

FROST & SULLIVAN

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# **Busworld Academy North America 2020 F&S Market Perspectives**

01

Section



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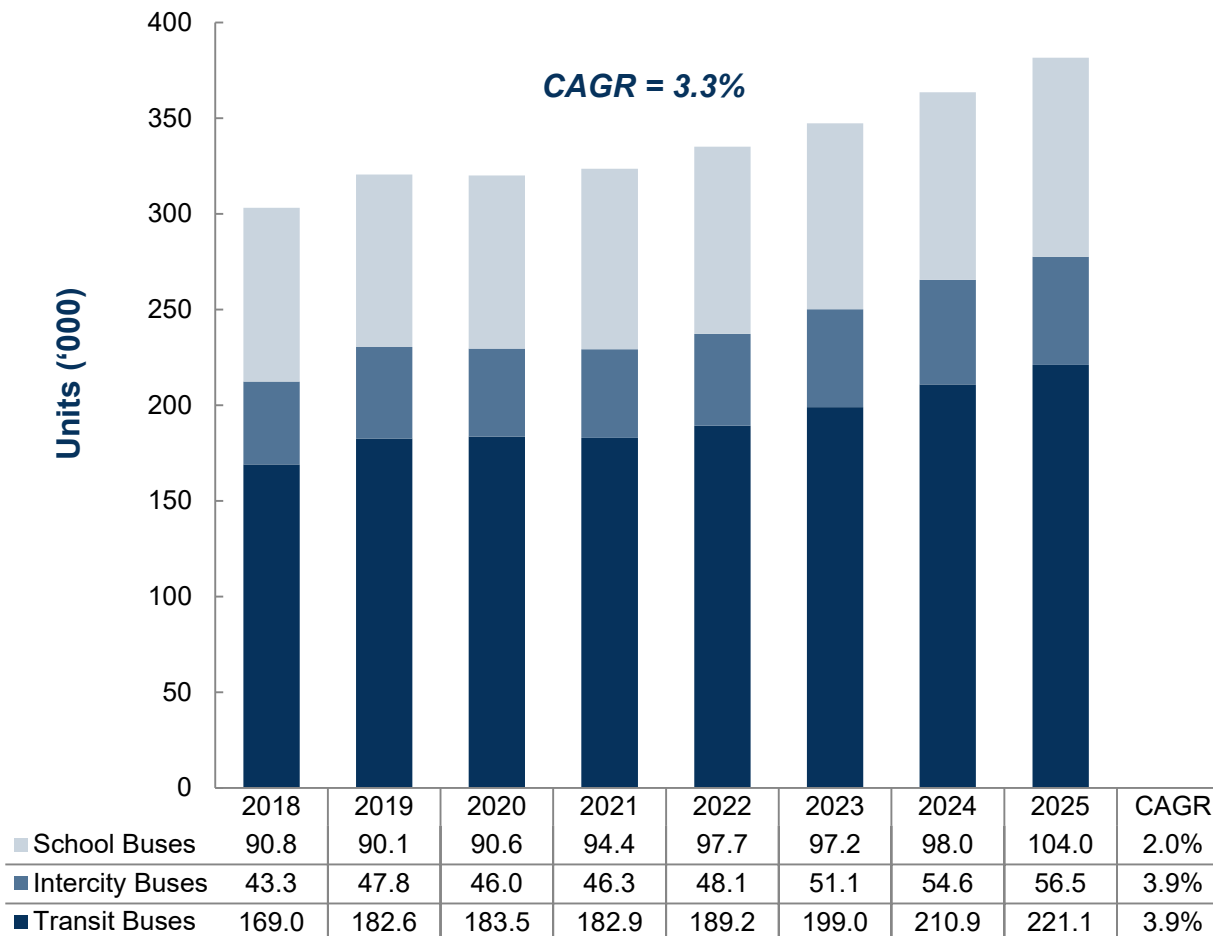
# Global Market Outlook

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# Global Bus Market– Unit Shipment Forecast by Application

Growing urban population and the need for low-cost and convenient urban transportation is the key driver of the market

## Total Transit, School, and Intercity Buses Market: Unit Shipment Forecast by Bus Type, Global, 2018 – 2025



- Transit accounted for 55.8% and intercity buses 14.3% of total bus sales in 2018.
- Improving first/last-mile connectivity, transit oriented development and Apps to drive transit bus market's growth.
- Few countries mandate the use of purpose-built school buses. Share of school buses to drop from 30.0% in 2018 to 27.3% in 2025.
- The total market expected to witness a modest dip in 2020 because of pre-buying in India to beat the BS VI emission standards.

