HDMA PULSE WEBINAR

WITH POWER SYSTEMS RESEARCH

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POWER SYSTEMS RESEARCH (PSR)

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Chris brings 30 years of industry experience including 15 years with Power Systems Research. He is responsible for oversight of the global medium and heavy commercial **vehicle** market. Chris primarily oversees the various commercial vehicle databases along with production forecasts and identifying market trends.

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Erik Martin oversees PSR's research and business development teams in China, India and Japan. He has experience working in many countries in East Asia, South Asia and Southeast Asia. Erik holds a B.A. in Chinese Language from the University of Minnesota and has been Director – Asia Region at PSR since 2014.

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POWER SYSTEMS RESEARCH OVERVIEW

- Global market research, industry data & forecasting
  - Utilized by engine manufacturers, OEMs, component and parts suppliers, associations, financial analysts, publications and more.
- All segments; global power products/drivetrain industry
- More than 40 years' industry expertise
- Proprietary market studies
- In-house call center
- Market intelligence & modeling

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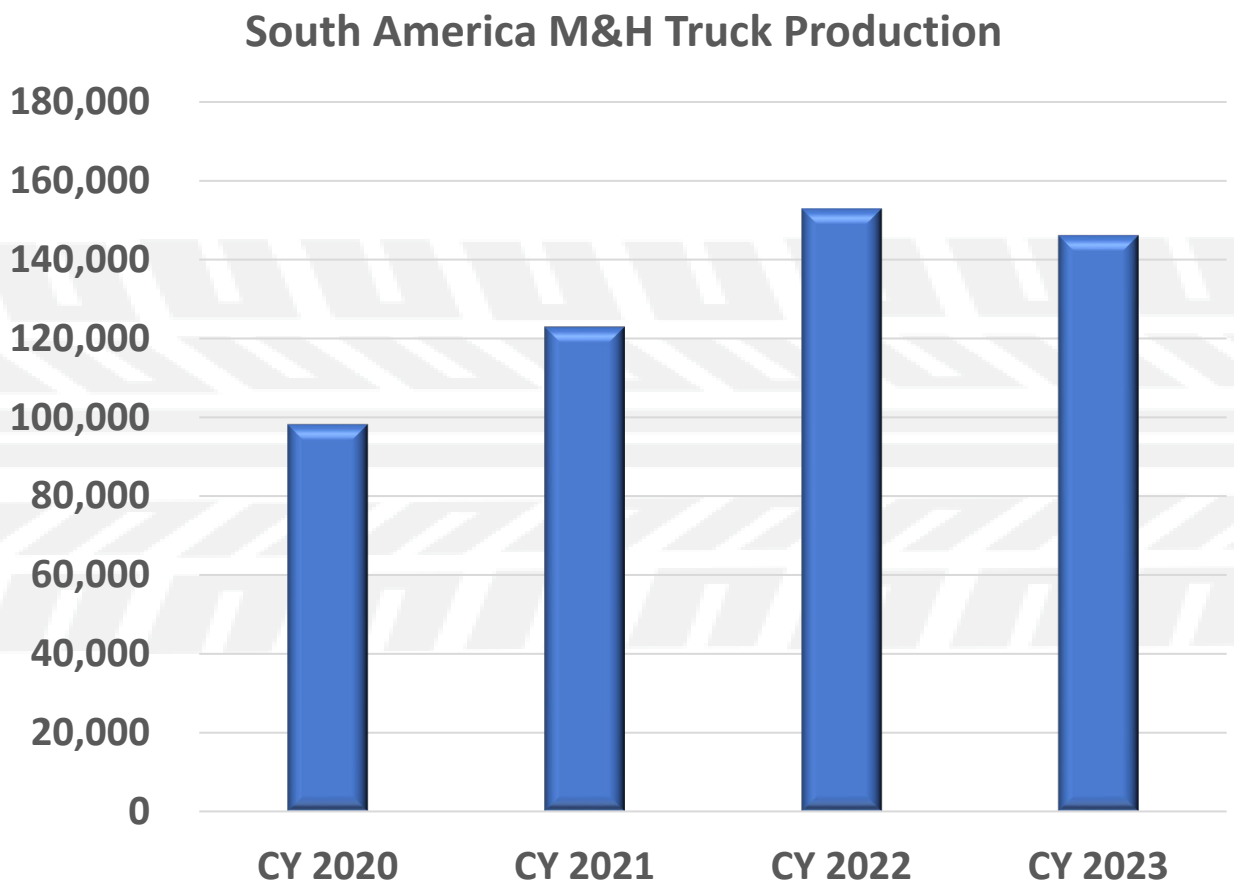
SOUTH AMERICAN OVERVIEW



- After a sharp decline in demand last year, production is expected to improve to pre-pandemic levels in 2021.
- South American production is being disrupted by supply chain issues.
- Euro VI emission regulations are expected to be implemented in 2023 which will likely lead to a truck pre-buy in 2022 due to the cost of the emission technology.

