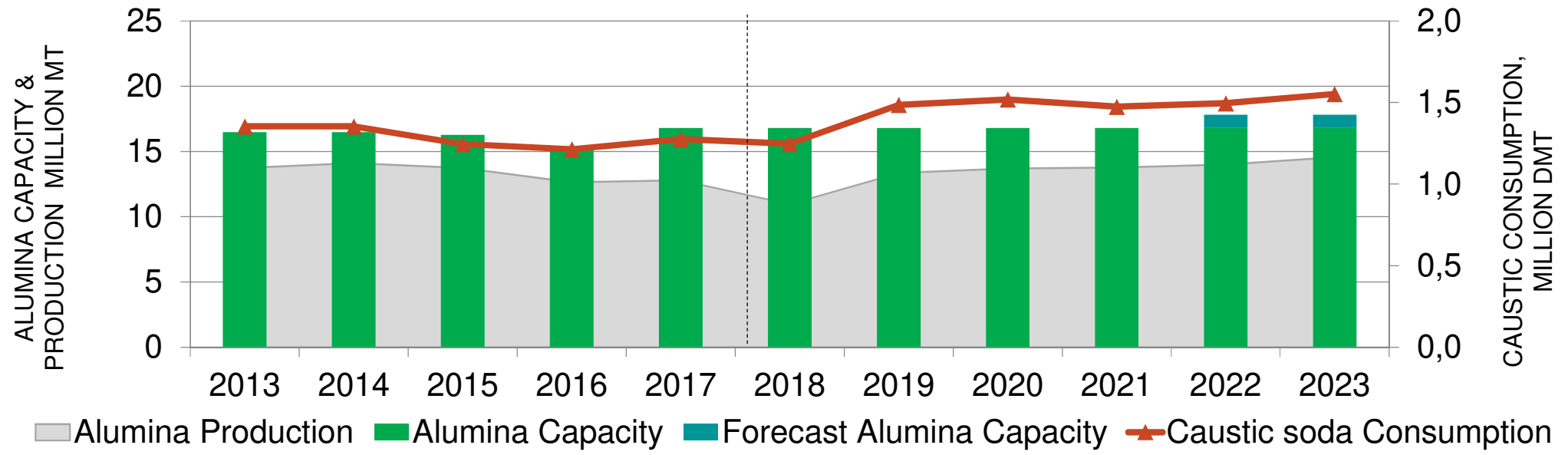


Source: IHS Markit World Analysis 2019

SAM caustic demand for alumina production continues to grow

- 5 year SAM caustic demand growth for ALA = 4.5%, net of projected Alunorte refinery operating rate recovery