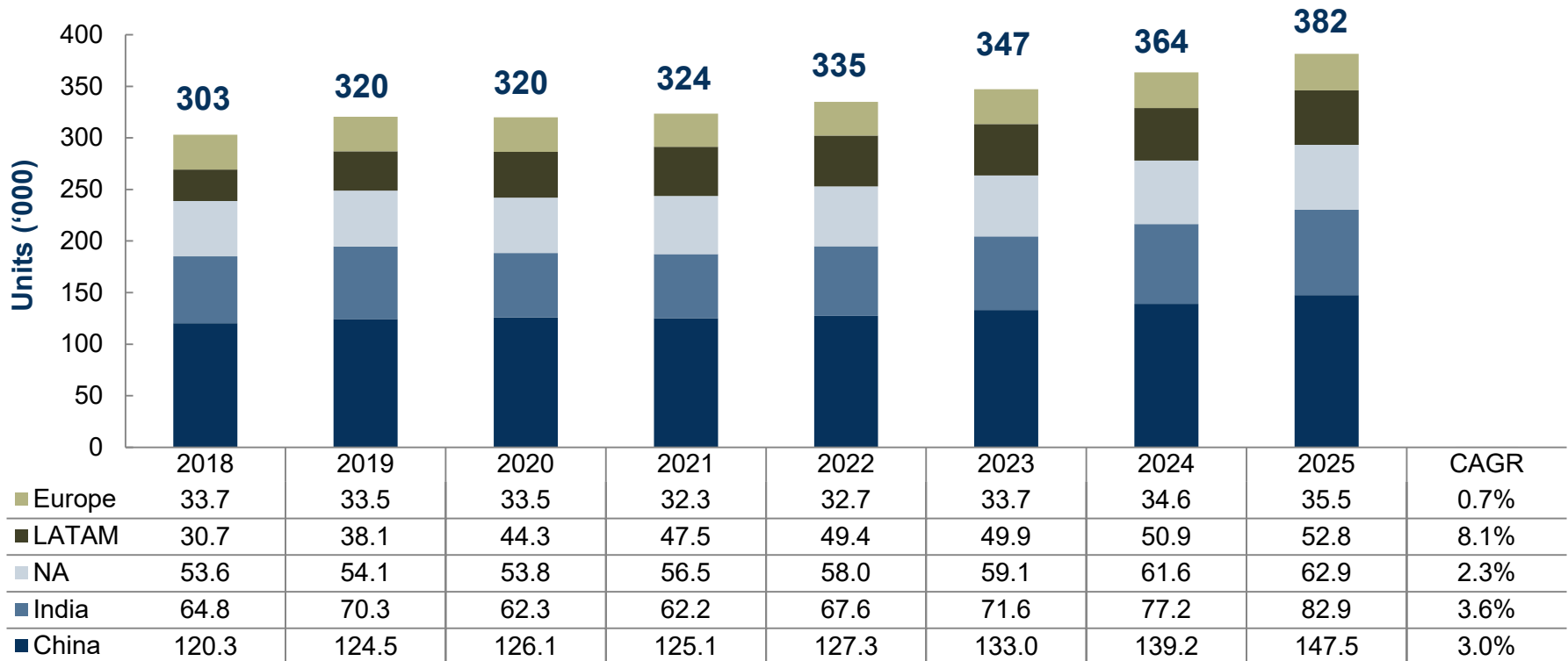
Note: Global includes North America, EU, LATAM, India and China. The base year is 2018 Source: Frost & Sullivan

# Global Buses Market – Unit Shipment Forecast by Region

LATAM, India and China are the key drivers of growth with Europe flattening out and NA trending on a weak growth trajectory.

## Total Transit, School, and Intercity Buses Market: Unit Shipment Forecast by Region, Global, 2018–2025

**CAGR = 3.3%**



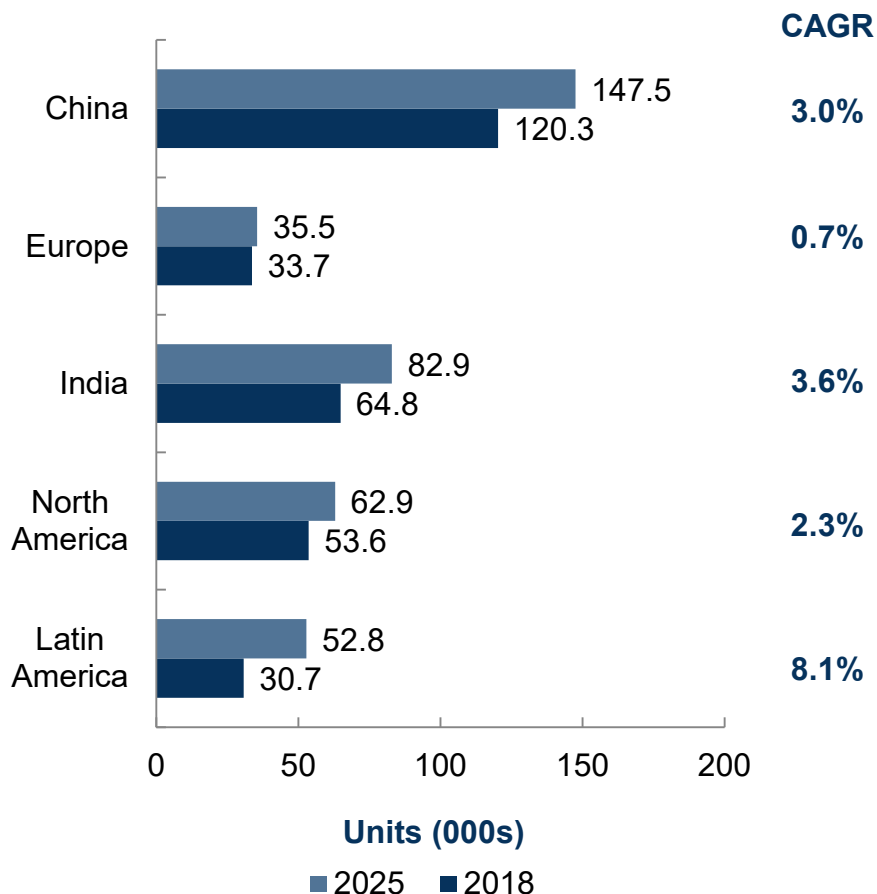
Reflective of a soft global economy with 2019 GDP growth of 2.4%, expected to gradually grow to ~2.7%, bus sales are expected to pickup later in the forecast, in particular with LATAM recovery, India and China continuing to grow at 5.5% to 6.0% with about 2.0% annual growth in urbanization rate.

Note: All figures are rounded. The base year is 2018. Source: Frost & Sullivan

# Global Bus Market —Regional Outlook

The global bus market is highly influenced by China and India the top two market s, particularly for transit and inter-city buses.

**Total Transit, School, and Intercity Bus Market: Unit Shipment by Region, Global, 2018 and 2025**



China bus sales in 2018 included 18% school buses. Transit and intercity buses are experiencing slow-down due to stricter e-bus subsidy qualifications and reduction in subsidy amounts. An urbanization rate of 60% growing at 2.0% pa. offers decent long-term potential.

Europe mostly does not require purpose-built school buses. The European market is expected to experience modest growth overall, with stronger growth in the xEV segment - major OEMs are launching electric buses.

With a low urbanization rate of 34%, growing at 2.4% pa., Indian offers strong long-term potential. 2018 sales included 34% school bus sales. The overall market is expected to experience healthy growth driven by fleet expansion and stricter emission and fuel economy standards

2018 sales in NA included ~80% school buses. With an urbanization rate of 82% and a strong "car culture" NA offers a moderate growth potential. Growth is expected to be strongest in the e-bus segment.

Economic recovery in Latin America, particularly in Brazil, Mexico and Argentina will drive strong bus demand.