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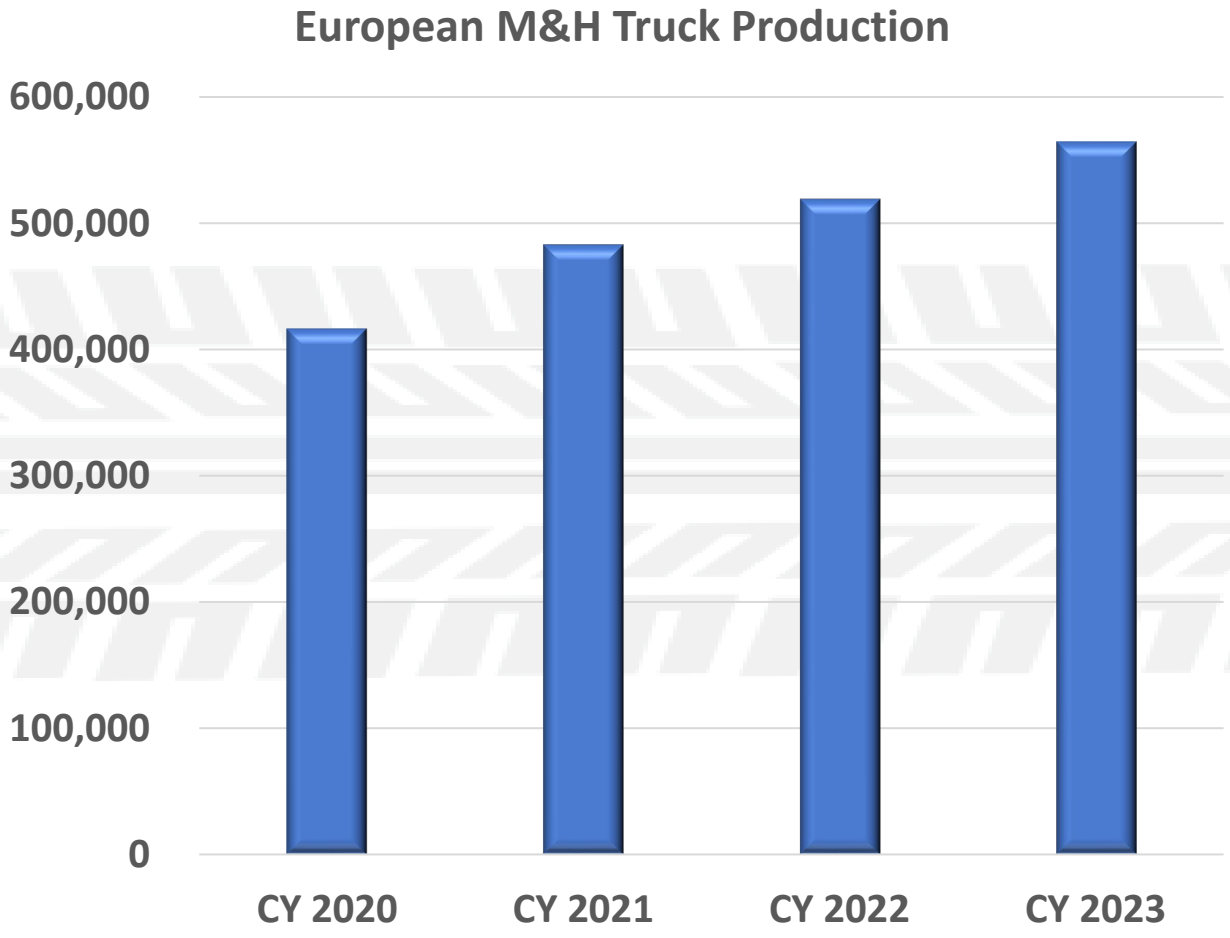
EUROPEAN OVERVIEW



- Medium and heavy truck sales declined by 25.7% last year.
- Order rates for trucks have been very strong during the past six months.
- Supply chain disruptions will likely hinder production for most of the year.
- Electric truck adoption will continue to grow mostly in the pickup and deliver segments.