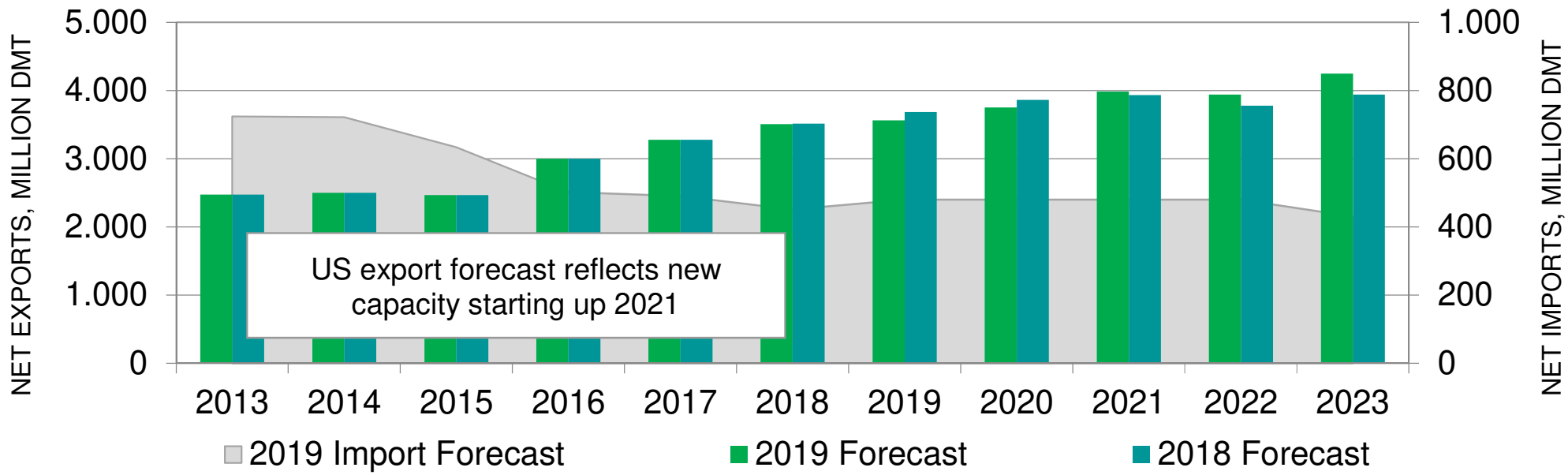
SAM Alumina Production & Caustic Demand



Source: IHS Markit World Analysis 2019

US net caustic exports are growing, raising production demand

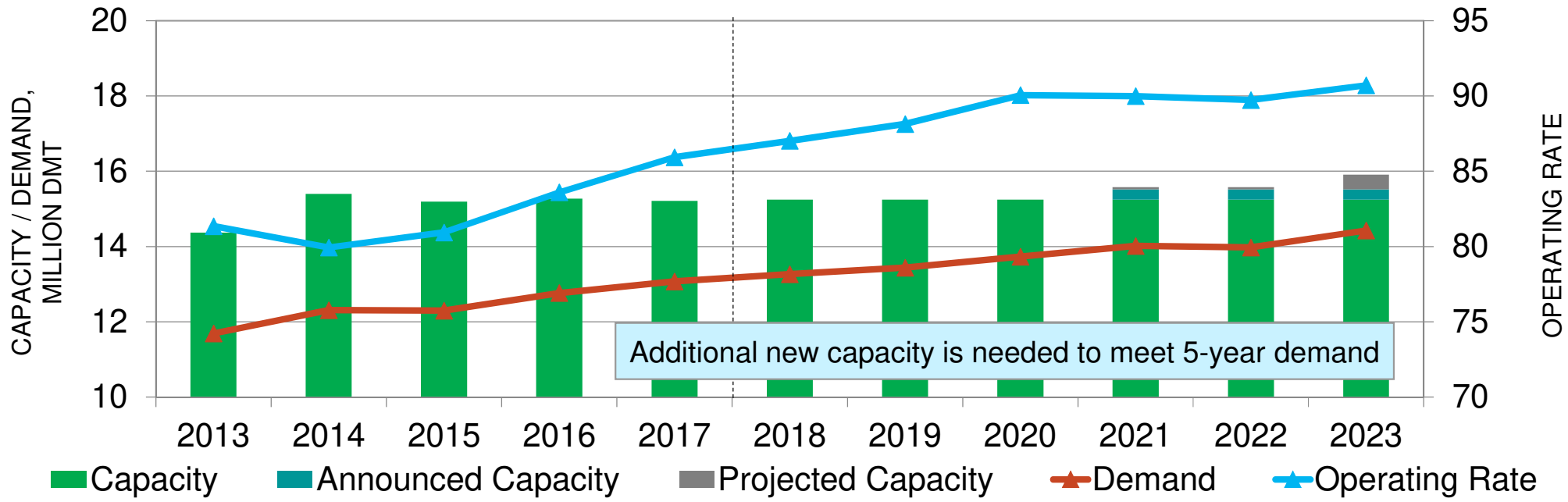
US Caustic Soda Import and Export Forecast



Source: IHS Markit World Analysis 2019

US operating rates increase – new capacity projected isn't enough to temper increasing operating rates

US Caustic Soda Supply / Demand and Operating Rate



Source: IHS Markit World Analysis 2019

North America market outlook summary

Domestic Demand

- Strong domestic demand through 2023; Vinyls and MDI are stand out chlorine growth segments; inorganic chemicals, organic chemicals and pulp are standout caustic growth segments

Net Exports

- 2018 caustic exports slightly lag 2017 exports due to Alunorte; 2019 – 2023 caustic exports grow in spite of Australian producers optimizing bauxite grade

Production & Trade

- Shintech adds 270 kdmta in 2021; additional hypo capacity assumed in 2023
- South American pulp growth and alumina rebound fuel USGC export growth

Operating Rates

- Average operating rates climb to 90% in 2021 – new Shintech capacity moderates rise until 2023

Prices & Margins

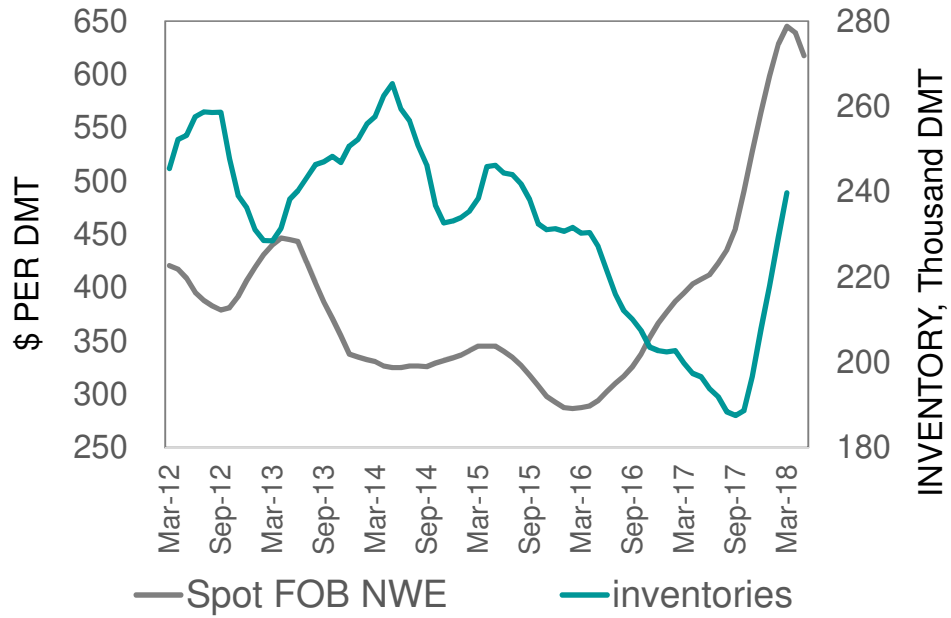
- Prices rise modestly to peak as global market awaits Asia recovery
- Low natural gas prices support continued globally advantaged economics

