propulsion Québec

Review of business models, valuation methods and market opportunities in the electric and smart transportation sector

SECTION 2

January 2023

Desjardins bdc CDPQ MKB MACKINNON, BENNETT & CO.

MAIN PARTNERS

Desjardins

bdc

CDPQ

MAJOR PARTNERS

GREATER MONTREAL CLIMATE FUND

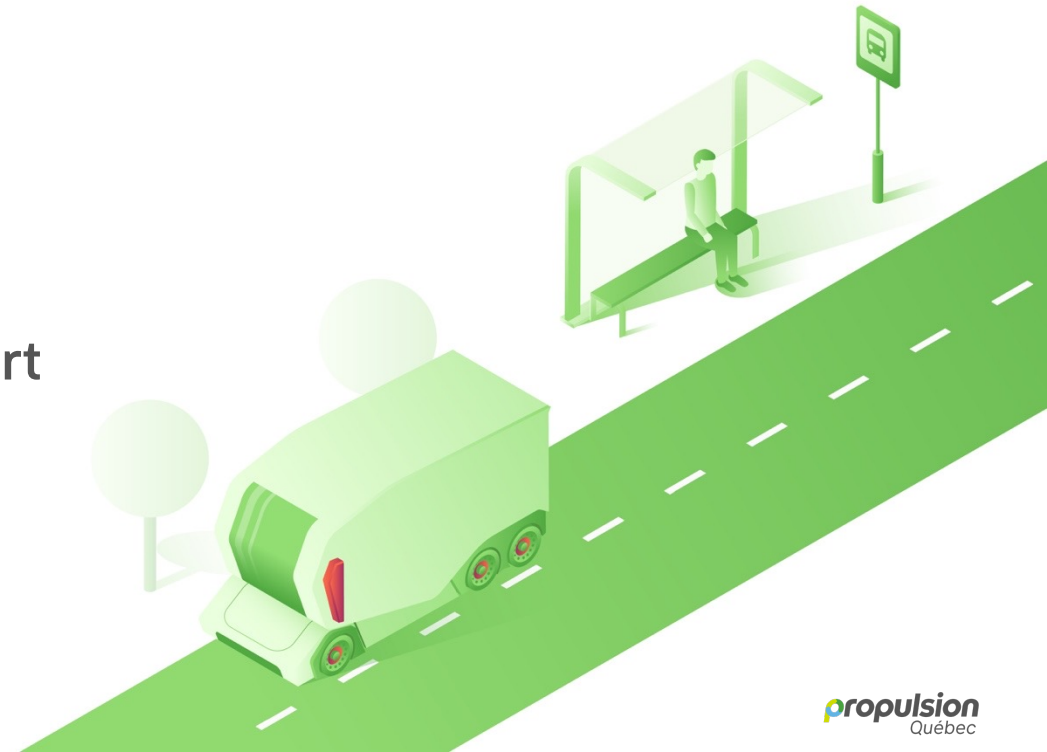
Fondaction
Giving money meaning.

MKB MACKINNON, BENNETT & CO.

D I A

G R A M

TABLE OF CONTENTS



Overview of the Mandate and of This Study

- Ernst & Young LLP (EY) was hired by Propulsion Québec to analyze various business models commonly used in the electric and smart transportation (EST) sector, as well as the valuations associated with these models (Section 2). EY's mandate also included analyzing several promising EST sector markets in Quebec (Section 3), and producing an investor presentation guide for entrepreneurs/executives wishing to raise capital in these markets (Section 4).
- Propulsion Québec launched this mandate to follow up on a forecast study of the funding chain in Quebec's EST sector and to achieve the objectives presented in the Ambition EST 2030 plan (links here). Its intent was also to raise the visibility of the sector and its companies, to facilitate and increase investments at various stages of business development, and to make Quebec's EST sector attractive to investors by promoting a virtuous cycle of growth for Quebec businesses and the ecosystem.
- Based on these objectives, Propulsion Québec identified three levers as the core objectives of the EY mandate:
    1. Build institutional and specialized investor interest and expertise in the EST sector;
    2. Develop the business case and make the EST sector more attractive in Quebec in order to showcase the strengths and aspirations of the ecosystem;
    3. Help incubators and accelerators better support EST companies and strengthen financial literacy, risk management and the market approach of these companies.
- In addition to other projects carried out concurrently by Propulsion Québec, this mandate could be used to make presentations to the government, to position Quebec with foreign investors, or to attract expertise that complements the Quebec EST value chain.

1

HARDWARE MODEL

Hardware

1.1 Main Characteristics of the Business Model

MAIN EST SUBSECTORS AFFECTED BY THE MODEL

Design and manufacture of ZEVs

Manufacture of charging equipment and infrastructure

Manufacture and assembly of batteries

Manufacture of ADAS components

MAIN LEVERS OF VALUE CREATION

To analyze the possible strategic approaches to a hardware model, three operational layers must be considered:

1. **Implementing production**
   - **Internal**: the company takes over the production process (manufacturing, assembly) and controls the parameters related to these activities
   - **Outsourcing**: the company decides to outsource the production process and focuses mainly on design and development activities
2. **Ownership of infrastructure and production equipment**
   - **Ownership**: the company owns the infrastructure (building, land, etc.) and equipment (machinery, etc.), which are recorded in its balance sheet
   - **Leasing**: the company does not directly own the assets it operates, but pays a fixed-term user fee to a third party that owns the assets
3. **Managing commercialization**
   - **Internal**: the company has its own sales team in charge of product commercialization
   - **Outsourcing**: the commercial strength of the company is mainly based on a network of distributors, which may or may not be exclusive

MAIN LEVERS OF VALUE CREATION

PRODUCT

- Ability to safely integrate various innovative expertise
- Ability to anticipate the R&D roadmap and ensure the relevance of the product/solution at the time of its commercialization

OPERATIONS

- Ability to expand operations quickly, smoothly and efficiently once initial R&D and prototype development activities are fully established
  - ✓ Successfully transition from prototype to full-scale production
  - ✓ "*Welcome to production hell*" (Elon Musk)
- Ability to effectively marshal and optimize the entire supply chain (e.g. modular approach to production, application of lean management concepts, etc.)

COMMERCIALIZATION

- Ability to quickly persuade ambassadors or early adopters about the relevance of the product/solution in order to give instant credibility to the brand/product
- Ability to set up the appropriate sales channels for the product

Hardware

1.2 Revenue Models and Cost Structure

Traditional revenue model

- The traditional revenue model for most hardware-based business models rests on the principle of one and done, that is, a one-time sale of a product with no other associated revenues, whether at the time of the sale itself or in the future.

Feature of the EST sector: combining hardware and software

- With the increasing digitization of activities and the evolution of mobility, the hardware products of EST companies are increasingly inseparable from software (proprietary or not). There are two major types of approaches:
  - Software is the enabler, allowing the product to function properly. The company's value depends primarily on the hardware itself, more than on the software.
  - The company deliberately puts its software solution at the core of its value proposition, resulting in companies with a hybrid business model (*see below*).

Observed trends and hybrid models

- Companies are gradually moving away from the traditional hardware revenue model. Their objective is to diversify revenue streams around the base product, while generating recurring revenues over the long term. As a result, more and more companies are pivoting their revenue models to hybrid models such as:
  - **Hardware-as-a-Service**: customers pay for the service provided by the hardware, rather than for the product itself. The hardware can only be used if the customer pays for the service(s) (e.g. Dcbel).
  - H**ardware-Enabled-Service**: involves the sale of a hardware that enables activation and sales of optional additional features/services. Similar to the previous model, except that the hardware can be used without subscribing to the proposed service(s) (e.g. Tesla).
  - **Hardware-as-a-Platform**: involves the sale of a hardware, which is then used as a platform for other third-party services/applications to operate and for which the company charges fees (to the third party and/or user) (e.g. charging stations and advertising).
    - A variant of this model is the Vehicle-as-a-Platform, where the vehicle serves as a platform to enable other services/applications and can be monetized.

Cost structure

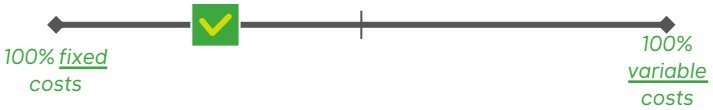
Top 3 cost centres

3 — *Cost of goods sold - Inventory*

2 — *Equipment / Production machinery*

1 — *Industrial infrastructure*

Proportion coûts fixes vs. Coûts variables



Rigidity of the cost structure

- Very rigid cost structure, with large upfront investments to build production capacity
- Inventory management is key to not affecting (too much) the company's cash flow

Potential for economies of scale

- Very high potential for economies of scale, once initial investments are fulfilled
- The success of the company depends on its ability to maximize its means of production

Hardware

1.2 Revenue Models and Cost Structure (cont.)

Other observed models

- Asset leasing (e.g. battery, vehicle, etc.): the manufacturer leases the asset to its customers, rather than selling it, and also charges for turnkey operation and maintenance services. In the field of electric batteries, this model is generally called Energy-as-a-Service (e.g. UgoWork).
    - A derivative model called *asset swap* is used especially for batteries (battery swapping); the battery manufacturer allows the user to charge the vehicle by replacing the used battery with one that is fully charged.
    - The manufacturer can generally charge for these rental services through two main mechanisms:
        - A subscription to the customer, who may use the asset for a period of time or a number of times over a specific time period.
        - Billing based on the amount consumed (pay-per-use) of energy, mileage, etc.
        - The market is also noted to have hybrid models combining both approaches.
- Vehicle conversion: customers are charged for costs of engineering, manufacturing, assembly, etc. related to the conversion of a combustion vehicle into an electric vehicle (e.g. Ecotuned).

Note : *Voir page suivante pour licences (licensing) et monétisation de données (data monetization)*

Hardware

1.3 Licensing and Data Monetization Revenue Models

- In addition to the hardware revenue models presented on the previous page, some companies in the IoT sector are choosing to monetize their activities via a licensing model and/or by monetizing data.

HARDWARE LICENSING MODEL

What is it?

- The hardware licensing model primarily involves the sale, to a third party, of a right to use proprietary technology and related industrial processes for the manufacture and assembly of a product (e.g. Lithion, Proterra).
- Some technologies and processes are sometimes too complex to be personalized to the needs of each customer. This can motivate companies to offer licenses associated with their technology, so customers implement the technology themselves and then tailor it to their needs.
- This hardware licensing model could be called "technology-as-a-service."