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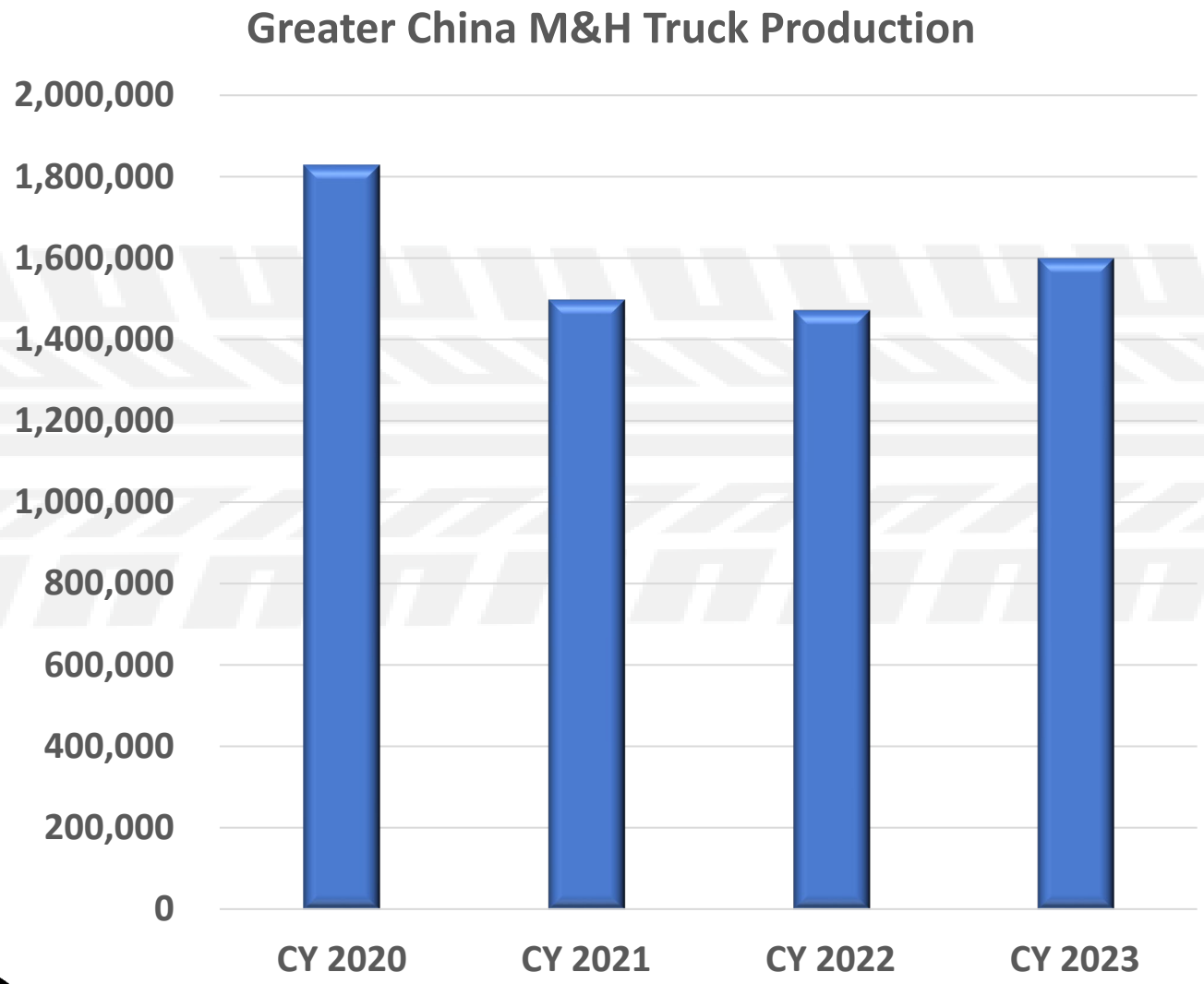
GREATER CHINA OVERVIEW



- Very high vehicle production in 2020 due in part to required replacement of Euro III emission vehicles with Euro V or Euro VI vehicles.
- Euro VI emission requirements to begin implementation this year.
- The added cost of the Euro VI emission technology will reduce heavy truck demand in the later half of the year.
- Some level of truck pre-buy is expected during the first half of 2021.