Europe

European chlor-alkali market: refreshed by new, modern capacity

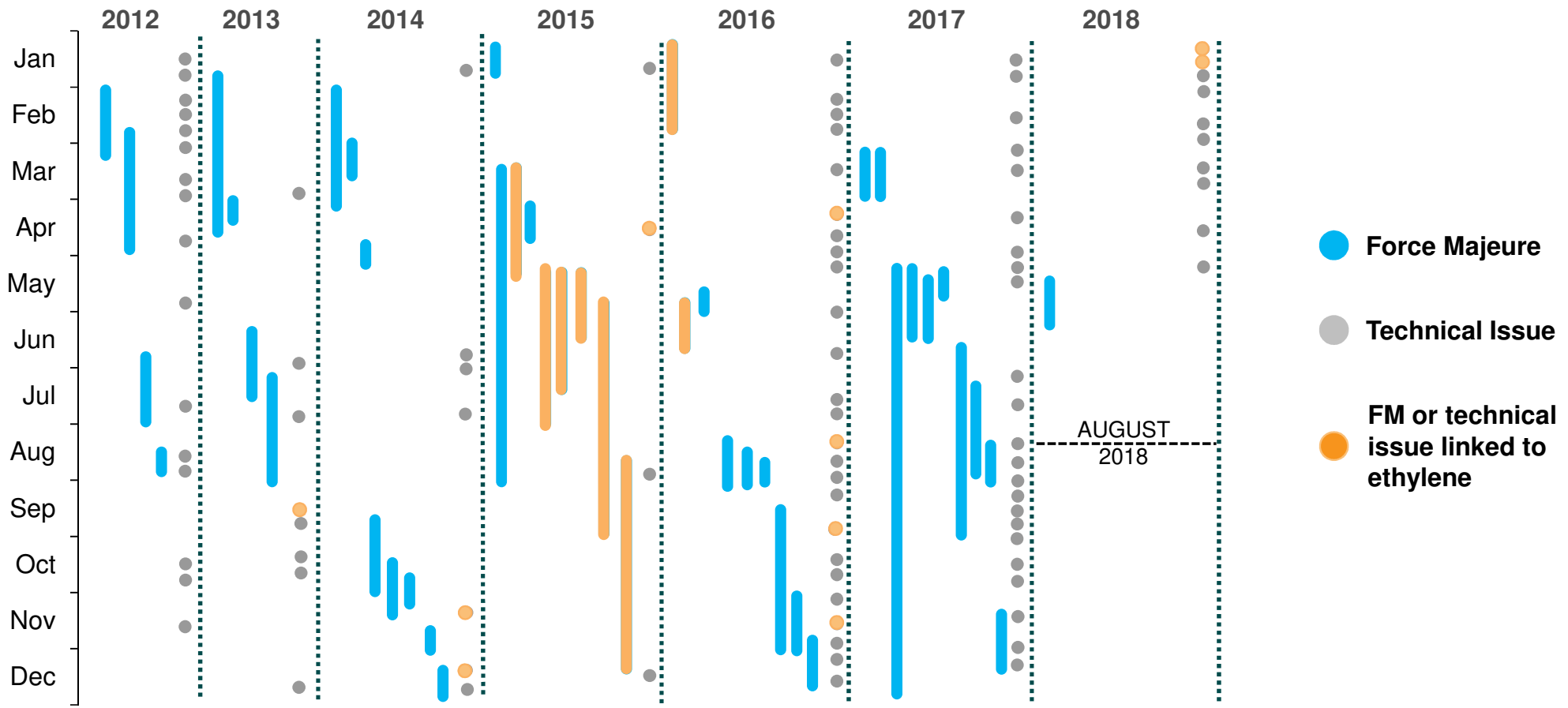
- Operating rates have risen
- Significant market shift from short to balanced after mercury-cell phase-out completion
- Better balance is repositioning continental pricing
- Participation in the export spot market participation is providing continental price support
- River system issues are keeping the market tight