Revenue streams linked to the hardware licensing model

- There are many revenue streams, including:
  - Royalties for the time the technology is used
  - Payment of royalties per unit produced by the technology
  - Support for adoption/learning/modification of the technology and industrial processes (engineering support)
  - Sale of certain equipment/components
  - Maintenance fees
  - Technology upgrades

HARDWARE DATA MONETIZATION MODEL

What is it?

- Hardware data monetization takes the following form:
  - The company collects data via sensors and software installed in its product. The data collected is initially for internal purposes (maintenance, performance monitoring, etc.).
  - The data collected may also be used for other purposes and monetized by the customer/user. It is then processed and analyzed by the company, which then allows it to understand how the customer/user can optimize the use of the hardware and its operations more fully.
- This revenue model alone is limited or non-existent in the mobility sector, especially among hardware-based companies. Data monetization is generally a good complement to other revenue streams and can be viewed by investors as an element to mitigate the risks in other aspects of the business model.
- It's also important to note that hardware data is only sold between the manufacturer and the user/customer. The sale of data to third parties is generally prohibited for hardware, primarily due to reasons of privacy.

Revenue streams

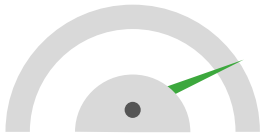
- Sale of raw data collected through hardware (very uncommon in mobility due to lack of added value)
- Sale of processed and analyzed data collected through hardware (e.g. UgoWork -> The company can inform their customers about the performance, effective utilization rate, etc. of its vehicles thanks to the UgoWork batteries installed in its vehicles. This allows the customer to optimize its operations.
- Share of savings/gains achieved through data analysis

Hardware

1.4 Understanding the Business Model

OPERATIONS

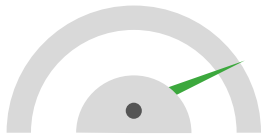
A. i. Degree of complexity in expanding operations



High

- Transition to highly complex mass production
- Requires expertise and experience
- Learning curve required

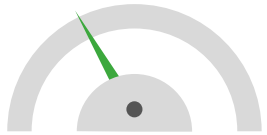
A. ii. Verticalization potential



High

- Natural tendency of hardware companies to want to develop upstream or downstream of their value chain to create value

A. iii. Horizontalization potential



Low to moderate

- Involves some complexity to develop a product relevant to several sectors/markets at once

COMMERCIALIZATION

B. i. Length of development cycle

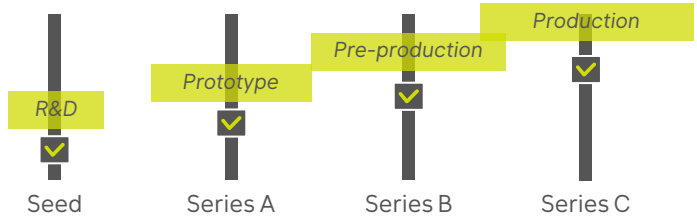
Short	Moderate	Long
		X

B. ii. Complexity of exporting out of the initial market

Low	Moderate	High
		X

- Complexity in setting up appropriate sales channels and heavy dependence on distributors
- Regulation/certification may restrict penetration into new markets

B. iii. Stage of development expected for each funding round



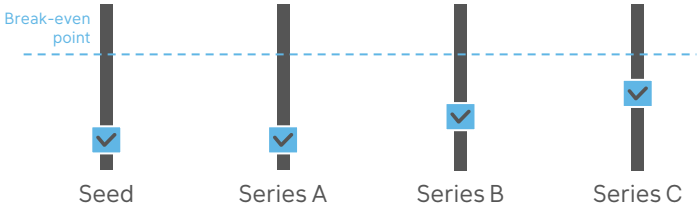
PROFITABILITY

C. i. Typical time frame for analysis

Less than 5 years	5 to 7 years	7 to 10 years
		X

- Analyzes the entire business development cycle
- Shows early years of profitability (or near break-even point)

C. ii. Expected level of profitability per round



C. iii. Time needed to reach break-even point

0 to 2 years	2 to 5 years	Over 7 years
		X

- Important to let the company focus on its development in the first 5 years, without increased pressure to generate profitability

Hardware

1.5 Milestones for Creating Value and Reducing Investment Risk

	BASIC IDEA AND CONCEPT	PROTOTYPES	PRE-PRODUCTION	PRODUCTION	*EXPANSION*
Industrial milestones	• Identification of market needs and definition of the proposed solution • Formulation and development of technology	• Virtual prototype/3D mock-up • Functional physical prototype • Physical prototype validated and safe	• Real-life validation of the product/solution • Initial development of production processes	• Industrialization of manufacturing processes • Start of production • Estimation of expected/potential economies of scale	• Increased production rate and optimization of manufacturing processes • Diversification of activities (verticalization, horizontalization)
Commercial milestones	• n/a	• Certification in the initial market • Initial positioning in the customer's industrial agenda (for B2B companies) • Definition of the revenue model	• Agreements (MoU) signed with customers • Supply chain secured • Alignment with customer specifications (for B2B businesses)	• Commercialization begun • First customer feedback • Diversification of customers • Optimization of the supply chain	• Winning of market share in the initial market • Start of geographic scaling – Approval in new markets • Recall management
Financial milestones	No revenues No profitability Limited investment	No revenues No profitability Moderate investment	No revenues No profitability High investment	First revenues No profitability High investment	Strong revenue growth Profitability in sight More moderate investment
Funding milestones	**Seed**	**Series A**	**Series B**	**Series C or IPO**	**IPO or Private Equity**
Comments	• *The entrepreneur develops their technology and begins to understand the potential commercial applications of their product* • *The company focuses solely on product development*	• *The Series A funding will enable the company to develop a solid prototype, ultimately certified by the authorities* • *Achieving this milestone is the first major event that realistically reduces investor risk*	• *The first agreements with future customers are an important milestone in confirming the commercial potential of the product* • *The company anticipates the production of products by setting up initial industrial processes*	• *The company begins to manufacture its products (modest volumes) and generates its first sales* • *The company begins to optimize its supply chain for larger scale production*	• *The company is on its way toward large-scale production, enabling it to reach anticipated economies of scale*

Note : Milestones submitted for a type of funding are those to be achieved once the funding is secured. It's therefore expected that, in order to secure specific funding, the company will have reached the milestones of the previous phase.

Hardware

1.6 Analysis of Barriers to Entry and Constraints

BARRIER	RESPONSES INVESTORS MUST DEVELOP IN THESE SITUATIONS
#1 – The brand • It's difficult for a young company to establish a powerful, credible brand with end users. • Gaining the trust of a critical mass of customers is a major barrier in a startup's development	• It's important not to underestimate the marketing expenses of a new hardware company. Instead of seeing it as an expendable cost centre, the investor should instead ascertain that the company invests enough at this level for adequate business development. This will ultimately generate the expected profitability.
#2 – Financing • Hardware models usually require a great deal of capital, particularly to finance infrastructure and production equipment. • Development and sales cycles are relatively long, which puts a lot of pressure on the company's working capital. • Capital patience is key with a hardware model, which often does not meet investors' expectations for quick returns.	• The hardware investor must analyze the entire business development plan and understand/anticipate all the capital needed to grow the business. • It's critical not to sacrifice the long-term success of the company by imposing a short-term vision of performance expectations. • A drip-feed or a "wait and see" approach to investing is unlikely to work in the hardware world, where companies need continuous support in the early stages of their development, particularly to design a relevant product and satisfactory production line.
#3 – Production capacity • Most start-ups working with a hardware model face the difficulty of moving from a relatively low production volume to actual industrial production. The evolution of the bill of process is complex and non-linear.	• The investor must have a thorough understanding of the company's entire supply chain and be sure of the choice of suppliers and components. • It's also vital to give the company time to properly build its production strategy. Poor planning at this level will prevent the company from producing the expected volumes at the expected cost, which will further affect investor returns.
#4 – Commercialization capacity • Creating the right sales channels is a long and costly process, especially when sales are made via dealer networks. • After-sales management can become a major issue, especially if the company fails to monetize these services.	• The investor must analyze the entire sales cycle of the company and ensure that the chosen channels of commercialization are the most appropriate and present a balanced growth/profitability/risk profile. • The management of the after-sales cycle should not be overlooked. The company must develop a relevant strategy that does compromise its long term growth and profitability.

Hardware

1.7 Combination of Models

- An increasing number of companies whose business model is primarily hardware-based complement and enhance their business and value proposition by integrating software and/or operator components into their business model. The following diagram presents possible combinations of models currently observed in the market. The purpose is to give the reader a better understanding of these models.

Dominant model	*HARDWARE*		
Example of local "pure" hardware companies	TAIGA MOTORS, LETENDA, LION		
Secondary model	*SOFTWARE*	*OPERATOR*	*SOFTWARE + OPERATOR*
Combination currently seen in the market?	☑	☑	☑
Explanatory comments	• With the rapid evolution of mobility technologies and the increasing digitalization of the world, more and more players are integrating software into the core of their value proposition, offering a product where hardware and software are seamlessly and optimally integrated beginning at R&D.	• This model is seldom seen in practice. The players who decide to verticalize generally favour a holistic approach in order to control the entire value chain. • However, there are a few specific examples, especially in the materials recycling sector.	• Certain hardware players choose to completely verticalize their business, especially to control the entire product value chain and capture all margins. • This model is mainly seen in the charging sector, where some manufacturers choose to operate their own assets.
Examples of local companies	UGO WORK, Calogy	Lithion Lithium-ion battery recycling	flo
Examples of foreign companies	R3E		NUVVE

propulsion Québec

Hardware

1.9 Case Study – UgoWork

COMPANY OVERVIEW

Date founded

- 2015

Description of activities

- UgoWork designs, manufactures and distributes an integrated solution including lithium batteries, chargers and a software platform for the industrial vehicle sector, mainly forklifts.
- The service offered by the company is turnkey and UgoWork guarantees its customers a certain level of performance and availability of batteries.
- Thanks to 24-hour battery monitoring, UgoWork is able to offer efficient preventive maintenance to its customers, while quickly detecting potential problems with the batteries.
- This monitoring also allows the company to accurately analyze all of the client's activities, and the client can then understand how to optimize its operations using the data collected by UgoWork.