Note: All figures are rounded. The base year is 2018. Source: Frost & Sullivan

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Section



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# North America Market Outlook

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# North America Bus Market - Unit Shipment Forecast

The North America bus market remains very dominated in terms of volume by school buses

## North America Bus Market: Unit Shipment (Transit, Intercity, School) Forecast, 2018–2025

### Impact of individualism

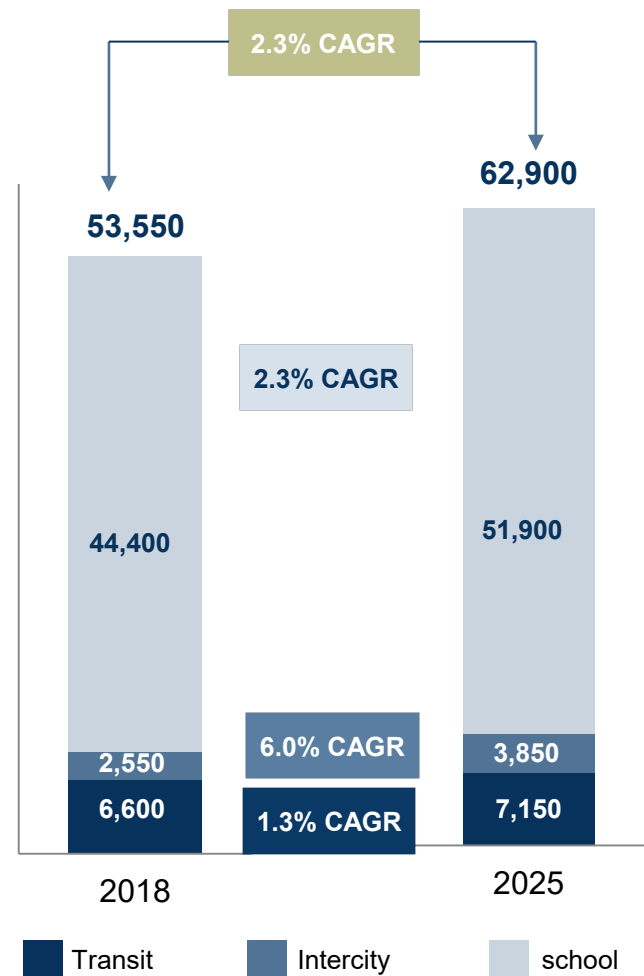
- Despite federal initiatives to accelerate introduction of BRT corridors and foster adoption of e-buses, market size of buses in North America remains small due to a predominantly suburban lifestyle (55% of population lives in suburbs) and “car culture”.

### Importance of school buses

- North America is the largest market for purpose-built school buses. The market is expected to experience a moderate growth driven by fleet modernization supported by EPA’s DERA program providing \$15-20K rebate for old bus replacement.

### Growth of electric buses

- Electric bus adoption is set to increase, particularly in transit application, due to introduction of Phase II GHG regulations, US DoT and CARB grants and incentives for e-buses, and fleet electrification plans of transit agencies.
- Under the Transportation Electrification Action Plan Quebec and Ontario provinces provide incentives for purchase of e-buses and charging infrastructure.