WEP Caustic Soda Supply / Demand and Operating Rate



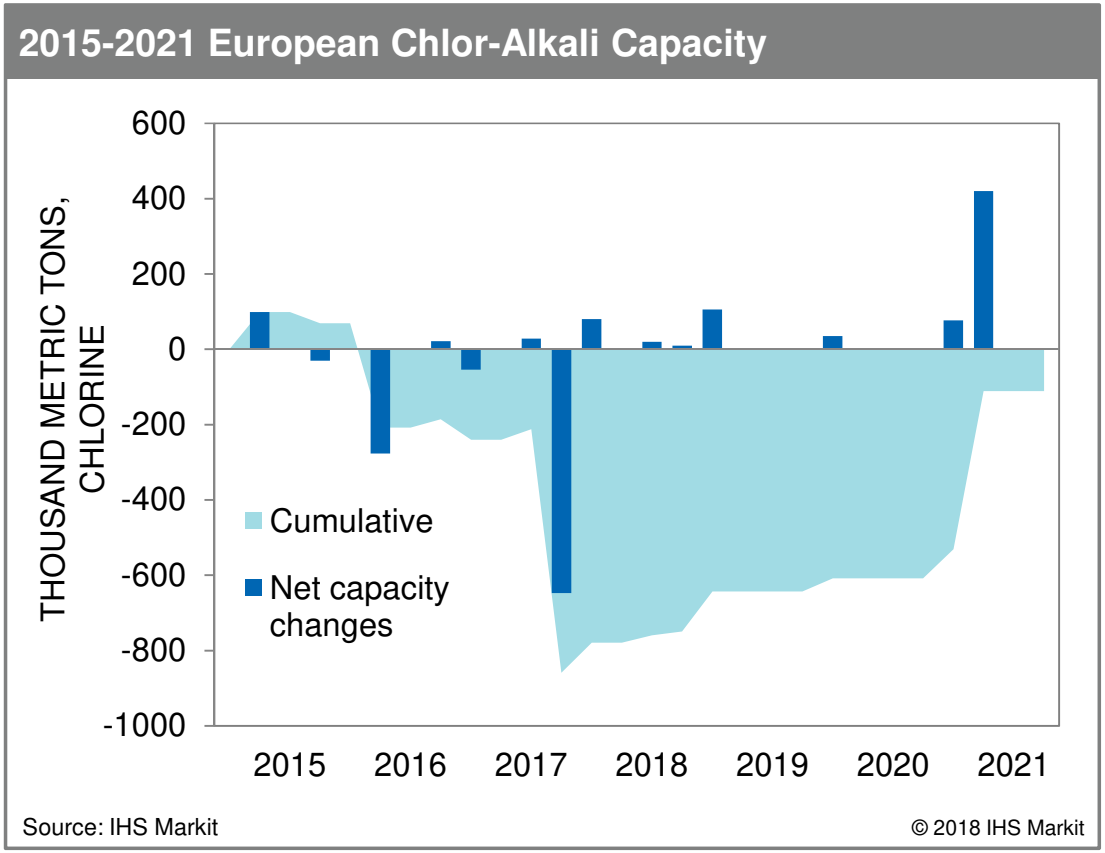
Source: IHS Markit

Improved reliability has stabilized the market balance …



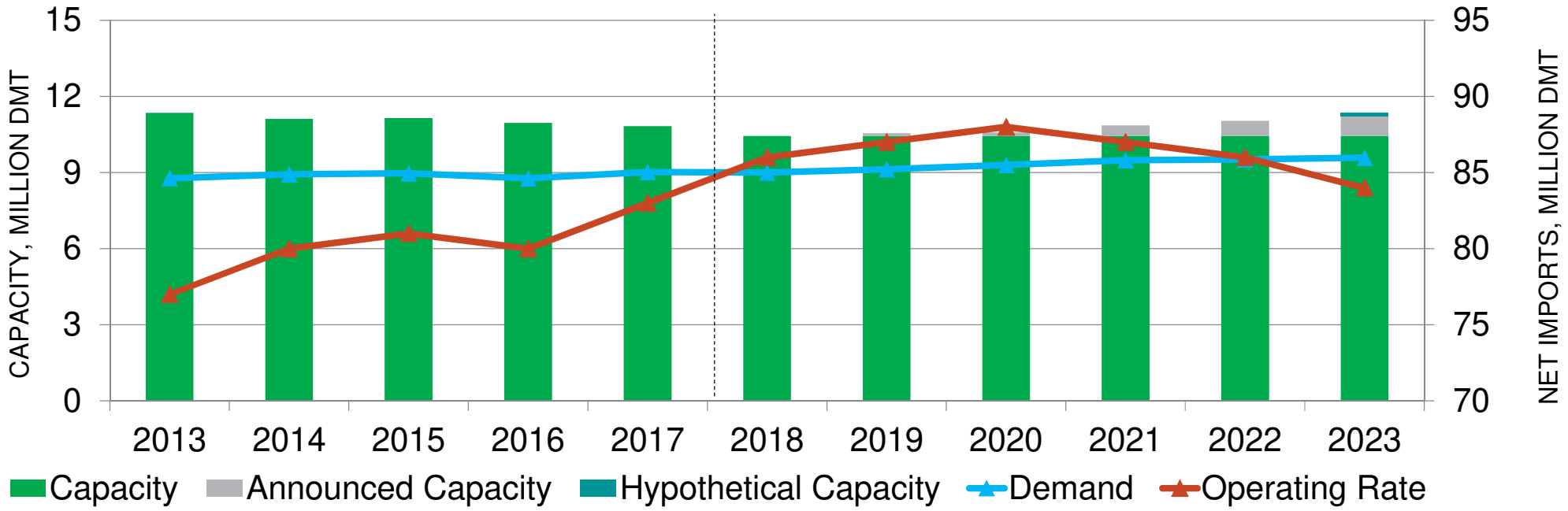
New capacity announced for Europe nearly off-sets demand loss from conversions, but not enough to cover growth

- 2017 capacity loss exceeds 900 kmt chlorine
- Numerous capacity debottlenecking projects announced for short to medium-term
  - > New capacity announced for start-up by 2022 equals 75% of lost capacity
- Additional hypothetical expansions forecast to sustain balance



European operating rates increase until new capacity is on-stream

WEP Caustic Soda Supply / Demand and Operating Rate



Source: IHS Markit Chlor-alkali World Analysis 2019

Europe market outlook summary

Capacity

- Market impact of 900,000 mt net chlorine capacity closures 2015 – 2017 is offset by higher operating rates. 2015 – 2016 mercury-cell plants operated at 62-66% of capacity.

Operating Rates

- Operating rates rise from 80% in 2016 to peak at 88% in 2020; new capacity on-stream gradually reduces rates to mid-80s% by 2023

Production

- New capacity will not mitigate high operating rates – 75% of demand growth is offset

Prices

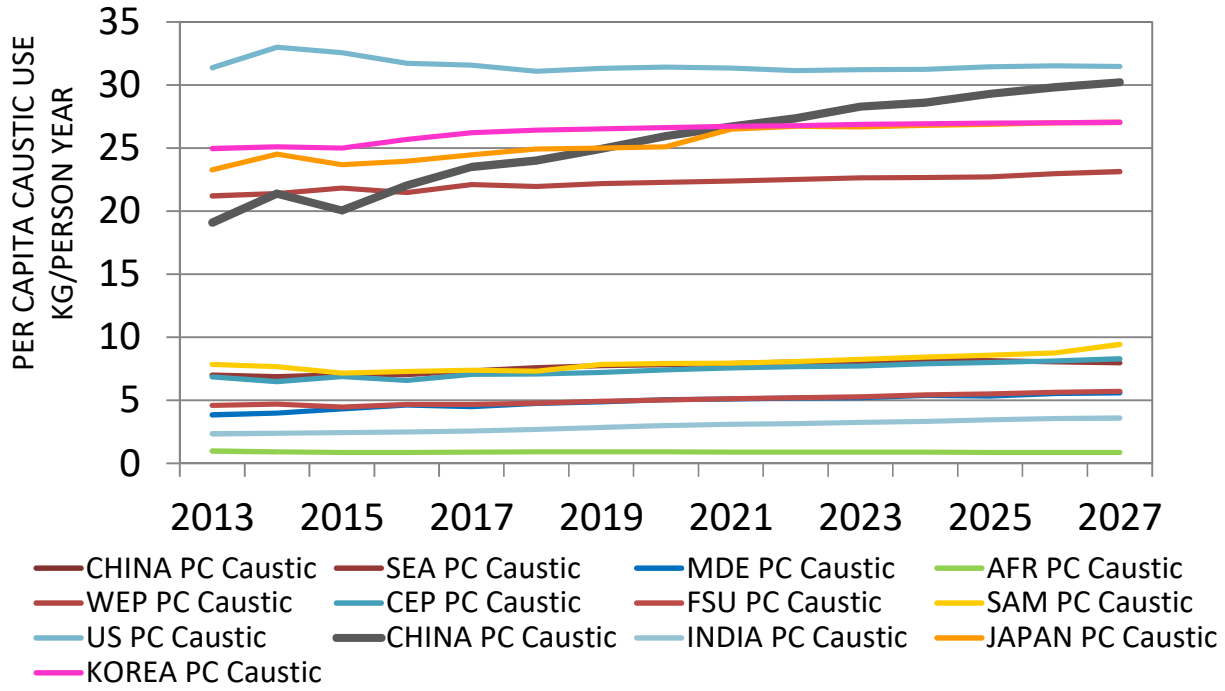
- Higher operating rates and dependence on imports bias the European market to more than historical price volatility