Management team and background

- Philippe Beauchamp, CEO
- Rami Jarjour, COO
- Frédérik Leclerc, Finance Director

Value proposition and differentiators

- *Cloud monitoring* and analysis of information/data from batteries in real time, providing customers with the relevant tools to optimize their operations.
- UgoWork offers a compact and universal charging infrastructure. While most competitors base their recharging offer on the three main forklift families (24, 36, 48) by proposing three different battery/charger combinations, UgoWork offers a universal recharging solution with on-board chargers that work with all recharging stations. This greatly simplifies and fluidifies customer operations, particularly battery recharging.
- The company has designed products with a unique *plug and play* architecture. UgoWork is able to change lithium packs quickly and easily once the lithium is consumed, without the need to intervene on the electronic and steel parts. This results in a better return on investment for the customer, maximized product life and a smaller overall carbon footprint.

Main barriers to development

- Relatively complex supply chain management
- Achieving critical economies of scale to become a reference player
- Regulated environment, including OEM and UL certifications
- Standardized sector subject to strong safety constraints (480v voltage, heavy loads, high energy).

Hardware

1.9 Case Study – UgoWork

BUSINESS STRATEGY

Business models

- Model leveraging a product combining *hardware* and *software* components

Preferred revenue model

- Two main revenue models :
  - Subscription *Energy-as-a-service* (EaaS)
  - Sale of hardware
- The company tends to focus its efforts on the *Energy-as-a-service* model, allowing it to generate stable and recurring revenues.
  - In the case of the *EaaS* model, the battery remains the property of UgoWork.
  - Different packages are offered to customers, depending on the amount of energy they consume over a given period of time (model relatively similar to cell phone subscriptions - x$ per period for xGB of data)

Cost structure

- The company's main costs are related to the acquisition:
  - Lithium cells
  - Electronic components necessary for the manufacture of batteries

Medium-term growth plan

- Confidential

FUNDING ELEMENTS

Amounts raised to date and current top investors

- 700k$ in start-up
- 2m$ in A series
- 23m$ in B series

Current key financial metrics

- n.a.

Upcoming round of funding

- Horizon of ~2 ans

2

SOFTWARE MODEL

Software

2.1 Main Characteristics of the Business Model

PRINCIPAL EST SUBSECTORS INCLUDED BY THE MODEL

- **Charging management solutions**
- ***Mobility-as-a-service***
- **ADAS software**
- **Fleet management solutions / Telematics**
- **Connectivity** (Cybersecurity, smart transportation, V2X)
- **Digital twins**

POSSIBLE STRATEGIC APPROACHES

There are three main approaches to software in the EST sector:

- On-premise software is installed within a company's internal infrastructure (offices, plant, etc.), on its fixed assets or local servers.
- Embedded software is installed directly into a company's rolling or static infrastructure, and is generally connected to the company's networks (closed network or via the Internet).
- Cloud-based software is hosted on external servers; the software and its applications are made available to the company via the Internet.

A growing number of EST companies are adopting a strategy that combines a number of the above approaches. They develop software that can be hosted both on the customer site and in the cloud, while being operational on the customer's rolling/remote assets.

MAIN LEVERS OF VALUE CREATION

PRODUCT

- Ability to develop its product/solution very quickly and in line with current/sought-after technologies (Disrupt or be disrupted)
- Ability to balance over-customization and over-standardization of a product or solution
- Ability to go beyond software as a simple "commodity" and generate differentiated content/performance
- Ability of software to integrate effectively with pre-existing and standardized digital architecture

OPERATIONS

- Ability to remain nimble to meet specific customers' operational expectations/requirements
- Ability to provide strong customer support

COMMERCIALIZATION

- Ability to build long-term customer loyalty and retention, ensuring a no/low churn rate
- Ability to quickly export sales outside the core market, either geographically or horizontally (from other sectors/subsectors)

Software

2.2 Revenue Models and Cost Structure

Principal software revenue models observed in the EST sector

A number of software revenue models are available to mobility businesses today, due to the democratization of wireless Internet and broadband connections:

- Licensing: A fixed or ongoing subscription fee is paid by the user to utilize the software features and its applications (e.g. Algolux). See next page for more detail.
- Data monetization : The model consists of a software to mainly collect and process data, which are then sold to customers. Note that this revenue model does not or rarely exists as a standalone in the mobility sector; it's usually combined with other revenue streams (e.g. Tesla). Tesla). See next page for more detail.
- Advertising: The software and its applications are (generally) available free of charge to all users, and the company pays for it by selling advertising space in the application (e.g. Waze).
- Freemium: The model that provides users with a free basic version with limited features, while allowing users to opt for a paid premium version to access additional content or functionality (e.g. Transit).
- Transaction fees: Commissions are charged (as a percentage and/or a fixed fee) depending on each activity/transaction carried out via the software and its applications (e.g. ChargePoint).
- R&D Services: The company develops basic software, and development fees are charged to develop or customize the software for specific applications/user expectations (e.g. Immervision).

  There are software-based companies in the market that provide hardware conception and design R&D services to their industrial customers. This helps shape the hardware product for software optimization (reverse engineering).

- An increasing number of software companies are adapting their revenue models to a demand management strategy . The software enables the company to adjust its offer and pricing in real time, according to actual demand, customer needs and the capacity of the support networks (e.g. electricity grid).

Cost structure

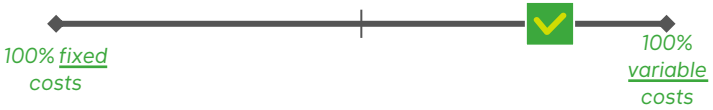
Top 3 cost centres

3 *Server hosting/Cloud*

2 *Marketing/Customer acquisition*

1 *Product development/R&D*

Ratio of fixed costs vs. variable costs



Rigidity of the cost structure

- Relatively flexible cost structure, with lower fixed costs and cost centres that vary greatly depending on the company's strategy.

Potential for economies of scale

- Moderate potential for economies of scale, with software development costs amortized among many customers, but very high marketing expenses to acquire/retain new customers

***Note** : See next page for licensing and data monetization*

Software

2.3 Revenue Models for Licensing and Data Monetization

- In addition to the software revenue models presented on the previous page, some companies in the ITE sector choose to monetize their activities via the licensing model and/or by monetizing data.

SOFTWARE LICENSING MODEL

What is it?

- The software licensing model is a contract between the software owner and the software user, where the company specifies the exact terms of use under which the user may utilize the product.
- The company retains ownership of the software and the user only purchases a right of use, which comes with certain conditions, as noted above.

Various revenue streams of the software license model

- Perpetual license: The company charges for the license only once and allows the user to utilize the software without time constraints. However, the characteristics of the software remain unchanged throughout the period of use.

  This model is less and less used in mobility, as the rapid and constant evolution of the software and its applications requires regular updates.

- Subscription license: The company charges usage royalties for a specific period (month, year, etc.) and users are granted access to the software during this period. Once the period ends, users must renew their license if they wish to continue using the software; otherwise, they lose access (e.g. Tesla software).

  This model tends to dominate today, and its 100% cloud computing variant is commonly called SaaS (Software-as-a-Service).

- License to use: The company charges royalties for a given number of versions over a period of time. Once the number of iterations has been reached, users must renew their license or increase the desired number of versions to continue using the software; otherwise, they lose access (e.g. Algolux).

  This model applies to companies that prefer a B2B model, especially with manufacturers/equipment suppliers.

SOFTWARE DATA MONETIZATION MODEL

What is it?

- The monetization of data in software consists mainly in :
  - collect data captured by the software from users' use of the product
  - and then resell this data to a third party.
- In the case of an exclusively B2C model, the data can be anonymized and then resold to a third party, but several software companies have shown reluctance to explore this avenue, mainly because of privacy issues.
- Similar to the hardware model, mobile software companies seem to see this revenue source as a complement to their core business, rather than as the core of their business strategy.

Revenue sources

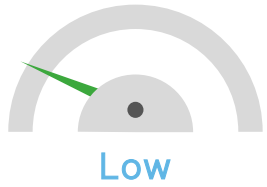
- Sale of raw data collected via software (little used in mobility because little added value for customers/mobility users)
- Sale of processed and analyzed data collected via the software (sale of reports/dashboard)
  - In a B2B oriented model, consulting activities can be derived from this

Software

2.4 Understanding the Business Model

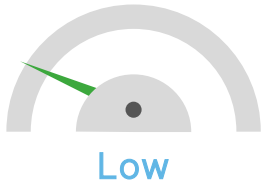
OPERATIONS

A. i. Degree of complexity in expanding operations



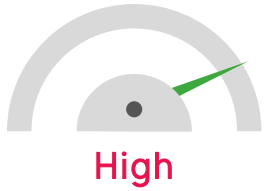
- Few operational constraints other than hiring the right talent to increase the volume of operations

A. ii. Verticalization potential



- Note that many mobility companies refuse to cross the "hardware barrier"
- Upstream/downstream value chain activities require a completely different expertise

A. iii. Horizontalization potential

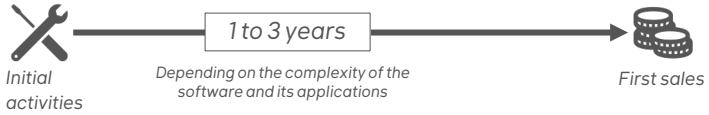


- "Ease" of developing relevant products/solutions for other sectors/subsectors than the core market

COMMERCIALIZATION

B. i. Length of development cycle

Short	Moderate	Long
X	X	

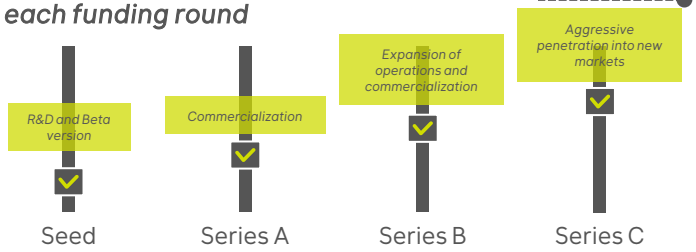


B. ii. Complexity of exporting out of the initial market

Low	Moderate	High
	X	

- Since the cost of customer acquisition is very high, the speed and scope of scaling is directly proportional to the investments dedicated to marketing and the sales force