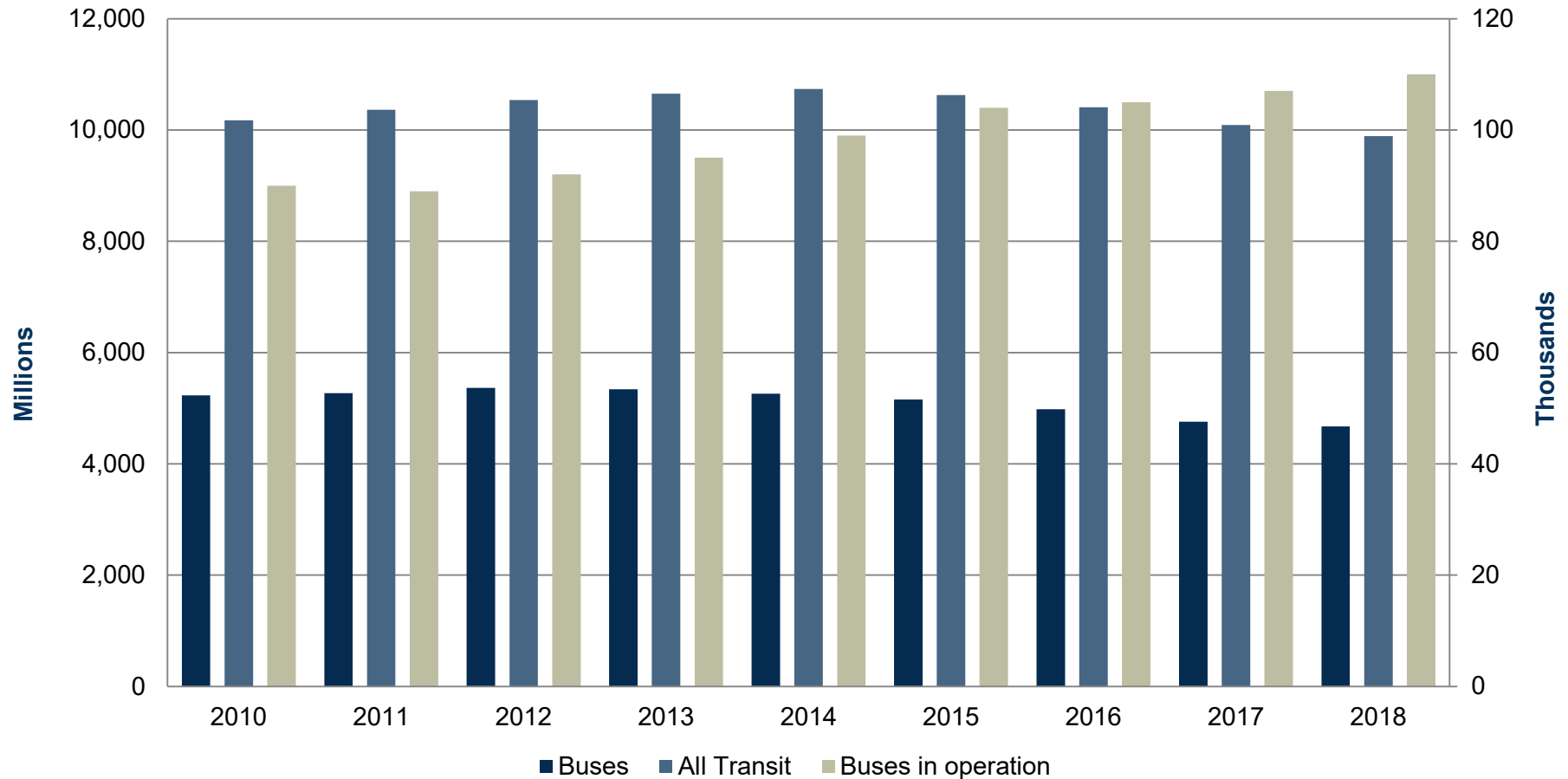


Note: All figures are rounded. The base year is 2018. Source: Frost & Sullivan

## Transit Bus Market – Challenging ridership evolution in the US

Despite the fact that transit bus ridership peaked in 2012 @5.36B rides and has declined since at a 2.2% CAGR, the number of transit buses in operation has kept increasing at 3.0% pace over the period to support service

**Passenger ridership per year – US, Buses vs. All Transit (left scale)**  
**Number of transit buses in operation (right scale)**



Sources: Frost & Sullivan, APTA

# Transit Bus Market – Evolving beyond Traditional Model

Re-evaluation of the mass transit model to keep up and anticipate consumer preferences is key to turn new technologies and sharing-economy from competition to complementary services

## Evolution from transit providers to mobility aggregators (Mobility-as-a-Service) key to regain ridership

### From initial competition ,,,

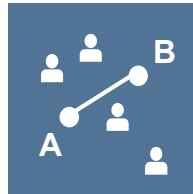
In an initial stage, new mobility solutions have been a source of erosion of traditional ridership

### ... to turning a challenge into an opportunity

Data, technologies, and new business models or platforms offer opportunities for enhancing and redefining mobility

Generational shift favorable to innovation - embracing multi-modal transit options, and providing new customer base

- 74% of millennials would use a multi-transit app\*



#### End-to-end service / Last-Mile Connectivity

- Acquisition and analysis of data allow to find out where and when people want and need to travel
- Specialized service cater specific times, locations, with integration and planning of extensions



#### Optimized schedules: flexibility and convenience

- Dynamic optimization combining predetermined schedules and real-time traffic conditions allow to offer optimal solutions around the clock



#### User-friendliness and cost-efficiency

- Trip design, coordination, and multi-modal payment directly managed through app
- Multiple choices allow passengers to select alternatives suiting best preferences and needs



#### Efficiency




- Complementation reinforces public transportation as the backbone of mobility offering energy and space efficiency for reduced footprint

\* APTA Survey, 2018

Source: Frost & Sullivan

# Key Electric Bus Use Cases

## Electric Bus Market: Use Case for Electric Bus

Application	Daily Operating miles	Operating Environment / Driving Characteristics	Premium over Diesel	Charging and Hydrogen Infrastructure	Use Case to Electrify	Comments
<b>Transit Bus</b> 	150–250	Urban Short hops, lot of transient state driving	\$250-600 k	Charging infrastructure and fuel-cell station largely located within depot and en-route through Opp-charge.	BEV: Moderate FCEV: Weak	<ul style="list-style-type: none"> <li>Intra city bus travelling within city limits in fixed routes to and fro points.</li> <li>Moderate payload, moderate daily kms and driving mostly in transient state in urban environment makes for a strong use case.</li> </ul>
<b>Coach</b> 	200–600	Semi-Urban, Inter-city Mostly cruise mode with little transit state driving	\$400-600 k	Would require charging facilities outside city limits and highways. Fuel-cell stations at fleet compounds at end of trips.	BEV: Weak FCEV: Moderate	<ul style="list-style-type: none"> <li>Buses used for inter-city travel mainly on highways between distant cities.</li> <li>Moderate payload, high daily kms and driving mostly in steady-state makes for a weak use case.</li> </ul>
<b>School Bus</b> 	25-75	Urban Semi-Urban, Rural Short hops, lot of transient state driving	\$120 k	Charging infrastructure and fuel-cell station largely located within depot and en-route through Opp-charge	BEV: Moderate FCEV: Weak	<ul style="list-style-type: none"> <li>School bus normally have fixed routes with pick-up/drop points.</li> <li>Driving limited to once in the morning and in the evening</li> </ul>

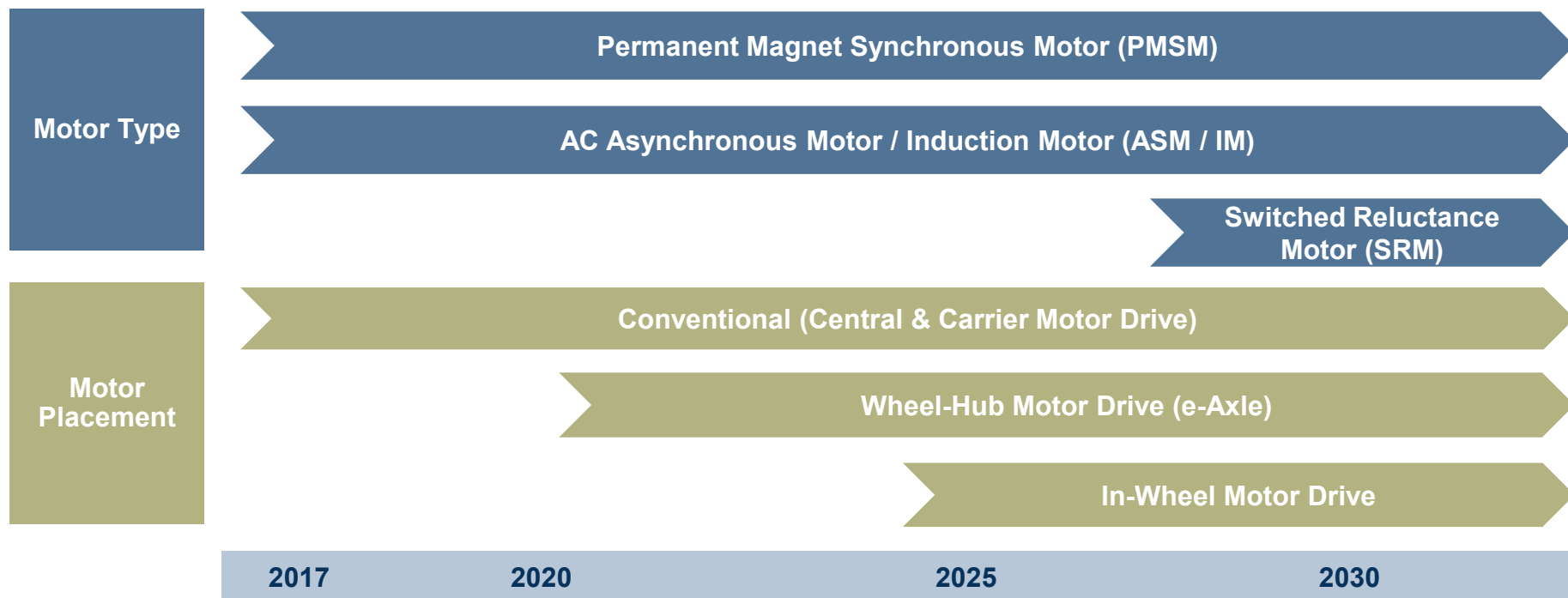
\* (stopping/ acceleration/ deceleration)