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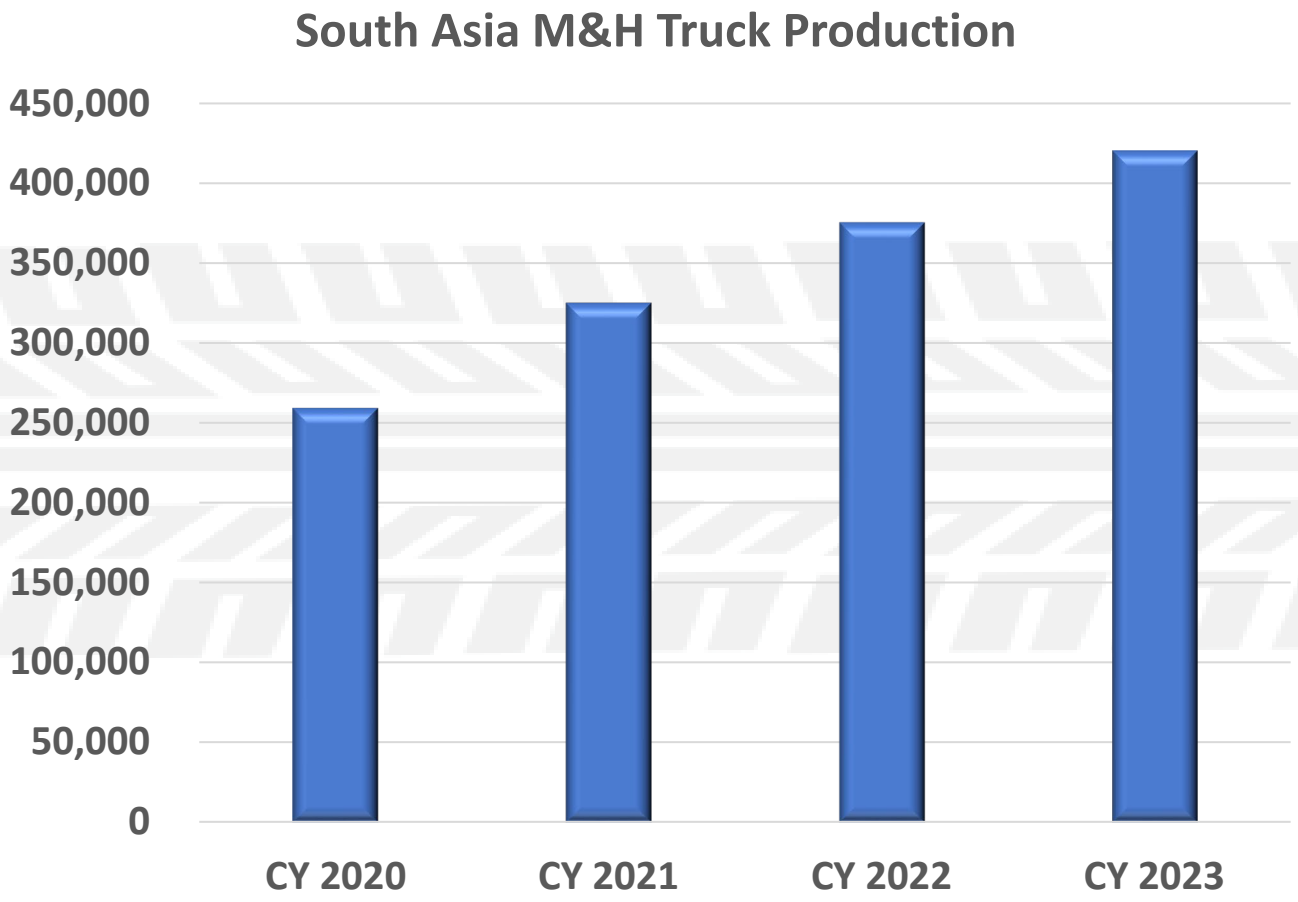
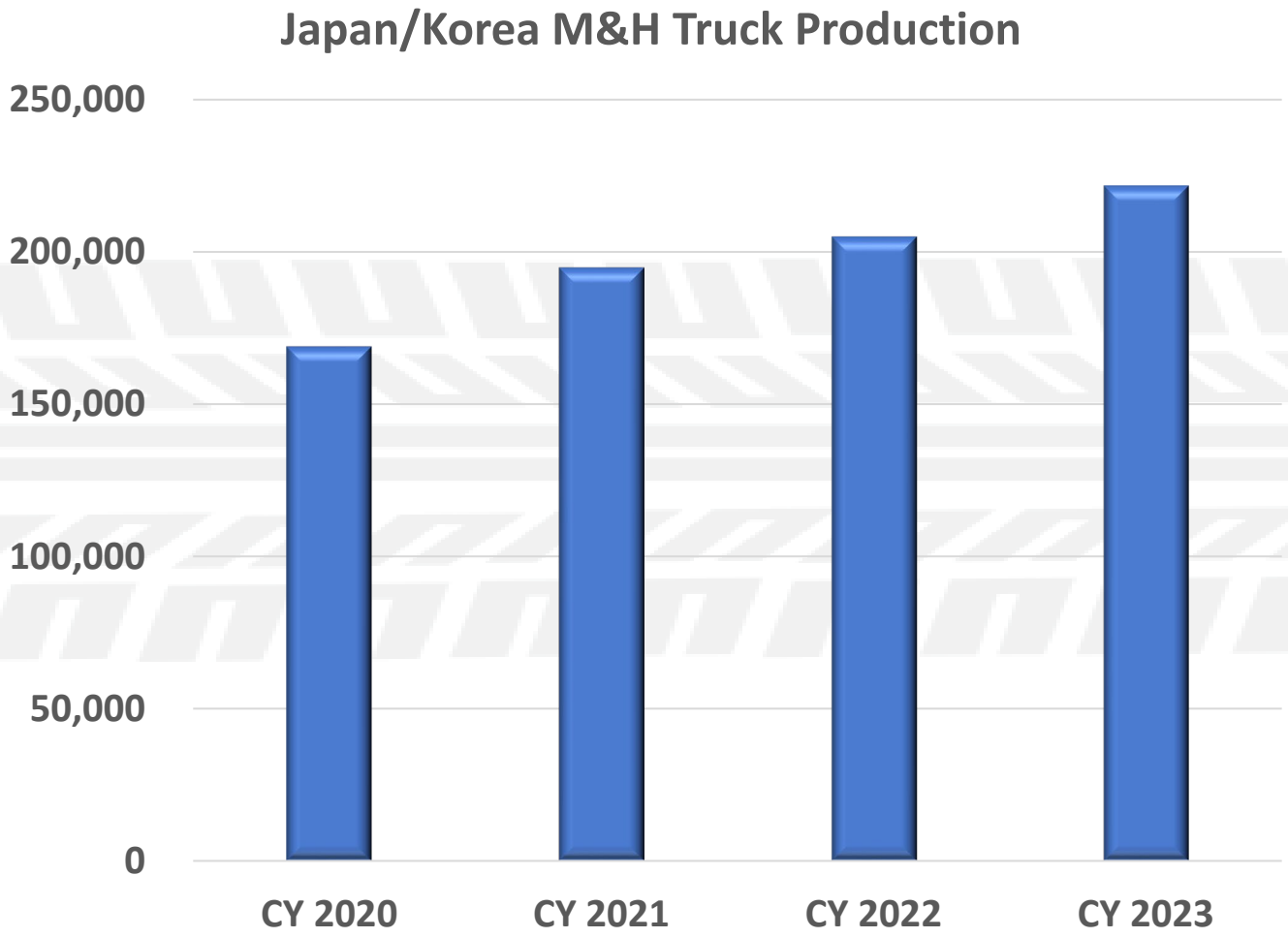
SOUTH ASIA OVERVIEW



- Commercial truck demand started to improve during the fourth quarter of 2020 and is expected to continue through this year.
- Headwinds for demand is expected to continue this year.
- In India, BS-VI emission regulations went into effect in April of last year.
- It will likely be a few years before demand recovers to pre-2020 levels.

JAPAN AND KOREA OVERVIEW



- After a significant decline in global truck demand last year, production levels for both Japan and Korea are expected to improve over the next few years.
- Improvement in both domestic and export markets.
- Like most other regions, supply chain disruptions will impact production throughout the year.