Asia

Asia leads the world in per capita caustic soda consumption growth rate …

- Chinese per capita consumption increases by almost 60% over the next 10 years
- Korean and Japanese per capita caustic consumption exceeds that of West Europe
- Chinese per capita caustic consumption approaches that of US by 2028

Per Capita Caustic Consumption



Source: IHS Markit Chlor-alkali World Analysis 2019

… But current market dynamics are mixed in China

- Chinese environmental inspections will continue to contribute to regional instability
  - > Widespread plant inspections impact caustic and chlorine demand (Jiangsu, Shanghai and Shandong)
  - > Recent unusual market dynamics have pressured caustic soda demand and price
  - > Mandated chemical plant relocations will contribute to unstable demand through 2020
- Shifting trade flow patterns – possible further shifts due to new tariffs
- Alumina demand is key to the caustic balance
  - > China domestic alumina price is less than LME price; sustained differential provides catalyst for increased Chinese operating rates
  - > Guinean bauxite imports have not negatively impacted caustic consumption yet … continued upgrading could lead to lower unit caustic consumption

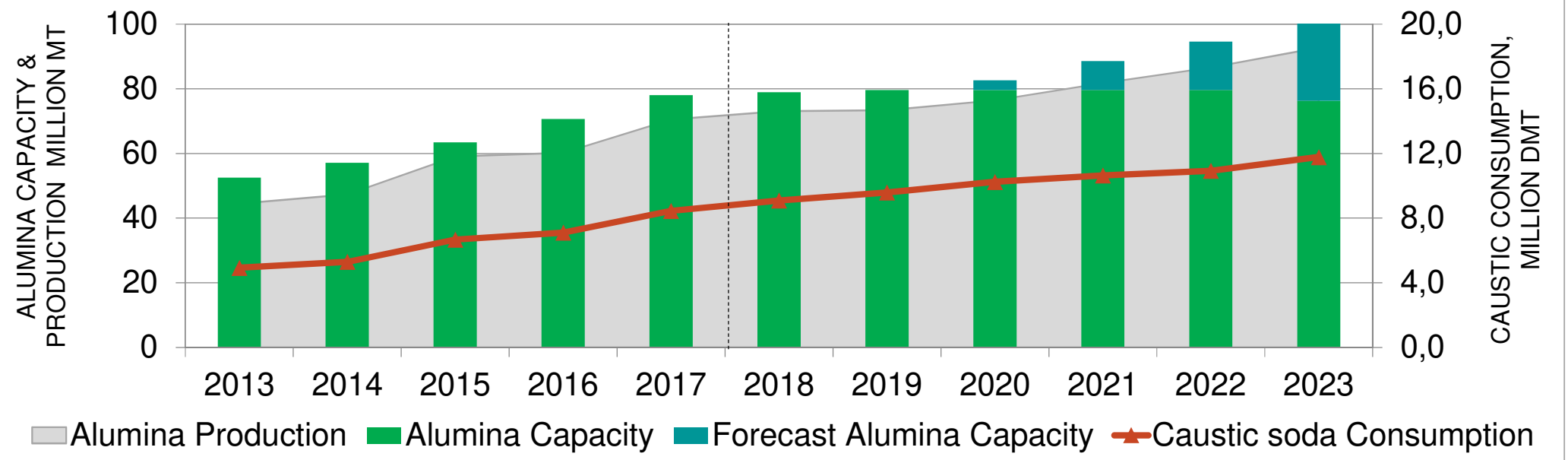
Uncertainty factors

- Impact of trade disputes – short-term or long-term?
- Environmental initiatives – short-term or prolonged?
- Increasing energy prices
- Capacity increase when plants are “moved” to industrial parks?
- Low cost construction v. higher operating costs
- Political / geopolitical issues and government interventions

Northeast Asia caustic demand for alumina production continues to grow

- New alumina capacity must be added to meet global aluminum demand growth
- Forecast new alumina capacity adds 2.7 Million dmt caustic demand