Source: Frost & Sullivan

# Electric Motor Roadmap

Improving power density and efficiency as well as reducing cost are key areas of innovation. Minimizing the use of expensive rare earth magnets whose supply chain is concentrated in China is another priority

## Electric Bus Market: Electric Motor Technology Roadmap, Global, 2017-2030



- Efficiency of motors is gaining prominence as increasing operating life and reducing energy consumption becomes a priority. Simultaneously, costs are poised to drop through innovation and scale.
- In the next five years, motor manufacturers are expected to reduce their dependence on permanent magnets that rely on rare earth elements and gradually migrate towards ASM and, after 10 years, towards SRM.

Source: Frost & Sullivan

# Future of Battery Chemistries

Lithium-based NMC and LFP are expected to continue to be the go-to battery chemistries and Lithium Sulfur is likely to be the next major battery chemistry to be introduced for commercial applications post 2022.

## Total EV Market: Future Battery Chemistries in EVs—Technology Roadmap, Global, 2017-2030

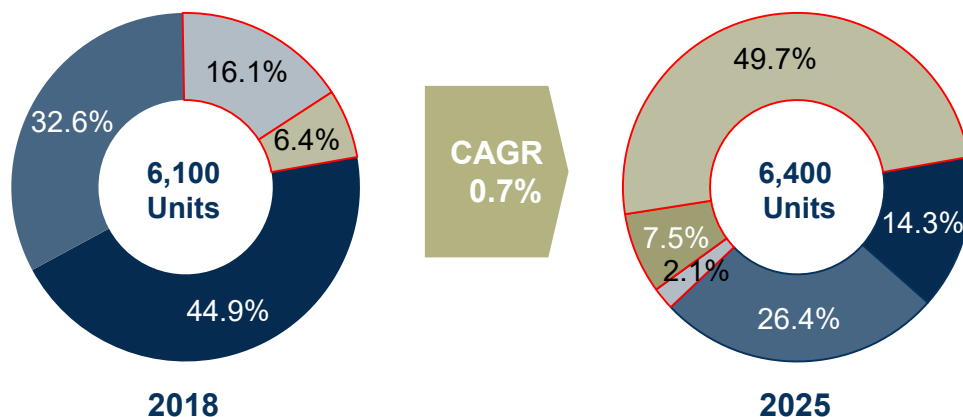
		2017	2020	2025	2030
Li-ion (LFP, LMO, & NMC)	Energy Density	110-220 Wh/kg		> 300 Wh/kg	
	Pack Cost	\$500>>>\$150/kWh		\$150>>>\$80/ kWh	
	Lifecycle	700-1,500 cycles		> 1,500 cycles	
Lithium Titanate Oxide	Energy Density	30-80 Wh/kg		> 150 Wh/kg	
	Pack Cost	\$1000>>>\$400/kWh		\$400>>>\$140/kWh	
	Lifecycle	3,000 cycles		~ 7,000 cycles	
Lithium Sulfur	Energy Density			500-600 Wh/kg (theoretical)	400 Wh/kg (practical)
	Pack Cost			\$500-\$350/ kWh	\$350-\$150/ kWh
	Lifecycle			500-1,000 cycles	> 1,500 cycles
Solid State Li	Energy Density			400 Wh/L	600 Wh/L
	Pack Cost			\$500-\$400/kWh	\$250-\$150/kWh
	Lifecycle			> 10,000 cycles	

Source: Frost & Sullivan

# North America Transit Bus Market - Sales and Powertrain Forecast

Due to flexibility, Medium Duty growth will outpace that of Heavy Duty, but the segment will remain limited; the main change is the development of xEV to the expense of Diesel, and even NG

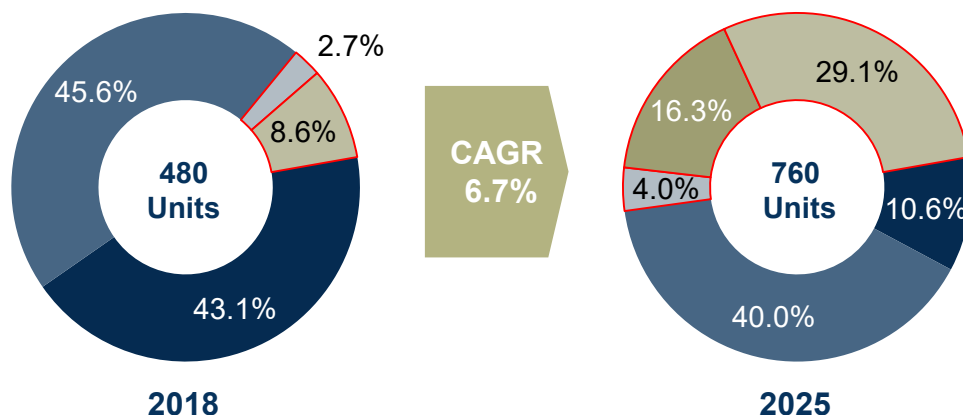
## HD Transit Bus and Powertrain Forecast, North America, 2018 and 2025