B. iii. Stage of development expected for each funding round



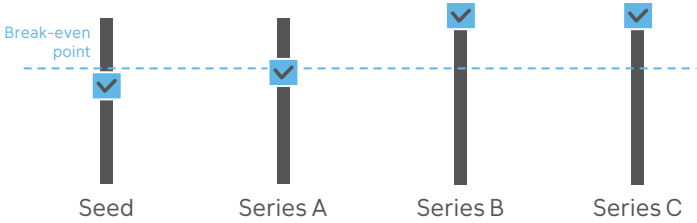
PROFITABILITY

C. i. Typical time frame for analysis

Inférieur à 5 ans	Entre 5 et 7 ans	Entre 7 et 10 ans
X		

- Financial projections over 3 to 5 years are generally sufficient to evaluate a software company

C. ii. Expected level of profitability per round



C. iii. Time needed to reach break-even point

0 to 2 years	2 to 5 years	Over 7 years
X		

- Relatively short path to profitability, with sales generally within a few months and an ability to generate high margins

Software

2.5 Milestones for Creating Value and Reducing Investment Risk

	R&D AND BETA VERSION	DEVELOPMENT	OPTIMIZATION	EXPANSION
Development milestones	• Identification of market needs and definition of the proposed solution • Initial lines of code and proof of concept • Version of minimally functional software/application	• Massive development of algorithms • Interface development • Customization of the software/application according to the expectations of the first anchor customers (e.g. OEM, public transportation enterprise, etc.)	• Continuous optimization of algorithms and basic software interface • Development of new functionality of basic software and applications • First iterations on new products/solutions	• Standardization of the basic software/application • Massive development of new products/solutions
Commercial milestones	• First closed-circuit tests of the software/application • Empirical validation of the product/solution, and of the value proposition with actual mobility users - First customer feedback • Definition of the targeted revenue model	• Signing of first agreements • Focus on a few anchor customers • Refinement of the revenue model • Set-up of customer support	• Significant increase in the number of customers in the initial market • Initiation of the expansion phase and search for the first customers outside the initial market • Optimization of customer support	• Development of partnerships/alliances • Horizontalization of activities • Geographic scaling • Rationalization of customer support
Financial milestones	No revenue No profitability Limited investment	First revenues Focus on profitability Moderate investment	Strong revenue growth Profitability Significant investment	Search for new sources of revenue Profitability Significant investment
Funding milestones	**Seed**	**Series A**	**Series B**	**Series C or IPO**
Comments	• *The enterprise determines its initial concept after identifying real-world market needs* • *The Beta version is tested with the first users* • *The company defines how it plans to monetize its activities*	• *The company develops its product/solution, both at the algorithm and interface levels, specifically based on the needs/feedback of the first major customers* • *The company focuses on a few key customers and refines its monetization strategy*	• *The company optimizes its software, both at the algorithm and interface levels, while developing additional functionalities* • *Revenues rise significantly, boosted by substantial investments to draw new customers*	• *The company standardizes its original software and operations, while developing new products/solutions* • *The company looks for new markets to continue its growth*

Note : Milestones submitted for a type of funding are those to be achieved once the funding is secured. It's therefore expected that, in order to secure specific funding, the company will have reached the milestones of the previous phase.

Software

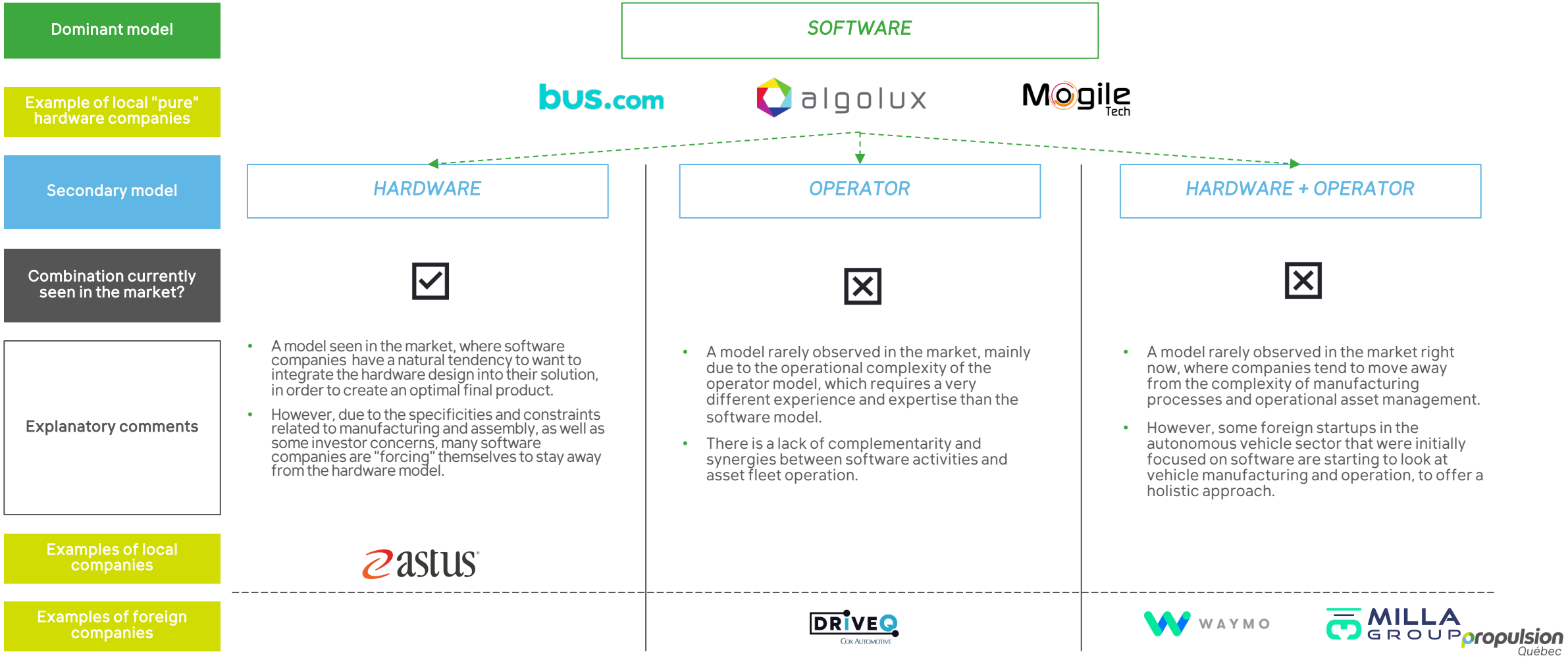
2.6 Analysis of Barriers to Entry and Constraints

BARRIER	RESPONSES INVESTORS MUST DEVELOP IN THESE SITUATIONS
#1 – Customer acquisition cost (CAC) pressure • Good control of the CAC is often the key to the long-term success of software companies, since finding and retaining customers can be extremely onerous for a company (see key metrics – Section 6). • Customer lifetime value is a key metric for a software company, especially in the case of revenue models without retention barriers (subscription, freemium, etc.).	• In competitive and/or mature markets, it's crucial to understand a company's saturation point in the markets into which it's expanding and to identify the point at which a customer costs more to retain than the total revenue can generate. • Sector or geographic diversification is generally a relevant option for a company to consider in order to reduce the CAC pressure on the company's finances.
#2 – "Commoditization" of software • It's very difficult for a software company to sustain its competitive and technological edge over time. The relatively short development times allow competitors to adapt and quickly offer equivalent solutions. • In some cases, there is a certain lack of willingness to pay for solutions, particularly for software/applications that are relatively standard and/or available to the public.	• Faced with the risk of "commoditization" of software and its applications, investors must ensure that they understand the company's strategy to maintain its competitive edge. There are a number of options that can also be combined, such as relying on more and more innovation (Red Queen concept: continuous evolution is required to stay relevant), strengthening the power of the corporate brand, imposing new regulatory standards or pivoting the company's strategy toward middleware.
#3 – The challenge of cybersecurity and data protection • The very nature of a software company's business involves processing and storing a large amount of data. Against the backdrop of ever-increasing "digitalization," the protection and confidentiality of this user data has become a crucial issue for companies. They must invest significant resources in skills such as cybersecurity, privacy protection and data archiving. Failure to comply with these "obligations" can have harmful and even disastrous consequences on the reputation and endurance of a company.	• Investors must ensure that these issues are understood and not overlooked by the company and they must understand what the company's potential flaws or weaknesses might be in this regard. • A thorough analysis of cybersecurity risk should be carried out by investors through a due diligence review, concretely identifying all the existing risks, their probability of occurrence and their impact on the company if they were to occur.

Software

2.7 Combining Models

- Certain companies with a predominantly software-based business model complement and enhance their activities and value proposition by integrating hardware and/or operator components into their business model. The following diagram presents possible combinations of models currently observed in the market. The purpose is to give the reader a better understanding of these models.



Software

2.9 Case Study – Algolux

COMPANY OVERVIEW

Date founded

- 2014

Description of activities

- Algolux is a software company that offers an evolving perception technology that can be integrated into existing cameras (clear perception) while allowing enhancement for new cameras.
- The company was founded on groundbreaking research at the intersection of deep learning, computer vision and computational imaging.
- Computer vision and image optimization solutions address the critical issue of vehicle Advanced Driver Assistance Systems (ADAS), autonomous vehicles, autonomous mobile robots as well as video security.

Management team and background

- Allan Benchetrit, CEO
- Domenic Durante, CFO
- Felix Heide, CTO
- Matthias Schulze, VP Europe & Asia
- Dave Tokic, VP Marketing & Strategic Partnerships
- Paul Boucher, VP Engineering & Technical Operations
- Sophie Laval, Talent Manager

Value proposition and differentiators

- One of the most competent and efficient companies in its sector for accuracy in object detection
- Robust technology for object detection under the most difficult road conditions (night, snow, rain, fog, etc.)
- Technology easily adapts to new camera components (sensors, lenses, etc.)
- Less training data required to adapt the neural network

Main barriers to development

- Due to the complexity of the products developed with Algolux technologies, sales cycles are long, particularly when compared to other EST subsectors or other sectors in general.
- Lack of local skilled labour, especially machine vision experts
    - Need to recruit labour outside of Quebec borders, which can sometimes be a challenge (salaries, geographic remoteness, etc.)