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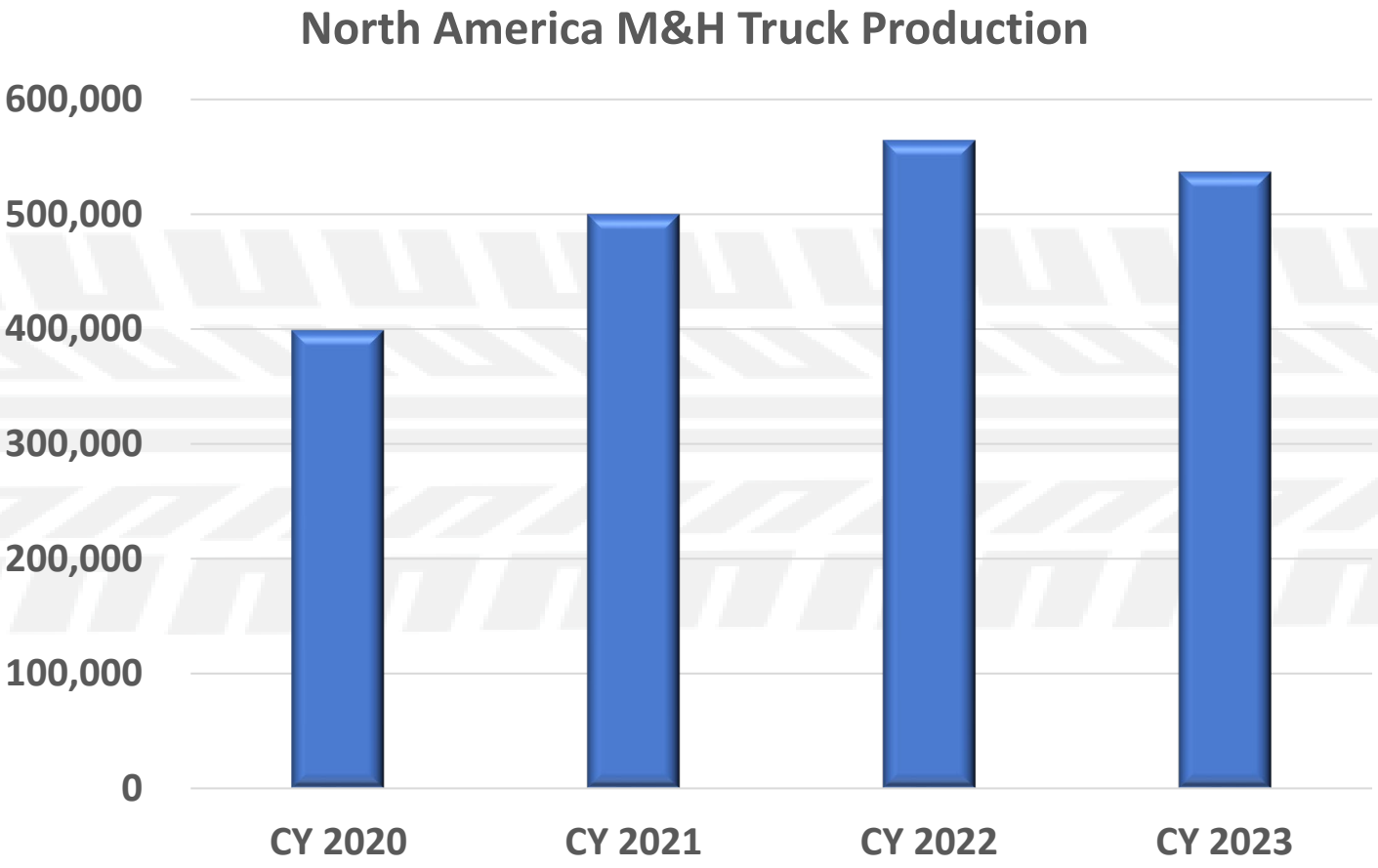
NORTH AMERICAN OVERVIEW



- Since the latter part of last year, heavy commercial truck orders have been extremely strong as freight rates remain very high.
- However, supply chain issues particularly with regard to semiconductors will be the biggest obstacle for sustainable production this year.
- Significant bottlenecks at the West Coast ports.
- Supply chain disruptions are not uncommon when demand sharply spikes over a relatively short period.

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GLOBAL COMPONENT SHORTAGE

- Both medium and heavy commercial truck OEM's are facing difficulty sourcing components to meet strong demand in the market.
- Most of the OEM's believe the semiconductor shortage will impact Q2 and likely extend into Q3.
- The semiconductor shortage in the automotive segment was spurred by chip manufacturers who pivoted toward consumer electronics during the worst of the pandemic as truck and auto sales sharply declined.
- According to a recent TMC report, other components such as reefer bodies and Exhaust gas recirculation coolers are also in short supply.
- It is possible that semiconductor chip shortages may continue over the longer term as more chips are required in multiple industries.

NORTH AMERICAN OEM STRATEGIES

- In March, Volvo announced that it will implement “stop days” across its global truck manufacturing operations. Both the Volvo plant in Virginia and the Mack plant in Macungie will be affected.
- Daimler has started a process of revolving downtime for medium duty production in Mount Holley and Santiago Mexico. The revolving downtime is used to maintain a reduced level of output while maintaining employment levels.
- Navistar and PACCAR are also adjusting production schedules accordingly. PACCAR estimated their truck deliveries were reduced by 3,000 vehicles during the first quarter.
- The OEM’s plan to maintain employee and capacity levels to be prepared for an uptick in production when conditions improve.