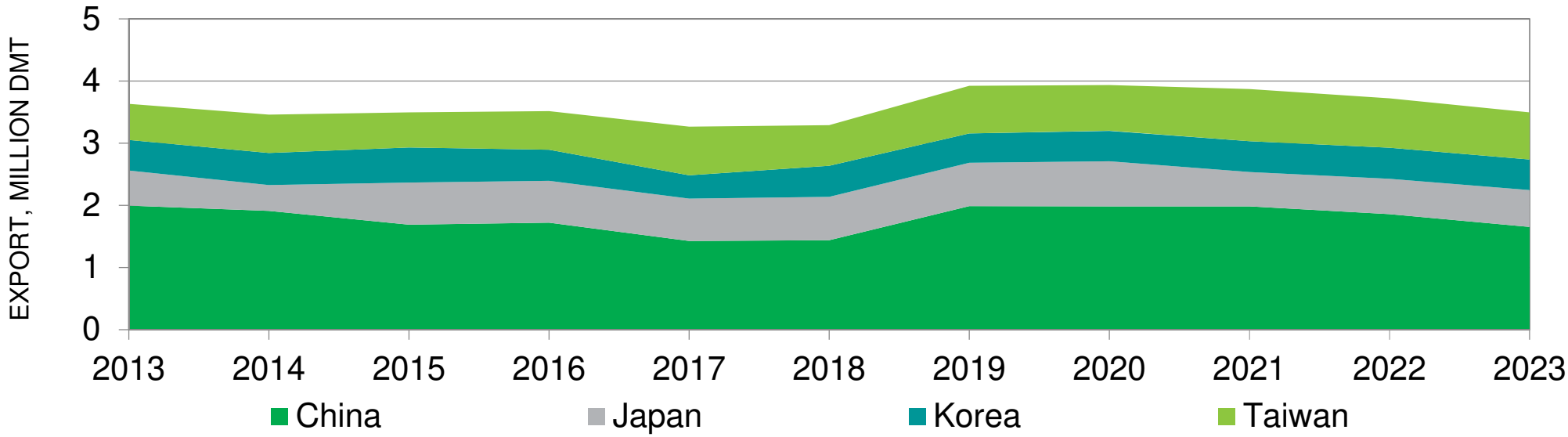
NEA Alumina Production & Caustic Demand



Source: IHS Markit Chlor-alkali World Analysis 2019

NEA caustic exports rise in 2019, then decline as Chinese operating rates increase

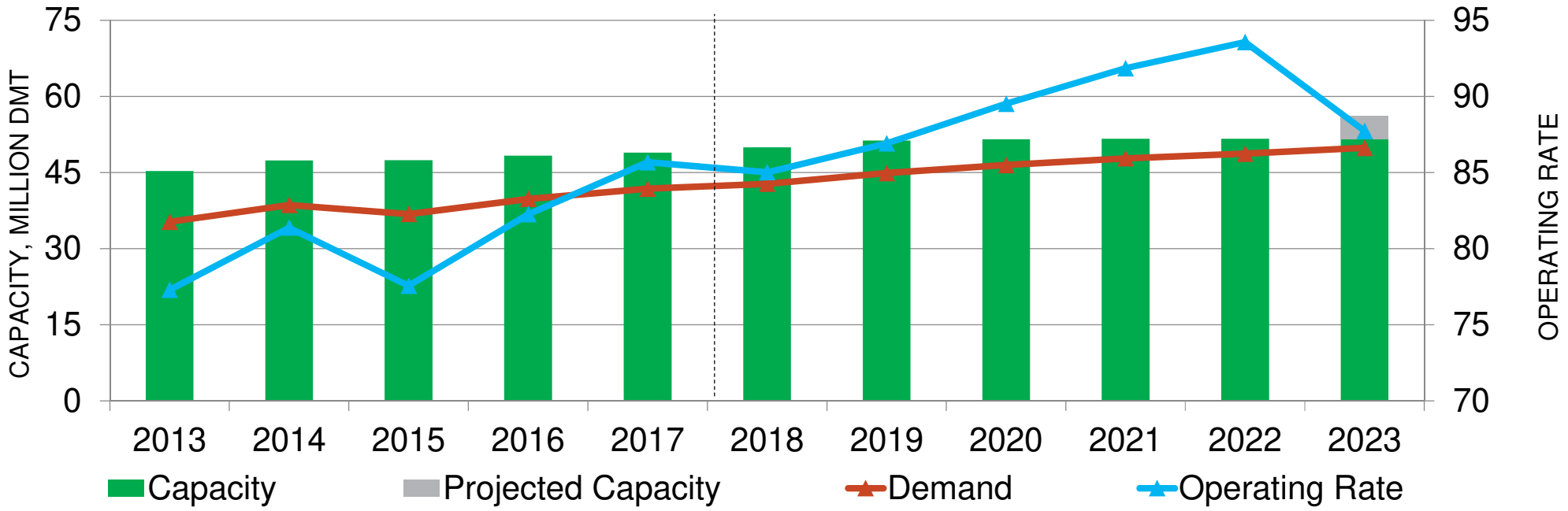
NEA Caustic Soda Export Volume



Source: IHS Markit Chlor-alkali World Analysis 2019

Northeast Asia operating rates rise to unprecedented levels

NEA Caustic Soda Supply / Demand and Operating Rate



Source: IHS Markit Chlor-alkali World Analysis 2019

Asia market outlook summary

Domestic Demand, AAGR

- Overall caustic demand growth rate exceeds chlorine demand growth rate

	NEA	SEA	ISC
Chlorine	2.9%	0.7%	5.8%
Caustic	3.1%	2.2%	5.1%

Capacity

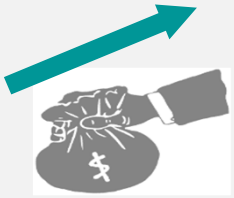
- Potential for small plant closures in China; some increase in India

Operating Rates

- Seasonal variations in operating rates; Northeast Asia operating rates go from 86% in 2018 to 94% in 2022

Production

- Production rises with operating rates
- Exports rise, but then decrease when constrained by high operating rates needed to accommodate domestic growth