Software

2.9 Case Study – Algolux

BUSINESS STRATEGY

Business model

- Software dominant (exclusively)
- SaaS model

Preferred revenue model

- Perpetual license (clear perception software installed in a camera): Monetization of the technology through a fixed-fee license, allowing the customer to experience the features of Algolux solutions for a number of years. A royalty is also charged by Algolux for each new installation.
- User license (ISP* software to optimize camera enhancement): Monetization of the technology for a certain number of predefined iterations and for a fixed period of time

Cost structure

- Main cost centre: R&D workforce (90% of Algolux employees work on R&D)
- Other relevant cost centres: mule vehicles equipped with ADAS, capturing real data to optimize software

Medium-term growth plan

- Confidential

FUNDING ELEMENTS

Amounts raised to date and current top investors

- Seed: $3.5M (2013-2017)
- Series A: $10M (2018)
- Series B: $18.4M (2021)
- Cumulative since 2014: $32.8M

Current key financial metrics

- Confidential

Upcoming round of funding

- Anticipated amount: Confidential

Software

2.9 Case Study – Clicknpark

COMPANY OVERVIEW

Date founded

- 2020

Description of activities

- Clicknpark operates a digital platform dedicated to the rental and management of parking spaces, in the spirit of efficient mobility, reduction of vehicle pollution and sharing economy.
- The company's main mission is to make it easier for drivers to find parking, while providing additional revenue opportunities for owners of parking lots.

Management team and background

- Carl Grenier, President
- Sara Joli-Cœur, Executive VP
- Simon Landry, Chief Technology Officer

Advisors/Advisory Committee

- Pierre Larochelle
  - Co-Managing Partner at Idealist Capital
  - Former CEO of Power Energy (Power Corp)
- Steve Robitaille
  - Co-Managing Partner at Idealist Capital
  - Formerly at Bombardier and WSP

Value proposition and differentiators

- Advance booking guarantees parking spaces and final pricing known in advance
- Makes available public parking spaces that were unavailable/not widely known or previously inaccessible
- Optimization and profitability of spaces for parking lot owners. Through its app and the data collected on driver behaviour, the company makes parking "smart"
- A field sales team able to convince and demonstrate the value-added offer of Clicknpark to parking lot owners

Main barriers to development

- Grow the company's parking inventory at a pace sufficient to meet increasing user demand
- Parking lots scattered among multiple owners within the same city

Software

2.9 Case Study – Clicknpark

COMPANY STRATEGY

Preferred revenue model

- Sharing of revenues with parking lot owners, via transaction fees charged for each parking booking made through the Clicknpark app
  - The company usually collects a 20-35% commission on the parking revenues generated.
- Ongoing revenues due to low turnover of parking inventory

Cost structure

- Initial technology development costs already paid
  - Relatively low fixed costs for maintaining the digital platform
- Major fixed costs related to general administration expenses, which are expected to remain stable starting in 2024

Medium-term growth plan

- Growth in the number of users
  - February 2020: 3,000/December 2022: 35000
  - 2025 (forecast): 200000
- Revenue
  - $2M in 2023/$8M in 2025
- 9,000 parking spaces managed by the end of 2025

FINANCIAL ELEMENTS

Amounts raised to date and current top investors

- $1M from private investors in 2021

Current key financial metrics

- Revenue 2022: $900K

Upcoming round of funding

- Anticipated amount: ~$5M in 2023

3

OPERATOR MODEL

Operator

2.1 Main Characteristics of the Business Model

MAIN EST SUBSECTORS AFFECTED BY THE MODEL

Fleet operation

Mobility-as-a-service

Logistics, urban delivery, intermodality

Smart transportation systems

POSSIBLE STRATEGIC APPROACHES

In order to analyze the activities and the strategic approach favoured by an operator-type company, three operational layers must be taken into account:

1. **Ownership of assets/fleet**
   - Ownership: the company owns the assets, which are recorded in its balance sheet
   - Leasing: the company does not directly own the assets it operates, but pays a fixed-term user fee to a third party who owns the property
2. **Ownership of the places where the operation is carried out**
   - Ownership: the company owns the space where it operates (roads, parking, sidewalks, etc.)
   - Leasing: the company pays rent/honorarium to a third party in order to operate its assets on specified sites
3. **Operational implementation**
   - Internal: the operation of the asset (moving, maintenance, etc.) is performed by company employees
   - Outsourcing: the operation of the asset is entrusted to a third party through an operations contract

MAIN LEVERS OF VALUE CREATION

PRODUCT

- Ability to secure asset supply while benefiting from competitive prices
- Ability to customize activities for each customer/market with a core solution

OPERATIONS

- Ability to stabilize operating margins (micro gain/efficiency)
- Ability to accurately predict/anticipate demand
- Ability to ensure availability of assets and associated workforce
- Ability to ensure the safety of users/passengers/goods
- Ability to ensure business continuity and react quickly to operational contingencies to maintain the highest uptime possible
- Ability to deliver accurate services/information/notifications in real time

COMMERCIALIZATION

- Ability to maximize/monetize asset occupancy, maintaining asset utilization above a certain threshold

Operator

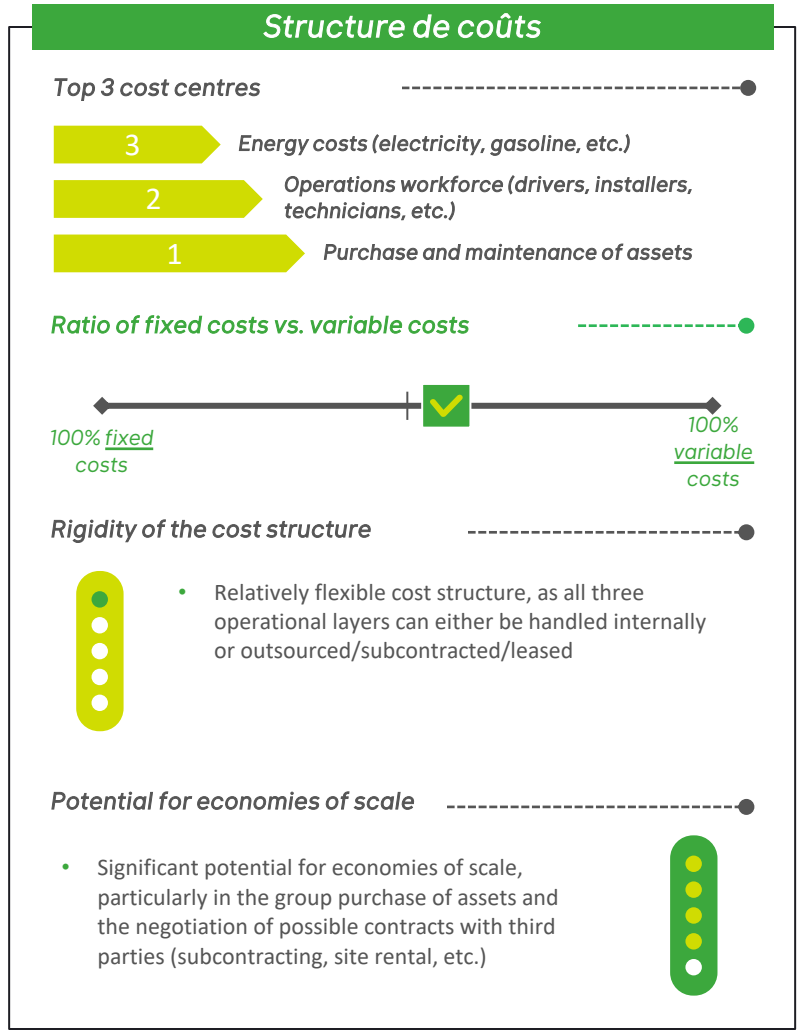
3.2 Revenue Models and Cost Structure

Traditional revenue model

- The dominant revenue model for an operator-type business is the pay-as-you-go model where the user pays for the consumption of the service based on a specific variable such as:
  - Time
  - Mileage (and its billing by zone variant)
  - Weight
  - Energy consumption
  - A combination of the above factors
- The unit cost of consumption generally decreases with the volume consumed.
- Some companies have introduced a dynamic pricing system, allowing the price of the service to change instantly, especially in response to supply and demand in real time (e.g. Uber model).

Other observed revenue models

- To build user loyalty, companies have developed alternative revenue models, by introducing the concept of a package/subscription into the equation. While the "all inclusive" subscription model does not or rarely exists in mobility in its pure form (outside of public transport), more and more companies have developed mixed models with packages/subscriptions allowing the user to enjoy a lower "pay-as-you-go" rate.
- Another hybrid model observed in mobility combines charging a fixed amount for consumption up to a specified amount, then pay-as-you-go billing after reaching the fixed amount.
- Lastly, fixed or variable transaction fees may also be charged for each transaction performed, possibly in addition to the standard pricing.



Operator

3.3 Licensing and data monetization revenue models

SOFTWARE LICENSING MODEL

- The licensing model can take two main forms for a fleet operator:
  1. Subcontracting: The operator manages a third party's fleet of assets "anonymously," in parallel with its own activities. The third party benefits from the same operational, technological, etc., features as the operator's own activities (e.g. Communauto)

     Revenue stream

     - Invoicing of operational subcontracting fees (monthly or yearly contract, with a predefined number of dedicated resources and access to the same features as the company)
     - Matching charges for linking the third party's operations with those of the company

  1. White label: The operator charges a third party for the right to use its operational processes, technology, interface, etc. without disclosing the operator's brand or name (e.g. Lyft)

     Revenue stream

     - Paying royalties for the time the technology is used
     - Tailoring support for adoption/learning/modification of the technology and industrial processes (engineering support)
     - Updating operational and technological processes

SOFTWARE DATA MONETIZATION MODEL

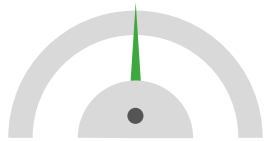
- Similarly to the hardware model, the fleet operator mainly uses data from asset transactions to improve and optimize its own operations.
  - The sale of data to third parties seems to be a model seldom used by operators, mainly for reasons of confidentiality and privacy.
- In the case of licensing revenue models, the operator can complement its core revenue streams by offering operations optimization services through real-world data analysis:
  - Subcontracting: The company can help its customers optimize their operations in the same way that it would optimize its own operations. As with hardware, the company can, for example, be remunerated through a share of the savings/gains achieved through data analysis (e.g. Levo Mobility).
  - White label: Here, data monetization mainly takes the form of tailored support. This enables the company to help its customers improve their operations by analyzing and putting into perspective the data collected through its own operations and those collected as part of the customer's operations (e.g. Levo Mobility).