Diesel and natural gas buses currently make up more than 90% of the market

- by 2025, Diesel will recede considerably as BEVs prices will fall to \$600,000 range

## MD Transit Bus and Powertrain Forecast, North America, 2018 and 2025



xEV adoption set to increase due to strict emission regulations in urban and semi-urban areas

- MD xEV will be particularly price- and TCO-competitive due to smaller batteries

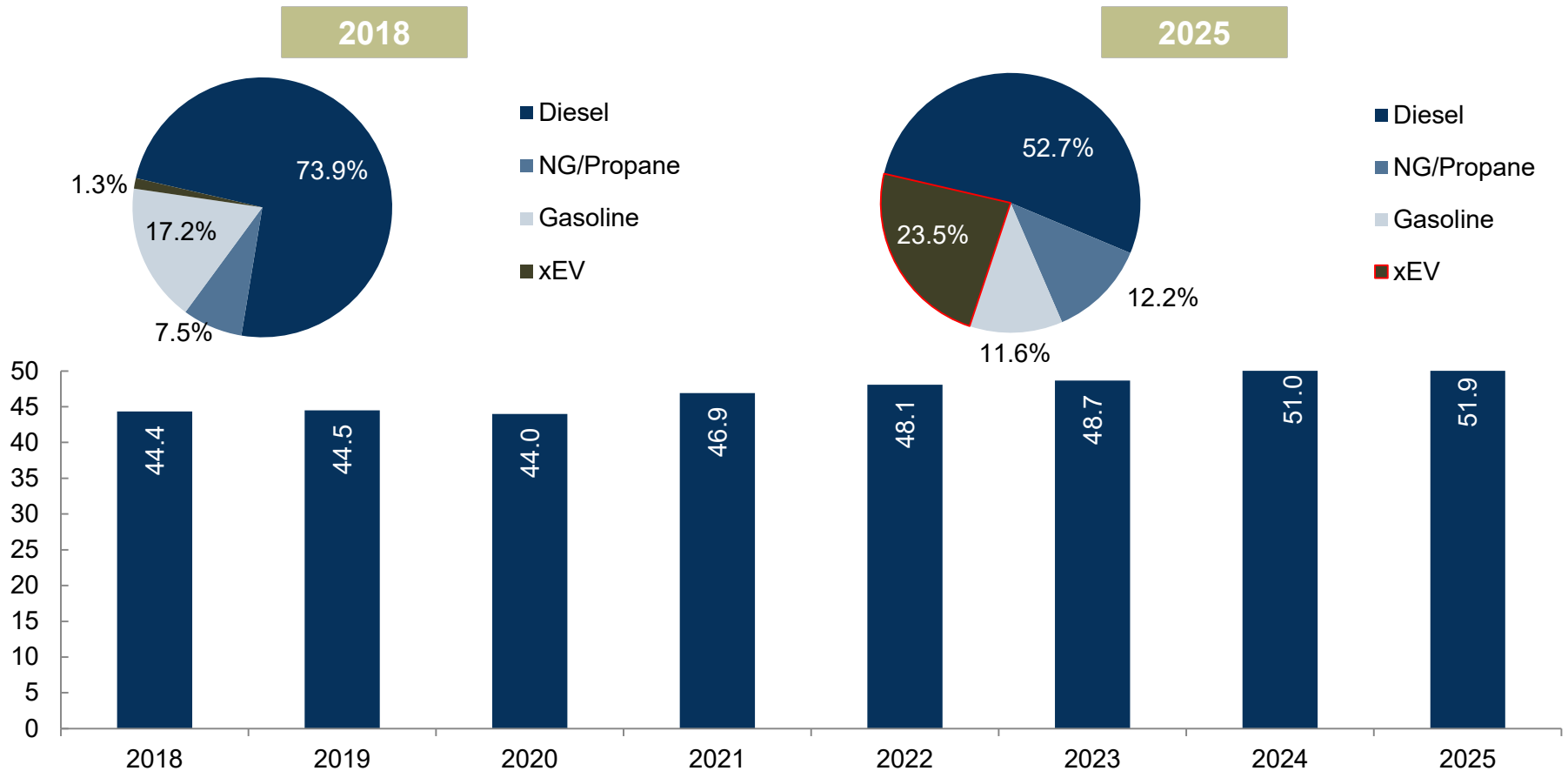
■ Diesel   ■ NG   ■ HEV   ■ FCEV   ■ BEV

Note: The base year is 2018. Source: Frost & Sullivan

# School Bus Market Forecast – US and Canada

North America will be adopting electric buses from 2020 onwards, but Diesel will remain the dominant powertrain

## School Bus Market: US and Canada Technology, projection till 2025 (thousand)



Lower mileage (10-14k miles per year) makes the shift to xEV less critical for school buses than for transit buses, while extra capital requirements putting a strain on tight budgets slows down adoption

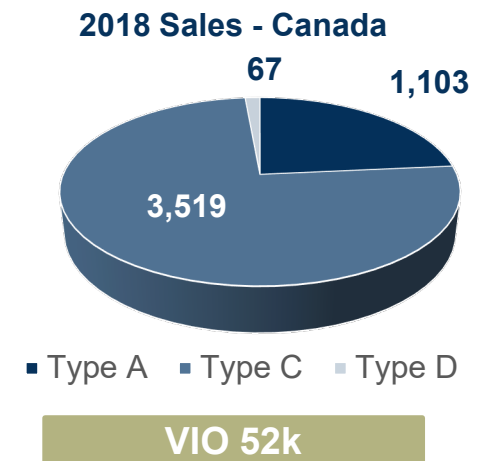
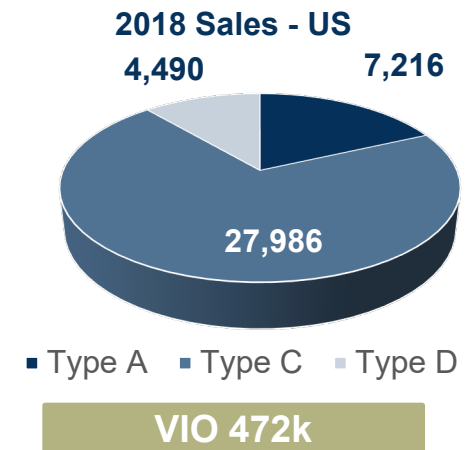
Source: Frost & Sullivan