Prices & Margins

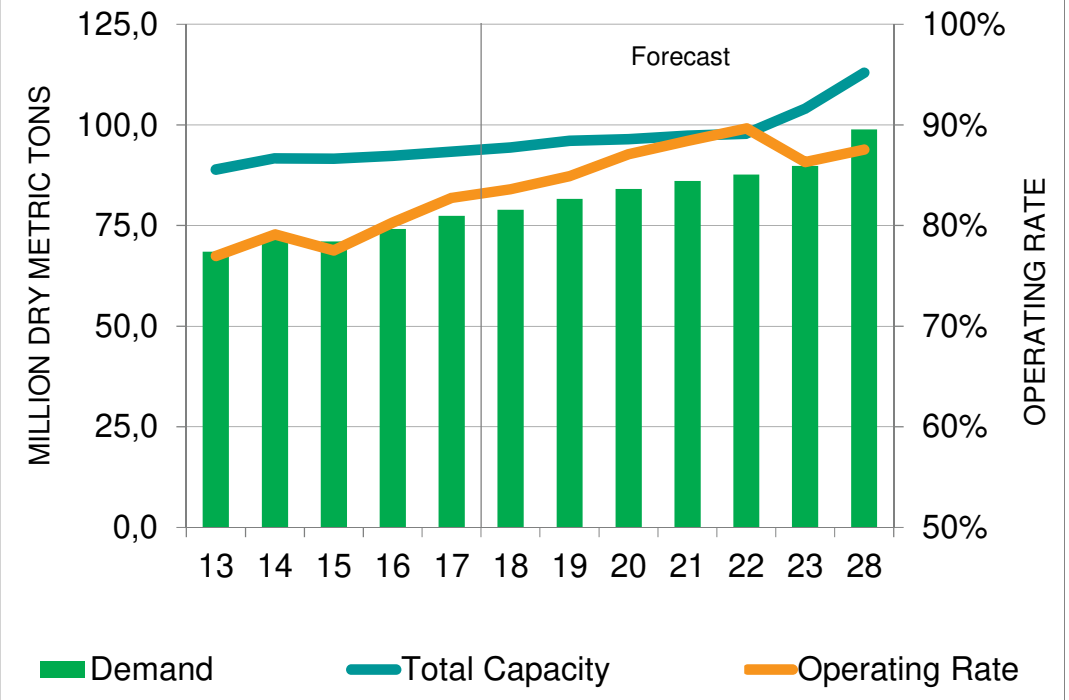
- Increasing demand, especially as caustic consumption rises faster than chlorine with no significant capacity increases, will push prices up. Some seasonality of caustic pricing may occur.
- ECU margin increase is countered by energy cost increases

Summary

Globally, the 5-year demand growth trajectory continues to support increasing operating rates

- GDP growth rate ≥ 2.9 AAGR through 2020 supports healthy manufacturing and key consumables demand growth
- IHS Markit projects ~ 2.3-2.4% global demand AAGR for chlorine and caustic through 2020
- 2018 global chlor-alkali operating rate is ~ 84%, with significant differences by region
- Cycle peak operating rates are still projected in 2021-2022
- Global cycle peak operating rate exceeds all prior global operating rates since 1990, including historic 2007 peak of 89%.