Operator

3.4 Understanding the Business Model

OPERATIONS

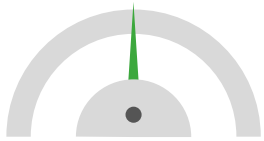
A. i. Degree of complexity in expanding operations



Moderate

- Relatively easy to expand in the core or established market(s), but complex to start new operations in a new market

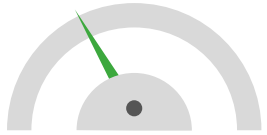
A. ii. Verticalization potential



Moderate

- Clear potential for verticalization of operations, particularly through ownership of operating sites, but with increased risk and different expertise required

A. iii. Horizontalization potential



Low to moderate

- Integration of new markets/customers can become complex as the systems required can be different
- Depends on degree of customization required

COMMERCIALIZATION

B. i. Length of development cycle

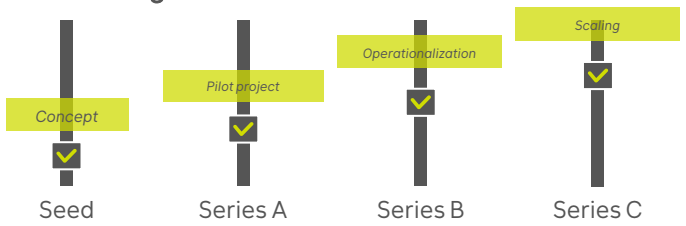
Short	Moderate	Long
X		

B. ii. Complexity of exporting out of the initial market

Low	Moderate	High
		X

- Geographic diversification is operationally complex, as it requires installing systems and assets in a new territory
- Complex management of customer support once diversification has taken place

B. iii. Stage of development expected for each funding round



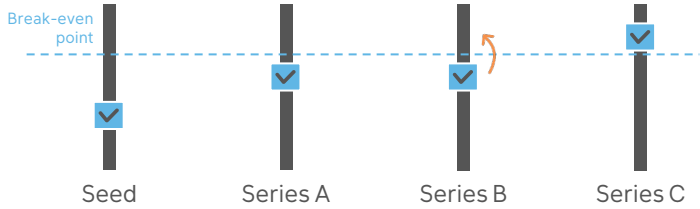
PROFITABILITY

C. i. Typical time frame for analysis

Less than 5 years	5 to 7 years	7 to 10 years
	X	X

- Based on the estimated lifespan of the assets
- Possible to analyze over a longer period to understand how asset renewals affect profitability

C. ii. Expected level of profitability per round



C. iii. Time needed to reach break-even point

0 to 2 years	2 to 5 years	Over 7 years
X		

- Business model must be well thought out in advance, as it's very hard to find elements of profitability once operations are established
- Profitability achieved once the anticipated critical mass is reached

Operator

3.5 Milestones for Creating Value and Reducing Investment Risk

	R&D AND BETA VERSION	DEVELOPMENT	OPTIMIZATION	*SCALING*
Development milestones	• Identification of market needs and definition of the proposed solution • Identification of hardware and software requirements for operations	• Initial implementation of the concept and discovery of the first operational realities • Refinement of the concept based on what has been learned in the field • Development of the customer interface	• Fully functional customer interface • Initial deployment of the asset fleet • Continuous improvement of the solution in response to the realities on the ground	• Massive deployment of the asset fleet • Micro-optimization of the solution in response to the realities on the ground • Ongoing optimization of customer interface
Commercial milestones	• Iterative search for target operational metrics for the concept to work (e.g. minimum utilization rate, minimum uptime, etc.) • First iterations on the revenue model and cost structure (fixed vs. variable)	• Empirical validation of product/solution and of the value proposition with "guinea pig" customers • First customer feedback • Refinement of the business model, including pricing strategy and cost structure	• Investigation of a healthy balance between supply (deployment) and demand (customers) • Defining the target critical mass • Securing the first major offtakers (B2B) • Set-up of customer support	• Critical mass achieved • Strong market share growth in the initial market and exploration of new markets • Maintaining the balance between supply (deployment) and demand (customers) difficult at first • Optimization of customer support
Financial milestones	No revenues No profitability Limited investment	Marginal revenue Profitability in sight Moderate investment	Moderate revenue growth Break-even point reached Major investment	Strong revenue growth Profitability Major investment
Funding milestones	**Seed**	**Series A**	**Series B**	**Series C or IPO**
Comments	• *The company established its initial concept after identifying real-world market needs* • *Target operational metrics begin to emerge, allowing the company to outline a potential revenue model and target cost structure*	• *The company deploys its concept in the field in a controlled/restricted environment* • *Early customer feedback allows the company to i) fine-tune its pricing strategy and strike the right balance in terms of cost structure and ii) fine-tune the customer interface before actual operations begin*	• *Asset deployment is demand-driven to maintain a sound cost structure while moving closer to the objective of profitability* • *The company discovers new realities on the ground, allowing it to fine-tune its operations, revenue model and cost structure*	• *Large-scale asset deployment to capture significant market share, ideally without impacting company margins* • *Opportunity to explore new markets to drive business growth*

Note : Milestones submitted for a type of funding are those to be achieved once the funding is secured. It's therefore expected that, in order to secure specific funding, the company will have reached the milestones of the previous phase.

Operator

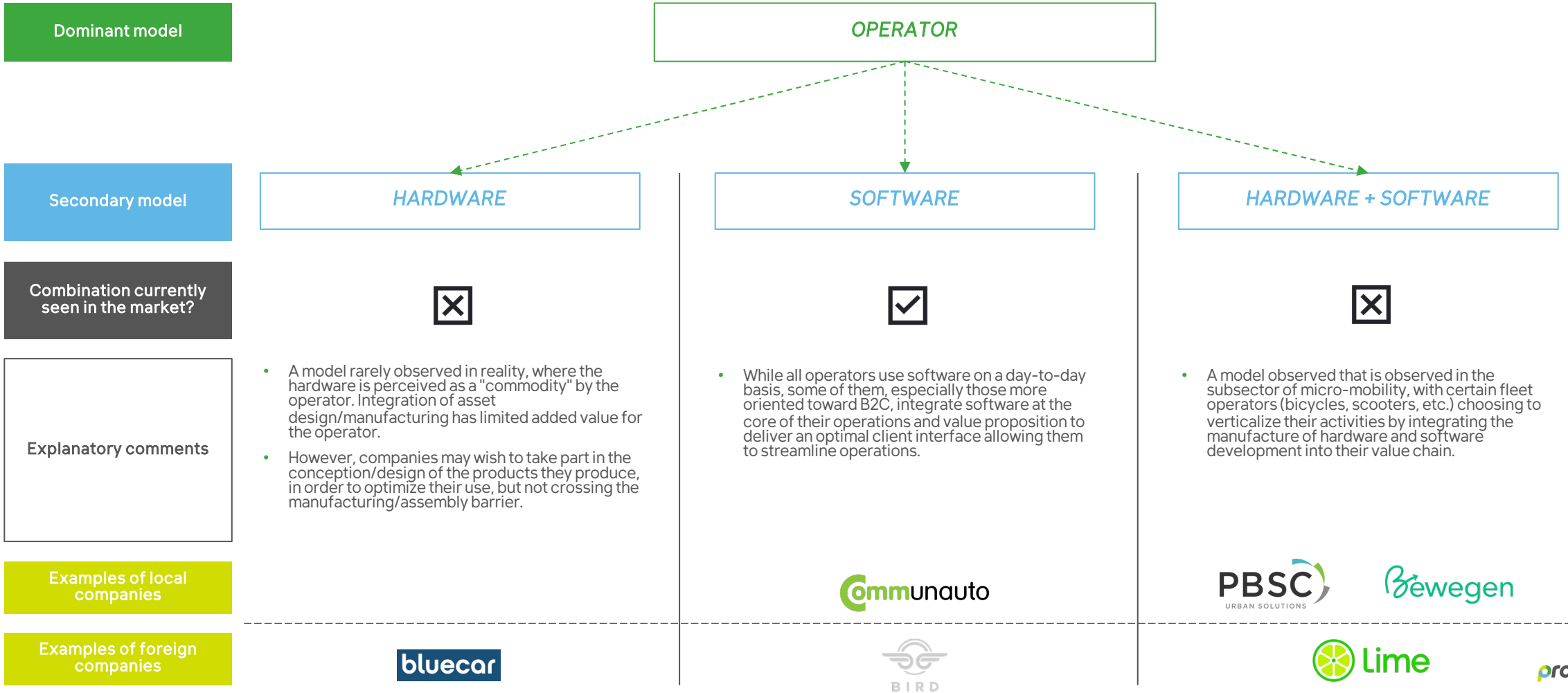
3.6 Milestones for Creating Value and Reducing Investment Risk

BARRIER	RESPONSES INVESTORS MUST DEVELOP IN THESE SITUATIONS
#1 – Achieving critical mass • The initial investments needed to quickly reach the critical mass necessary to make operations profitable are very large and require significant injections of funds. • It's also necessary to generate economies of scale from the outset of operations ("go big or go home"), particularly in terms of asset/equipment purchases and operations/leasing contracts. • Negotiating power with suppliers and the business network is a critical issue at this level, particularly in "a winner takes all" market.	• The investor must make sure that the target critical mass is consistent with the initial investment plan announced. It must also be ambitious enough to meet the stated sales and profitability targets. • Analysis of anticipated economies of scale is a key element here. The investor must confirm the validity of the expected discounts granted to the company by its suppliers, based on the purchase/contract volumes.
#2 – Difficulty pivoting the business model on a path to profitability • The operator model is generally based on low margins and high, recurring business volumes. This makes the profitability of the company highly sensitive to micro-variations of numerous factors. • If the business model is "ill conceived" initially, it's very complicated to pivot and develop along the road to profitability. • The strategy "let's see later how we make money" is generally to be avoided for operators and their investors (Uber model).	• The investor must verify the consistency of assumptions of use and uptime of the assets, and ensure that they are realistic and aligned with current/future market trends. • It's also essential for the investor to have a good understanding of the company's operational strategy, including its pricing and cost structure, and the plausibility of the profit margins to be achieved. The impact of internalizing vs. outsourcing the various operating layers is a crucial exercise in understanding the flexibility available to the company. • The analysis of price elasticity of demand is critical, particularly in a context of inflation/variability in energy and labour prices.
#3 – Workforce recruitment and retention at the right price • Workforce availability is a crucial issue for an operator so it can ensure a utilization rate and/or uptime appropriate for its assets. • In an inflationary environment, controlling the payroll also becomes a priority in order not to strain the company's tight margins.	• The investor must ensure that the company's recruitment/retention policy and the salary conditions offered to workers are both realistic and compatible with the company's profitability projections. • It's critical to understand the inflection point where a business grows to the detriment of its operating margin due to insufficient payroll.