# School Bus Market – US and Canada

The School Bus market has grown at a 4.5% CAGR from 2010 and 2018 in North America; type C is the dominant segment with 71% of the sales

## School Buses – New Buses Sales US and Canada 2018

Classification	Design
<b>Type A School Buses</b>	<ul style="list-style-type: none"> <li>• Van conversion or bus constructed on cutaway front section</li> <li>• Accommodate between <b>15 and 30</b> passengers</li> <li>• Widely used to transport neighborhood school students</li> </ul>
<b>Type C School Buses</b>	<ul style="list-style-type: none"> <li>• Conventional school buses</li> <li>• Entrance door behind front wheels</li> <li>• Often installed upon flat-back cowl chassis</li> <li>• Accommodate <b>35 to 72</b> passengers</li> </ul>
<b>Type D School Buses</b>	<ul style="list-style-type: none"> <li>• Designed like a transit bus with flat front</li> <li>• Entrance in front of wheels</li> <li>• Largest bus type built to accommodate more than <b>90</b> passengers</li> </ul>

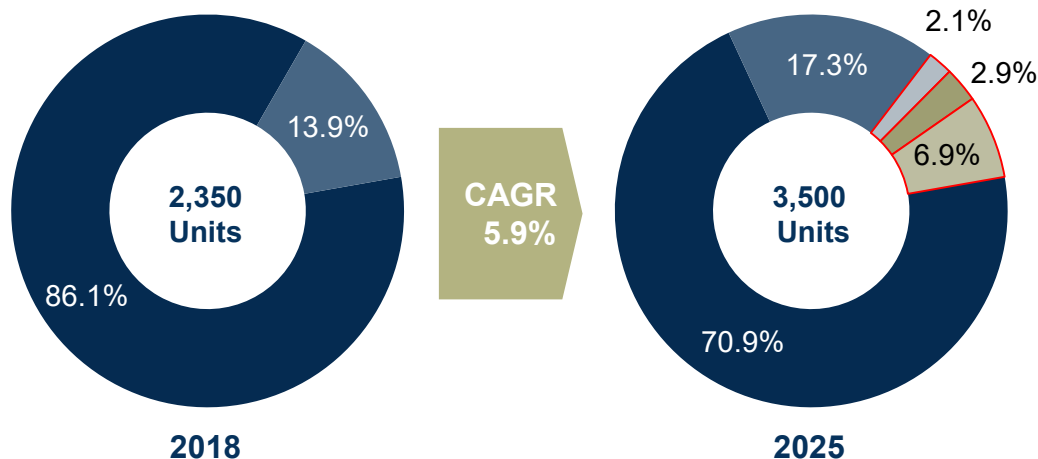


Sources: Frost & Sullivan, School Bus Fleet

# Intercity Bus Market - Sales and Powertrain Forecast

New services / stratified offer, addition of routes, complementation to rail / air, dynamic pricing and use of tech platform support the development of the market

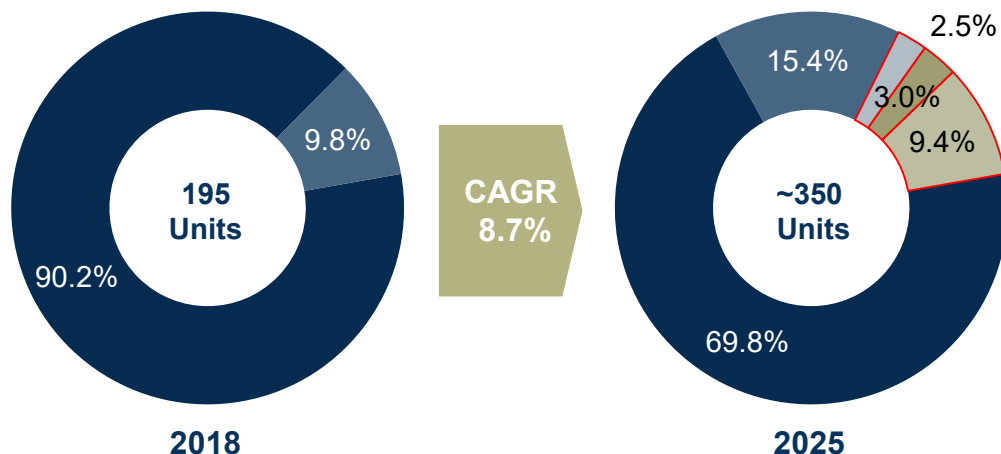
## HD Intercity Bus and Powertrain Forecast



Fuel cell electric buses will see introduction / testing starting in 2020, building upon growing FCEV interest from HD trucks to cars:

- All major OEMs can be expected to launch FCEV coaches by 2020.

## MD Intercity Bus and Powertrain Forecast



Adoption of xEV coaches will be lower than transit buses, in particular for BEV owing to longer charging time required to meet higher duty cycle

- Advent of mega chargers with 1MW will help overcome this challenge in HD intercity buses

■ Diesel ■ NG ■ HEV ■ FCEV ■ BEV

Note: All figures are rounded. The base year is 2018. Source: Frost & Sullivan

03

Section



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# Demand-Responsive Transit (DRT) Outlook

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# Evolution of Public Bus Transit Systems

Mass transit transport systems, among the most important, have evolved continuously, primarily to make themselves more efficient, effective, and economical, with better utilization of time and resources.

## Demand-Responsive Shuttle Market: Evolution of Public Transit, Global, 1833–2018

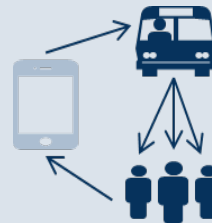
### Traditional Bus Transport



### Bus Rapid Transit System (BRT/ BRTS)



### Demand-Responsive Transit



### Autonomous & Electric Buses



1833 – Present

1980 – Present

2013 – Present

2015 – Present

Source: Frost & Sullivan

## DRT Use Cases

Majority of the DRT operators cater only to commuters at present. As the market matures, there will be additional use cases.