UNITED STATES INFRASTRUCTURE BILL

- Included in the massive stimulus package that Congress is working though is $174 billion to increase electric vehicle demand.
- It bets heavily on spending meant to increase the use of electric cars, which today make up just 2 percent of the vehicles on America's highways.
- With the goal of reducing the vehicle price by incentivizing electric vehicle batteries.
- The money would also fund the construction of about a half-million electric vehicle charging stations.
- The plan proposes $100 billion in programs to update and modernize the electric grid to make it more reliable.
- The plan proposes an additional $46 billion in federal procurement programs for government agencies to buy fleets of electric vehicles.

OEM HAPPENINGS

- Daimler, Isuzu and Hino have announced their plans to use the Cummins engine offerings to support their medium duty engine requirements.
- Hino recently announced plans to install the Cummins 6.7 liter and 9 liter engines on their new L and XL series trucks in North America by October 2021.
- In February, Isuzu and Cummins announced their partnership that will allow Cummins to install the B6.7 liter engine platform on the Isuzu medium truck lineup.
- Also in February, Daimler and Cummins signed a memorandum of understanding to establish a global strategic partnership for medium duty engine systems.
- We are seeing the OEM's collaborate with each other to offset the costs of stricter emission requirements and offset the high cost of developing future technologies.

PSR ASIA TEAM

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ASIA REGION NARRATIVES – FACTORS BEHIND THE TRENDS

- The ‘why’ behind current trends in Asia; economic, technological, governmental, logistical & other factors impacting local markets.
- India
  - Semiconductor Shortage
  - Government Policies
  - Logistics and Markets
- Far East and Southeast Asia
  - Semiconductor Shortage
  - Supply Chain
  - Alternative Energy
- China
  - Semiconductor Shortage
  - Government Policies
  - Logistics and New Energy Vehicles

INDIA – SEMICONDUCTOR SHORTAGE

- Semiconductor Usage
  - BS-VI emission norms
  - Increasing adoption of smart trucking
    - All major OEMs offer smart trucking solutions for effective fleet management
    - In July 2020, Eicher became India's first CV maker to offer 100% connected trucks & buses
- Semiconductor Shortage
  - Low 2020 sales meant semiconductor suppliers diverted product to tech.
  - India OEMs used remaining inventory in the growing Q1 truck production leading up to the end of the fiscal year.
  - We anticipate the semiconductor shortage will hit hardest in April and May and likely continue for the next 5-6 months.
  - 2021 MHCV recovery will be dampened by the semiconductor shortage.

INDIA – GOVERNMENT POLICIES

- Emissions Norms – Bharat Stage VI
  - As of April 2020, all MHCV production for domestic market (approximately 85% of total) is BS VI compliant.
  - Some exported vehicles are at the lower BS IV level.
  - A handful of vehicles used for India military are BS III (very small volumes).
- Low Channel Inventory
  - OEMs were supposed to start selling BS VI vehicles on April 1, 2020.
  - OEMs scaled down BS IV production by December 2019.
  - In March 2020, the government imposed a strict nationwide COVID lockdown, which slowed BS VI MHCV production.
  - As a result, the entire inventory was impacted.

INDIA – GOVERNMENT POLICIES

- Scrappage Policy and Challenges
  - Vehicle owners will get incentives to scrap old & non-compliant vehicles.
    - Gov't recommends OEMs give 5% discount for new purchases against scrap certificate.
    - Scrap value for old truck will be 4-6% of new truck ex-showroom price.
  - The India market is very price-sensitive. We believe these incentives are insufficient to attract customers which may limit the policy's effectiveness.
  - India MHCV market is very fragmented; dominated by small fleet owners (85% have less than 3 trucks; most are single truck owners).
    - Owners/drivers regularly use trucks for 12+ years due to stressed financial condition.
    - In the BS-VI era a good truck costs about 40-50 lacs.
    - Running costs are up drastically. (Diesel prices increased by almost 20% in the last year.)
    - Freight rates are relatively constant.
  - India has in excess of 35M vehicles with more than 15 years of service.
    - Critical to ensure that scrapped vehicles don't find their way back on the roads.
    - Logistics hurdle moving scrapped vehicles from customer to scrapyard.

INDIA – GOVERNMENT POLICIES

- Scrappage Policy Status
  - Finance Minister announced the scrappage policy will be effective April 1, 2022.
  - Still awaiting official word regarding gov't & OEM incentives, scrap yard procedures (cost burden, logistics management, material recycling, etc.)
- Infrastructure Spending
  - Overall infrastructure spends were weak the past 2 years. Now the government wants to use infra spends to revive the economy.
  - The Ministry of Road Transport and Highways total expenditure for 2021-22 is estimated at Rs 1,18,101 crore. This is an annual increase of 23% over the actual expenditure for 2019-20.
  - The government is planning to inject INR 100 lakh crore (~US$ 1.3 Trillion) under the National Infrastructure Pipeline Project

INDIA – LOGISTICS AND THE MARKET

- ICV & Cargo Truck Sales Grew as E-commerce Deliveries Increased
  - This trend is likely to continue in the coming years.
- Buses
  - Social distancing will continue to impact all the segments through Q3 CY2021.
  - New bus demand will be muted over the next year pending gov't pressure.
- Used Truck Market is Gaining Traction
  - In September 2020 Daimler India Commercial Vehicles (DICV) launched a used truck exchange platform.
  - DICV expect 3x growth compared to new truck business.
  - Post BS VI the price gap between new and used trucks widened.
  - Highly unorganized market = certified used truck business opportunities.
- Rail Freight – Competition from Indian Railways
  - Indian Railways aggressively increasing freight; will impact road logistics.
  - Plan to increase freight transport market share from 28% to 44%.