Operator

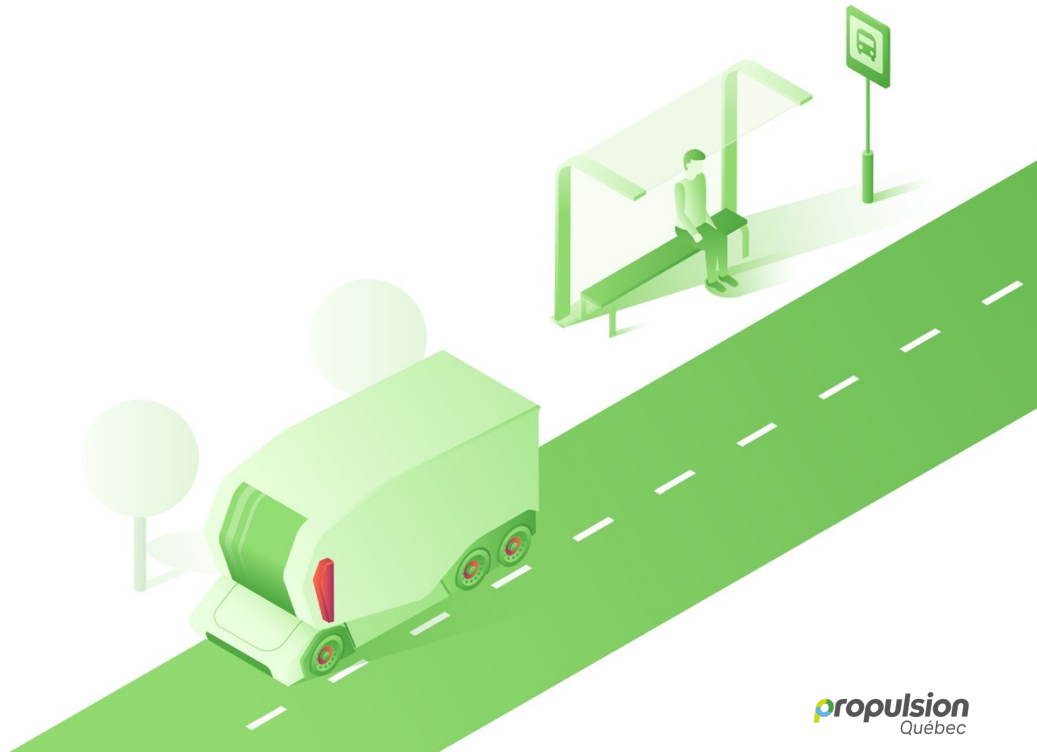
3.7 Combining Models

- Some companies with a predominantly operation-based business model complement and enhance their activities and value proposition by integrating software components into their business model. The following diagram presents possible combinations of models currently observed in the market. The purpose is to give the reader a better understanding of these models.



4

PROJECT FINANCE MODEL



Project Finance

4.1 Context

What is project financing?

- Project financing is a method commonly used by companies to finance specific projects, such as:
  - Infrastructure projects: construction of roads, bridges, airports, utilities, etc.;
  - Energy projects: renewable energy production (dams, wind turbines, solar power plants), power transmission lines, etc.;
  - Large-scale construction projects: commercial buildings or residential complexes.

  Other types of projects can be funded through project financing such as mining projects, agricultural projects or manufacturing facilities.

  ➲ Essentially, any large-scale project (requiring at least tens of millions of dollars) with a specific development schedule and identified and stable revenue streams can be funded through a project financing structure.

Key characteristics of a project financing structure

- Typical elements of project financing include:
  - Creation of a special purpose vehicle (SPV), a separate legal entity created for the specific purpose of holding assets or liabilities on behalf of the company
    - The assets and liabilities of the SPV are not consolidated with the company's balance sheet, so they do not affect the company's financial parameters.
    - This generally allows the company to do what is called off-balance sheet financing, that is, to obtain financing without recording the debt on its own balance sheet. The debt is therefore not included in the company's total liabilities and therefore does not affect its debt ratio or other financial measures.
  - Non-recourse financing means that the lender's only source of repayment is the project itself, without any possible recourse to the general assets or solvency of the company sponsoring the project
  - Financing involving a complex set of contracts and written agreements among several parties, including the borrower (SPV), the lender, the project sponsor and any general contractor, operator or subcontractor involved in the project
  - The success or failure of the project directly affects the borrower's (SPV's) ability to repay the loan, so the lender will carefully assess the feasibility and viability of the project before providing financing
  - The lender will require the borrower (SPV) to provide collateral or other security, such as a mortgage on project assets, to ensure repayment of the loan

Project Finance

4.1 Applicability of Project Financing to the Mobility Sector

Type of projects financed

- In the mobility sector, project financing mainly applies to two types of projects that fall into the category of asset fleet deployments:
    - Deployment of networks of electric charging stations
    - Deployment of electric vehicle fleets

We can also look at the construction of manufacturing infrastructures and/or assembly of elements of the mobility value chain. However, the financing of such assets may fall under mechanisms other than project financing alone (e.g. mortgage financing, sale leaseback, etc.).

Commercial considerations for financing asset fleets

- Project financing applied to the mobility sector is still a relatively new area, which is still not very mature at the commercial level.
    - Traditional lenders and investors continue to have reservations about the adoption rate of zero-emission vehicles (ZEVs), as well as about the usage rates of charging infrastructure, making them reluctant to finance major projects in the sector.
    - The interest rates and yield requirements observed in the market are relatively high for mobility project financing, reflecting a certain apprehension of lenders and investors.
- The life cycles of mobility assets (stations, vehicles, etc.) are generally shorter than those typically funded through project financing (see previous page). This therefore requires a recalibration of certain basic parameters of project-type financing, such as:
    - Lifecycle reserve account (LRA);
    - The the reserve account for asset replacement, a risk that is normally very low in project financing.
        - As mobile technologies are relatively new, historical depreciation is relatively uncertain and subject to technological changes, making projections of residual values all the more risky.

        Example: will lithium batteries still dominate the market in 15 years?

Examples of public project financing programs implemented across Canada

➲ CIB's Charging and Hydrogen Refuelling Infrastructure (CHRI) Initiative

- $500M program to finance projects through a project financing mechanism to help private and public organizations roll out fast-charging infrastructure across the country
- Under the program, the CIB shares the risk of using the stations by aligning capital repayments with levels of use. If use does not reach specific agreed-upon levels, the required capital repayments will be proportionally lower.

➲ Financing of Quebec's zero-emission school buses

- $400 million program to support the purchase of 3500 zero-emission school buses and associated charging infrastructure
    - 8-to 10-year loan
    - Rate at 1.2% for the term of the loan
    - Calculation of loan based on mileage
    - Loan value ranging from $65,000 to $100,000 per bus

Project Finance

4.1 Applicability of Project Financing to the Mobility Sector (cont.)

Commercial considerations (cont.)

- Project financing has a proven track record in a stable regulatory environment with projects that have relatively secure revenue flows. The regulation of the mobility sector is expected to evolve rapidly, resulting in additional regulatory risks and, consequently, additional uncertainty for investors.
  - *Example: uncertainties related to potential regulatory changes in the carbon credit market introduces an unusual risk concept*
- Risk sharing between the various project stakeholders (sponsor, general contractor, asset manufacturer(s), entity in charge of O&M, etc.) must be recalibrated according to established market standards. Performance concepts differ because of the introduction of new technologies and different types of assets. This gives rise to the risk of mispricing when preparing long-term contracts.
  - *Example: how do you properly define the terms and conditions of the O&M subcontract? How long can the manufacturer ensure that the asset is working properly? Is the entity in charge of the O&M prepared to assume the risk of replacing the asset if it were to become obsolete before the projected end of its useful life?*

➲ *As a result, most financed mobility projects benefit from advantageous public funding grants or programs in order to see the light of day and provide a certain commercial and financial interest for the project sponsor. However, this is not unusual in that project funding has often received similar support in the deployment of new technologies, including solar and wind*

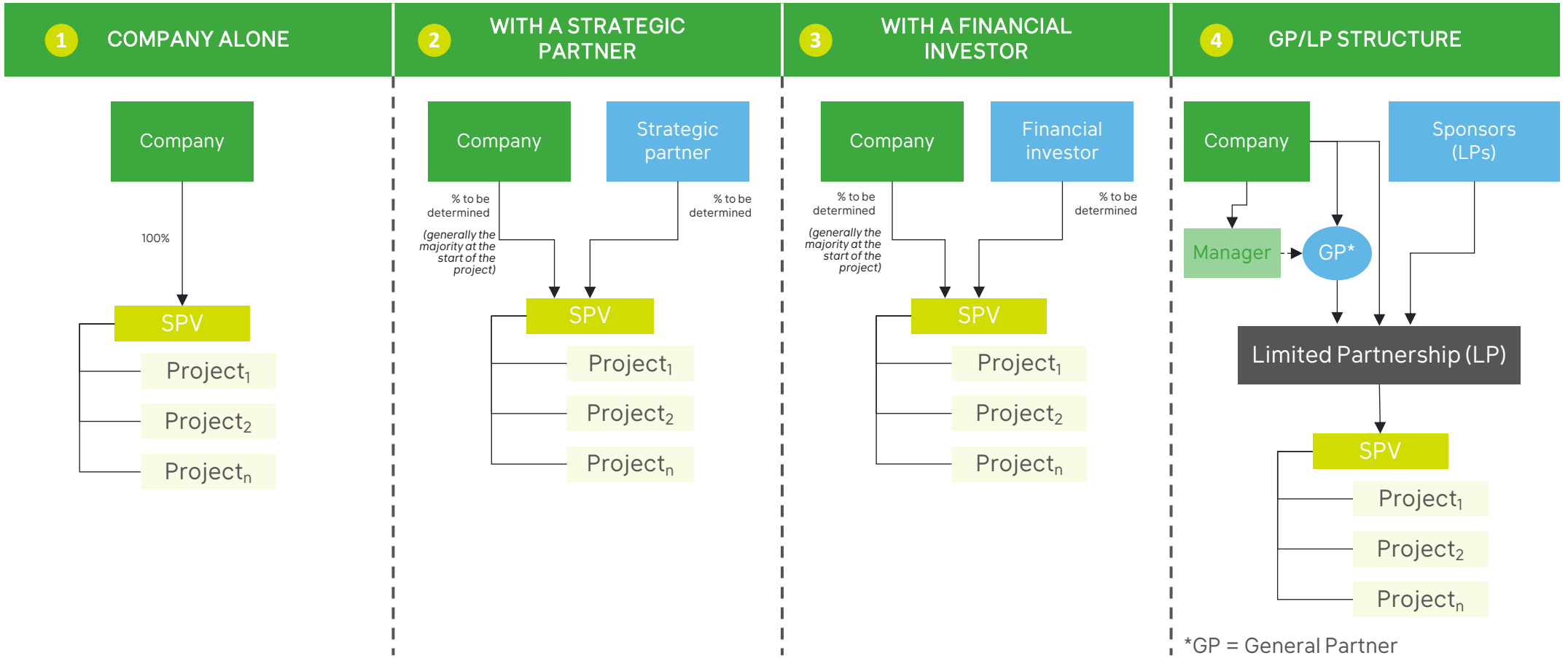
Benefits of project financing for the mobility sector

- The mechanism of project financing represents an effective way for a company (sponsor) to gain strong financial leverage in a sector that justifiably suffers poor access to capital due to major capital expenses (CapEx).
- Among other things, project financing allows for the development of the basic infrastructure that is so important to the growth of the various products and solutions related to sustainable mobility and the entire EST sector.
- It's also a mechanism to properly limit and control the risks of each of the project's stakeholders, and represents a relatively stable long-term investment opportunity in an often short-term environment. This risk allocation broadens the pool of potential investors in the mobility sector.