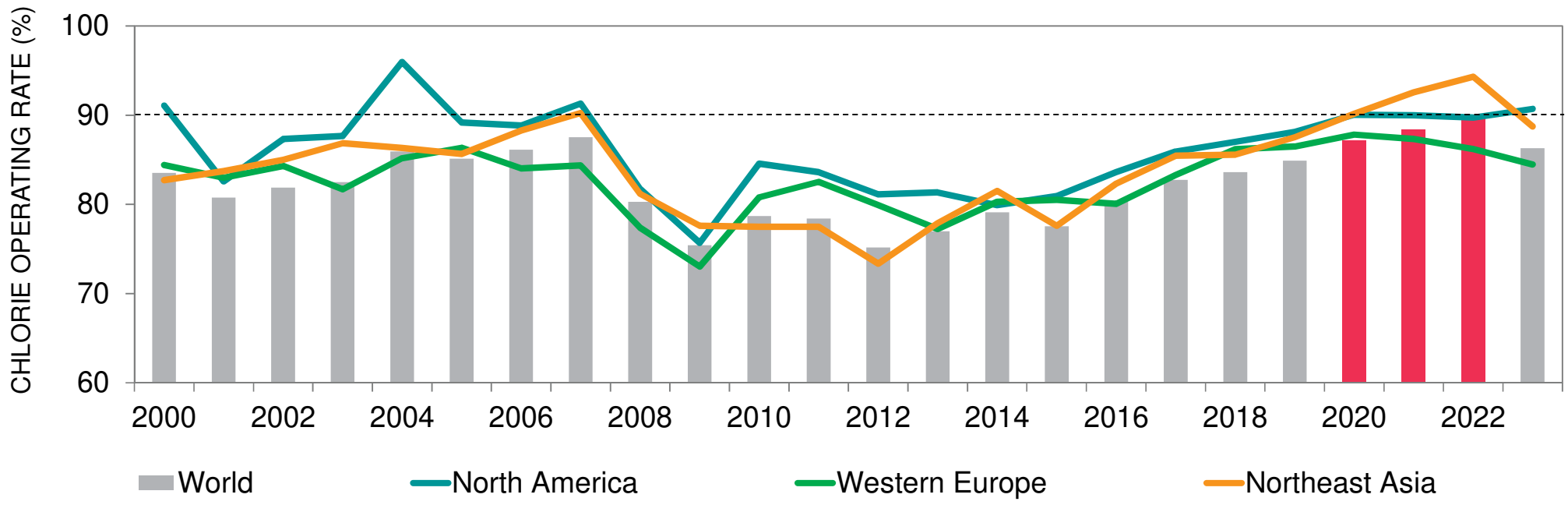
World: Caustic Soda Supply & Demand



Source: IHS Markit World Analysis 2019

WEP, NEA and global chlor-alkali operating rates reach record levels

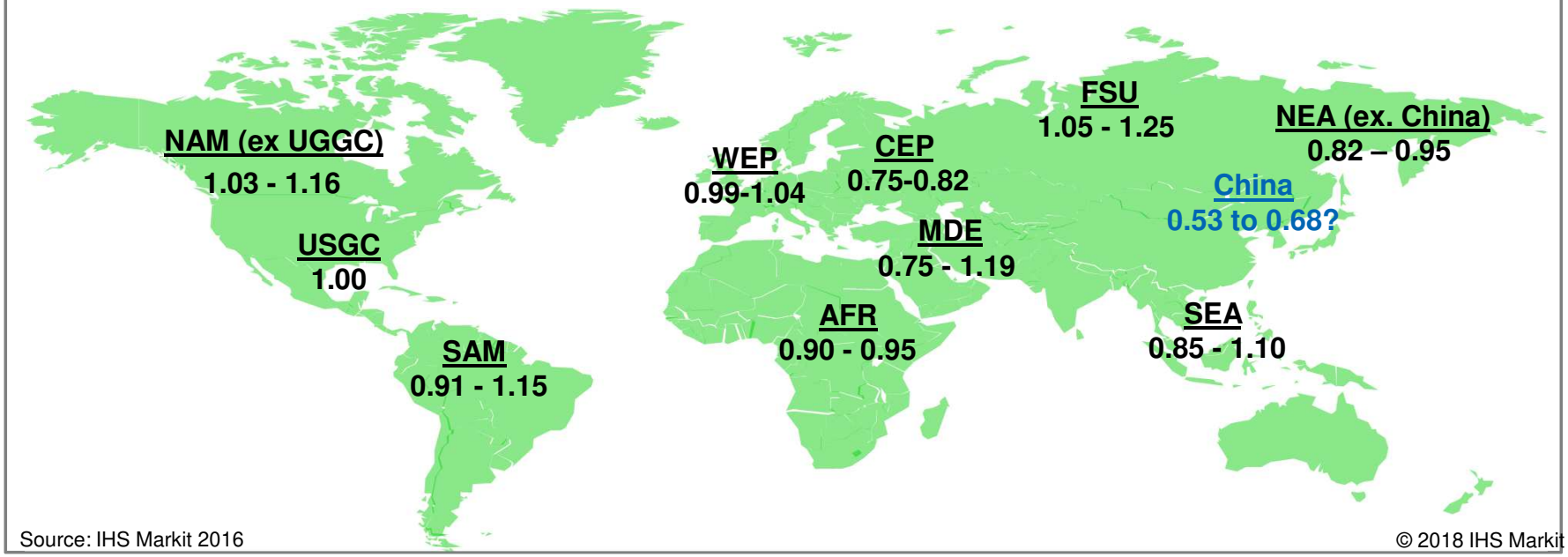
Global and Select Regional Chlor-alkali Operating Rates, %



Source: IHS Markit 2019 World Chlor-alkali Analysis

Relative investment costs influence capacity addition geography

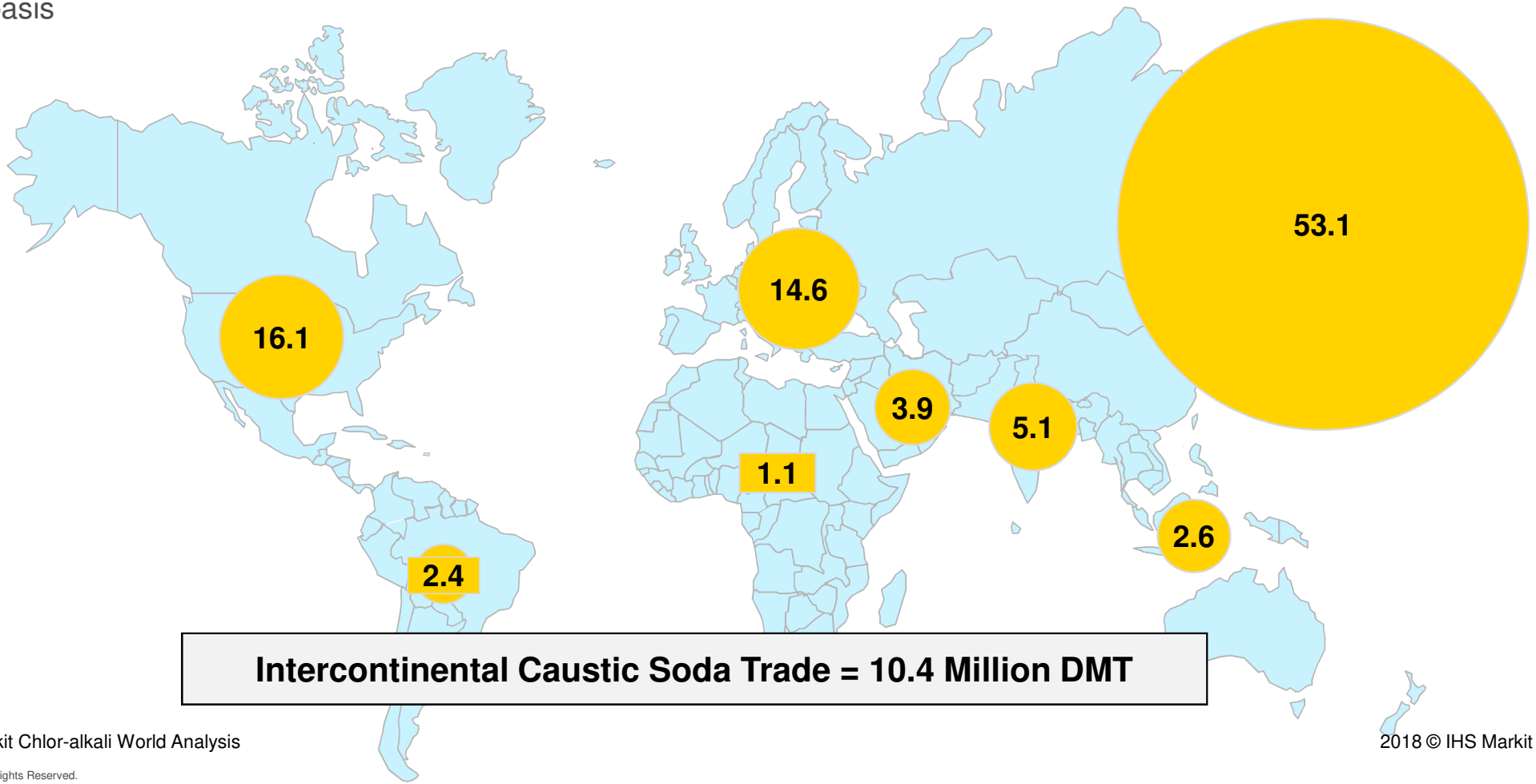
Construction Location Factors (2016)



Source: IHS Markit 2016

2023 Chlor-alkali capacity = approximately 99 million tons

Chlorine basis



Source: IHS Markit Chlor-alkali World Analysis

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