FAR EAST & SE ASIA – SUPPLY CHAIN FRAGILITY

Japan: Ibaraki Prefecture

Fire shuts down Renesas Electronics semiconductor plant

US: Austin, Texas

Cold wave impacted NXP, Infineon & Samsung semiconductor plants

Suez Canal

Shipping bottleneck

Straits of Malacca

Shipping bottleneck

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FAR EAST & SE ASIA – SEMICONDUCTOR SHORTAGE

"Of the MHV models manufactured in Japan, there is not a single model that does not require semiconductors."

- Semiconductor Shortage
  - Chip production halted due to power outages caused by a cold wave in Texas.
  - The Renesas Electronics fire in Japan was more serious as many Japanese OEMs placed chip orders with Renesas, so the impact spread throughout.
  - Electronic devices like cell phones & require a 3-5nm class. Semiconductor manufacturers prioritize these since they are more profitable than the chips sold to the automotive market.
  - Semiconductors for the automotive industry are often produced in older equipment, and the productivity of older equipment is low. As a result, production of semiconductors for the automotive industry will not increase, and the supply shortage will continue.
  - Japanese automakers traditionally looked to China act as a buffer.
  - Today there are no semiconductor manufacturers in China to be that buffer.
  - We predict this situation will not be resolved until the end of 2021.

FAR EAST & SE ASIA – SUPPLY CHAIN

- Japanese OEMs formerly used vertically integrated supply chains.
  - Planning, design, procurement, assembly and manufacturing done through a vertical division of labor among the company, affiliates, and partners.
- Current trend in manufacturing is toward horizontal development.
  - Apple's iPhone is designed in California, outsourced to Hon Hai Precision Industry in Taiwan and manufactured at Hon Hai's plant in Shanghai, China.
  - The vertical integration system, once the forte of Japanese automakers, has its advantages, but it also has a disadvantage: it lacks flexibility.
- Most models released today were planned 2-3 years ago. This means that it takes about 2-3 years to launch a new car from scratch.
- We are at a turning point; COVID-19, semiconductor shortages & electrification. It is hard to forecast the market 2-3 years from now.
  - OEMs fear the unknown, so many projects tend to be put on hold.
  - Forecasting within a higher risk horizontally-integrated supply chain model makes speculation even harder.

FAR EAST & SE ASIA – ALTERNATIVE ENERGY

- Current focus is on CO2 emissions while driving (Tank to Wheel).
- Impetus to include LCA (Life Cycle Assessment) - which considers comprehensive CO2 emissions during energy generation (Well to Tank) and manufacturing and recycling (Mfg & Rec) – in future regulations is spreading from Europe. Japanese OEMs must respond.
- From this perspective Japan is at a disadvantage.
  - Japan mostly relies on CO2-producing thermal power for electricity.
  - Cars and batteries made in Japan are exported by ships which also emit CO2.
  - Europe uses cleaner energy & is less dependent on ship exports than Japan.
  - This increases the possibility that manufacturing EVs in Japan won't be cost effective, & Japanese OEMs will have to focus on manufacturing EVs overseas.
- MHV electrification is in its infancy. Batteries are the core component.
  - OEMs that can't make their own batteries must source them at higher costs.
  - The key is that all EV OEMs must decide where and how to procure batteries.
  - Conventional vehicle manufacturing wisdom is no longer sufficient.

FAR EAST & SE ASIA – ALTERNATIVE ENERGY

- Hurdles Exist Converting Japanese CVs to EVs.
  - China's BYD EV buses increasingly adopted by Japanese companies.
  - Japanese bus OEMs haven't launched competitively-priced EV buses.
- A key concern for Japanese OEMs is losing sales opportunities because they can't match price, regardless of spec level or performance.
  - Particularly in the case of commercial vehicles where profitability is key, low initial cost is directly related to sales performance.
  - Batteries are still very expensive, and since Japanese OEMs currently cannot manufacture their own batteries, they must purchase them from other companies.
  - On the other hand, BYD is able to procure its own batteries.
  - This is a huge benefit for BYD and a huge challenge facing Japanese OEMs.

FAR EAST & SE ASIA – NEW TECHNOLOGIES

- Fuel Cell Vehicles (FCV)
  - Toyota has superior FCV technology, design and production knowledge to offer its group company, Hino, and its collaborator, Isuzu.
  - Comparing FCVs and EVs we see FCVs are superior in terms of recharging time and cruising range. But this does not equal demand for FCV MHVs.
  - FCVs are unlikely to become popular unless the issue of the difficulties involved in expanding the number of stations is solved.
    - The cost to build a new hydrogen station to produce hydrogen on site or an off-site facility plus the land cost would require 100 years to amortize.
    - To increase the amortization the filling price must be much higher than the current proposed price that is only designed to increase popularity.
    - This business model will not attract investors & the number of hydrogen stations will not increase.
  - The hydrogen station infrastructure is desperately lacking, and building it out will require a great cost. Given these concerns, the conversion of MHVs to FCVs may still be a dream at this point.