### Demand-Responsive Shuttle Market: Use Cases, Global

<b>Leisure Activities Like Shopping</b>	<ul style="list-style-type: none"><li>• Services linking supermarkets and shopping centers that are not well serviced by public transport.</li><li>• DRT services can be offered on a pre-determined schedule at fixed dates and times.</li></ul>
<b>Airport Transfers</b>	<ul style="list-style-type: none"><li>• Many small cities lack the service scale to support a comprehensive transport ecosystem. This gap in the market makes traveling to the nearest major airport difficult.</li><li>• DRT service offers an efficient alternative for airport transfers by operating on fixed pre-determined routes.</li></ul>
<b>Commuter Services</b>	<ul style="list-style-type: none"><li>• Commuters are increasingly using rail services to commute to work. This is placing pressure on car parking spaces in railway stations.</li><li>• DRT services can act as feeders to existing public transport, especially rail services. Services can be offered at fixed schedules to connect commuters to pre-determined train services.</li></ul>
<b>Intra-city Travel</b>	<ul style="list-style-type: none"><li>• Traveling occasionally for leisure (specifically for sport events, concerts, exhibitions etc.) is a market that is not exclusively serviced by public transport.</li><li>• There is a huge opportunity for DRT service providers to offer services on crowd-sourced routes on specific days of the events.</li></ul>
<b>Corporate Shuttles</b>	<ul style="list-style-type: none"><li>• Companies are looking to offer alternative mobility services that are cost effective and sustainable for their employees.</li><li>• DRT can offer services specifically catering to individual companies. Companies would have to pay for their employees' transportation to and from their homes, transit hubs, and the office.</li></ul>
<b>Late Night Transportation</b>	<ul style="list-style-type: none"><li>• Access to public transportation during late-night hours can be limited. In-addition, hailing taxis during those hours would be very expensive.</li><li>• DRT providers can operate between 11 p.m. to 4 a.m. to service this gap in the market.</li></ul>
<b>Rural Hopper</b>	<ul style="list-style-type: none"><li>• Rural areas are not sufficiently served by public transport as they generate low demand and as they are geographically scattered.</li><li>• DRT services can be offered to link rural settlements to city centers.</li></ul>

Source: Frost & Sullivan

# Demand-Responsive Shuttles—Market Size Overview

Europe and APAC are the two largest markets for demand-responsive shuttles.

## Demand-Responsive Shuttle Market: Market Overview, Global, 2018

### Europe

**Total Number of Shuttles:**

20.6K

**Total Number of Rides/Year:**

320 Mn

**Market Revenue:**

\$2.61 billion

Europe is expected to be the key market driving the growth for DRT.

### North America

**Total Number of Shuttles:**

370

**Total Number of Rides/Year:**

10 Mn

**Market Revenue:**

\$0.02 billion

NA offers robust growth potential as shared modes of mobility gain increasing acceptance.

### APAC

**Total Number of Shuttles:**

2930

**Total Number of Rides/Year:**

28 Mn

**Market Revenue:**

\$0.10 billion

DRT currently act as a substitute to public transport in high-density areas.

### LATAM

**Total Number of Shuttles:**

60

**Total Number of Rides/Year:**

0.5 Mn

**Market Revenue:**

\$0.01 billion

DRT services are currently relatively nonexistent, with less than five players operating.

### Africa

**Total Number of Shuttles:**

70

**Total Number of Rides/Year:**

0.7 Mn

**Market Revenue:**

\$4.0 million

DRT is still a nascent concept in Africa.

Source: Frost & Sullivan

# Demand Responsive Transit—2030 Outlook of Key Regions

Europe, North America, and Asia Pacific are expected to be the hotbeds with DRT complementary to public transit in the developed markets and substitute public transit in the emerging markets.

## Demand-Responsive Shuttle Market: Fleet Size and Total Number of Rides, Key Regions, 2018 and 2030

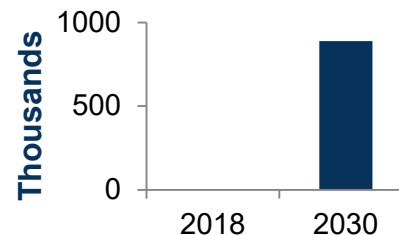


### North America

NA is the region with maximum participation of public transit authorities seeking to convert low-density routes into demand-responsive shuttle routes.

The shuttle fleet is expected to grow at a CAGR of 82% over 2018–2030, on the backdrop of increased acceptance of shared modes of mobility.

Total number of DRT Shuttles



North America-  
Revenue 2030-  
\$91.83 billion

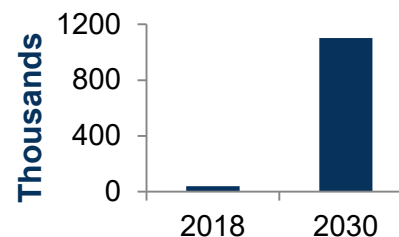
DRT Shuttles 2030  
-889,775  
Number of rides per  
year in 2030-19.97



### Europe

Europe is expected to be a key market for demand-responsive shuttles. Growth is linked to both increase of the number of short-distance demand-responsive shuttle service providers and long-distance demand-responsive shuttle service providers,

Total number of DRT Shuttles



Europe  
Revenue 2030-\$230.49  
billion

DRT Shuttles 2030  
-1,102,818  
Number of rides per  
year in 2030-24.76

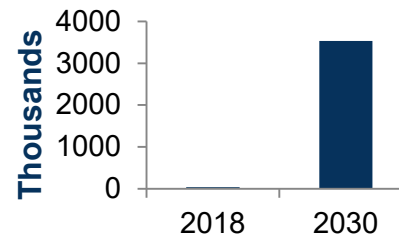


### Asia Pacific

Asia Pacific market is expected to grow moderately as South and Southeast Asia are highly densely populated where fixed route models work efficiently.

While demand-responsive shuttles currently act as substitutes to public transport, they are expected to reorganize in the long term, limiting shared mobility, ridesharing and taxi sharing to short distances

Total number of DRT Shuttles



Asia Pacific  
Revenue 2030-\$195.33  
billion

DRT Shuttles 2030  
-3,534,937  
Number of rides per  
year in 2030-43.6

Source: Frost & Sullivan

*Thank you!*