CHINA – SEMICONDUCTOR SHORTAGE

- Semiconductor Usage
  - Components to meet China VI emissions standards.
  - Telematics and smart technologies used to monitor vehicles and engines.
  - Components submitted for certification testing must match production.
- Semiconductor Shortage
  - 90% of semiconductors in China branded MHVs are imported (Europe & NA).
  - Meeting demand with locally made semiconductors is difficult
    - Rigid standards, lengthy testing procedures and heavy investment.
    - 3-5 years required to achieve real mass production.
  - We feel that with the implementation of national emission standard China VI in July, the market shortage will be felt most in Q3.
  - It is estimated that with the recovery of chip supply in the fourth quarter, the shortage will be largely alleviated.

CHINA – GOVERNMENT POLICIES

"From the purchasing perspective, government policy is undoubtedly the biggest driving force."

- Infrastructure Stimulus Policies
  - Infrastructure stimulus policies will continue in 2021 and will accompany the gradual recovery of China's economy.
  - The state will maintain stable infrastructure investment, strengthen new urbanization and accelerate major construction & transportation projects.
  - The launch of new national infrastructure projects will act to increase demand for heavy trucks in 2021.
  - New urbanization projects will inevitably bring more market demand for commercial vehicles, especially dump trucks, mixers, etc.
  - High speed railway projects will continue throughout China, not just to carry people, but also to free up lines for railway freight.
    - Some will be dedicated rail freight lines.
    - Over time, expanded rail freight may eventually impact heavy duty truck sales.

CHINA – GOVERNMENT POLICIES

- Elimination of China III Vehicles
  - The replacement of China III emissions-level vehicles has been a key factor in the growth rate of Chinese CV from 2018 through 2020.
  - The target was to replace 1 million China III vehicles by the end of 2020 (the last year for China III vehicle elimination subsidies.)
  - As of now, most regions have only eliminated about 70% of China III vehicles, with 30% yet to be processed.
  - As a result, we still see a huge stock of China III heavy duty diesel trucks.
- Emissions Standards
  - China VI-A will go into effect July 1, 2021.
  - Some big cities such as Being, Shanghai and Guangzhou will skip China VI-A and go straight to China VI-B (Scheduled for 2023).

CHINA – GOVERNMENT POLICIES

- Tractor Trailer Demand Growth Through Policy
  - Tractor trailer demand has now surpassed dump trucks.
  - Strict implementation of GB7258 safety regulations
    - 12 ton+ open trucks must improve brake systems including disc brakes and hydraulic systems
    - This adds US$10K in cost
    - Customers now choose tractors with closed trailers (solid or canvas).
  - Tolls are assessed based on axle count, not truck weight.
  - Since this policy implementation demand for 4 × 2 tractors in the express industry is growing.
- Highway Freight Volume and Freight Rates
  - Road freight growth and logistics demand strengthened heavy truck sales in 2021.
  - An interesting side effect of the pandemic is that national road freight rates did not continue their previous rise, but instead fell.

CHINA – LOGISTICS & NEW ENERGY VEHICLES (NEV)

- Natural Gas Truck Sales Expected to Grow Long Term
  - Vigorous state promotion has expanded adoption of NG-powered MHCV.
  - Fluctuating NG prices & uneven distribution create short-term uncertainty.
  - Environmental policies will increase the NG truck share over the long-term.
  - Expanded NG station networks will increase sales of NG-powered MHCV.
- NEV in Logistics Applications
  - During daily operations and the end of routes, electric logistics vehicle are recharged.
  - Slow development of charging facilities will not be the key factor restricting the promotion of light and medium duty pure electric logistics vehicles.
  - Expanding the charging pile networks will inevitably drive the further development of the heavy-duty logistics vehicle market.

CHINA – LOGISTICS & NEW ENERGY VEHICLES (NEV)

- MHV Electrification – Governments
  - Battery MHVs are found mainly in metro areas as a sign of national promotion by the government.
  - Guangdong Province (Shenzhen), Henan Province (Zhengzhou) and Beijing are the top three regions for electric heavy truck sales in China
  - Electric bus, dump truck and garbage truck adoption is happening fastest in Shenzhen and Beijing.
    - City buses and route vehicle maintenance and operations systems are well established.
  - For many provincial and municipal governments this is still too costly.
  - So far, this adoption is lacking with other municipal electric MHV applications.
- MHV Electrification – Battery Swap
  - MHV battery swap systems and technology is emerging from some OEMs
    - Hualing Heavy Truck is vigorously promoting such technology in dump truck applications
    - This is ideally suited for urban construction sites.

CHINA – LOGISTICS & NEW ENERGY VEHICLES (NEV)

- MHV Electrification Challenges
  - New energy heavy duty sales volumes in 2020 were 48% lower than in 2019.
  - Regardless of the COVID-19 impact, sales would have dropped.
  - New energy heavy truck (mainly pure electric) ranges are too limited.
  - Technological breakthrough is required to overcome battery limitations.
  - Medium and long-distance routes have limited charging piles.
  - Electric heavy duty truck charging is slow, which impacts the bottom line.
  - The price of an electric heavy truck is at least RMB 100,000 (US$ 15,000) higher than a diesel heavy truck with the same horsepower.
  - The primary consideration of heavy truck customers is not environmental protection; it is cost and economics. As a result, some customers lack enthusiasm to buy new energy heavy-duty trucks.
  - Lithium-ion battery safety concerns inhibit some buyers.
    - Thermal runaway during operation causes vehicle fires or accidents.
    - CATL factory explosions in Yunnan (material production) and Hunan (recycling)