Project Finance

4.2 Shareholding Structures in Project Financing

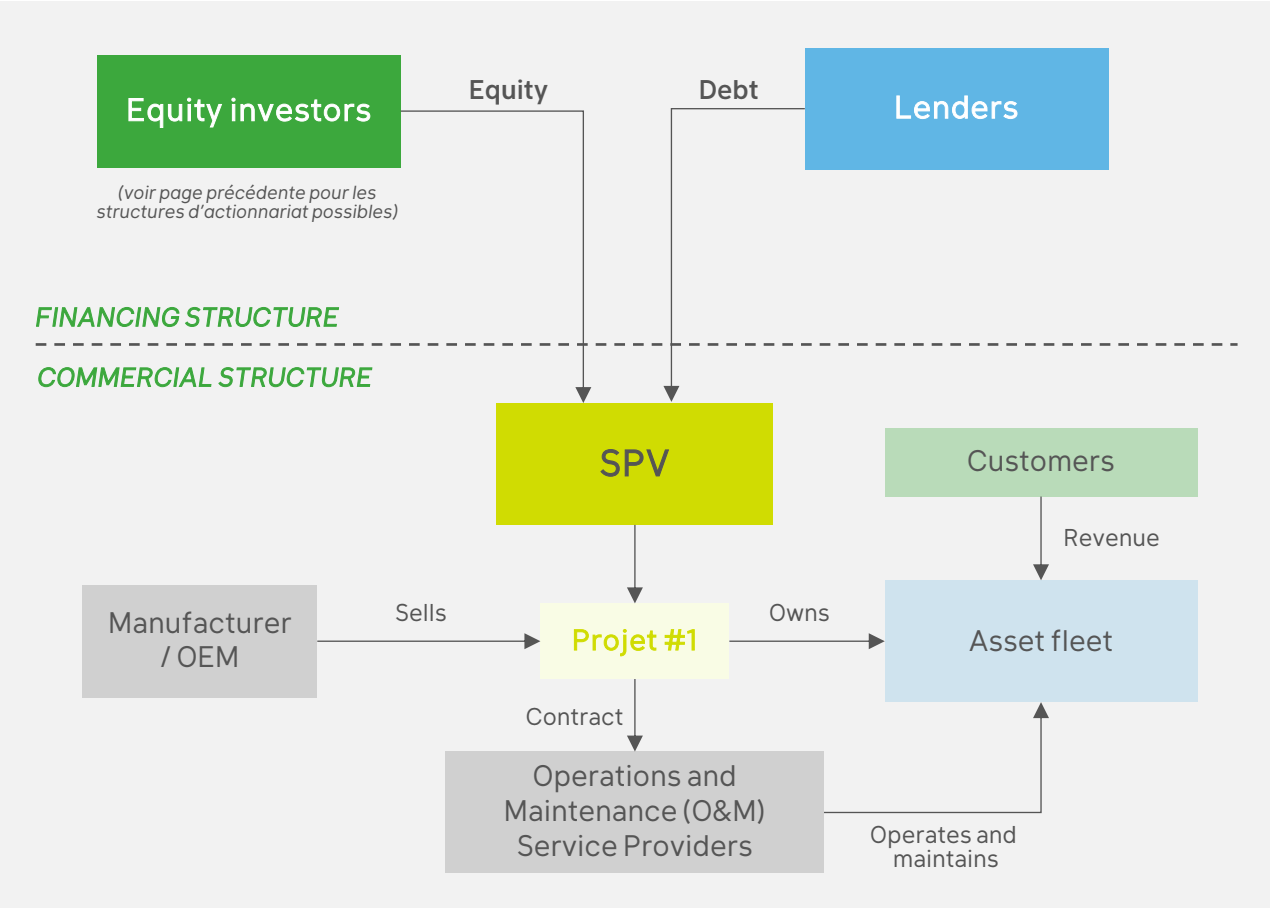
- A company wishing to develop a mobility project can usually choose between four main shareholding structures to finance a project:



Project Finance

4.3 Hypothetical Case Study Applied to the Mobility Sector

- The following diagram presents a typical (simplified) financing and business structure that could apply to the financing of a project by a mobility fleet operator (e.g. a fleet of electric buses, of electric charging stations, etc.):



Key considerations

- The Debt/Equity (D/E) ratio of a project varies widely depending on the asset class and investor appetite for the project. Some of the main factors affecting the leverage ratio include:
  - Revenue certainty (long-term contracts)
  - Cost structure and ability of the project to repay the debt
  - Complexity of operations and maintenance activities
  - Useful life of the asset
- As a guide, the typical D/E ratios observed for stable long-term infrastructure projects are around 70/30.
  - For the mobility sector, due to the generally shorter lifespan of asset fleets, the "novelty" of the sector and the business uncertainties that may still exist, a reasonable D/E ratio is around 60/40 or 50/50 for some that are riskier.
- O&M activities can be separated and outsourced to different organizations. The SPV and the "Project #1" entity are "shell companies" whose aim is to hold and manage the assets via procurement and O&M contracts.
- The structure of "Project #1" can be copied, with the SPV holding several similar but distinct projects.

5

VALUATION OF COMPANIES IN THE EST SECTOR

Valuation

6.1 General Observations

The method of valuation used for companies in mobility is relatively independent of their business model

- Companies seem to be valuated less in terms of their business model than in the type of investor they have chosen, and in the underlying reasons behind its willingness to invest in them.

Valuation seems to be a secondary issue in many cases

- Investors are often entrusted with leadership in the valuation exercise, with companies generally having a fairly accurate idea of the expected valuation, especially after comparing themselves to similar/competing companies that have raised funds before them.
- In the case of a successful transaction, the exercise is in many cases a formality and the process is often fluid.
- A major valuation stumbling block between the investor and the company generally does not bode well for the long-term compatibility of the two parties.
    - Forcing a company to accept too low a value usually has negative consequences for its future development and therefore undermines the investor's performance expectations.

Convertible debt is a double-edged sword, even a toxic gift in some cases

- Convertible debt is a useful short-term tool for the company to finance itself without dilution, but it presents certain dangers that entrepreneurs tend to overlook:
    - The subject of latent valuation is rarely or not discussed or even actually negotiated. Entrepreneurs think they're just postponing this discussion. Meanwhile, the course set is very rarely to the advantage of the entrepreneurs and can force them to dilute themselves to a value far below their initial expectations.
    - Mismanagement of convertible debt and its future effects can jeopardize the future growth and development of the company and, hence, returns to investors.
    - Some companies are in fact over-indebted due to the accumulation of convertible debt. This often prevents new shareholders from investing in the company, since they have a more junior position than convertible debt lenders.

What we heard throughout the interview process with companies and investors

"We quickly agreed on the valuation."

"Convertible debt was a good option to start with, but it backfired later on because we didn't really understand the valuation at the time of conversion."

"The valuation has never been an issue with companies that are a natural fit for our fund."

Valuation

6.2 Main Valuation Methods Observed

Traditional valuation methods

- Traditional valuation methods, such as Discounted Cash Flow (DCF), revenue multiples or EBITDA/EBIA, are almost exclusively reserved for revenue-generating, perhaps profitable, companies, or those with at least a clear path to profit/revenue generation.
- These methods are rarely used at the Series A stage and tend to become more common in subsequent rounds of funding.

Alternative approaches to early-stage business valuation in mobility

- To avoid traditional valuation methods, some companies and investors have developed alternative approaches, which are sometimes combined to determine multiple scenarios, thus providing a reasonable value range. These approaches include:

Multiples of the previous valuation	Intellectual property valuation	Valuation via target market size and projected market share
• The company values itself in a certain round using a multiple of the value accepted in the previous round. • This technique is favoured by many VC investors, who thus ensure a certain return at the time of a possible exit in a subsequent round.	• The company values itself by estimating the royalties that customers/competitors will be forced to pay for using their technology, or even the fines imposed for violations of intellectual property. • This approach is adopted by some companies with technology that they alone offer on the market.	• The company and/or investor make growth projections regarding the size of the company's target market, and allocate a market share to it. • This allows the company to estimate its potential revenues and to apply a multiple to estimate the valuation.

Strategic valuation and exploitation of potential synergies	Relative valuation, based on the value of other similar companies	Valuation of replacement cost
• The investor values the company according to the synergies that will be generated by the combination/fusion of the company's activities with the existing activities of the investor or its portfolio companies.	• The company or investor estimates the value of the company by observing transactions of similar/competing companies that took place in a relatively similar context (same round, same stage of development, same size, etc.) in the relatively recent past.	• The investor assesses the in-house development cost of a technology or project, and values a company having that technology by applying a reasonable premium on the in-house development cost (for the purpose of acquiring it).

It's important to mention that in most cases experienced mobility investors are primarily looking to invest in companies that have a vision of mobility and a future compatible with their own. With startup companies that have little or no established revenue and no assurance of profitability, they look beyond the quantitative aspects that can potentially be measured through the previously mentioned approaches. They can then focus on a management team that they believe in to realize the company's mission.

***Note** : Les approches de valorisation ci-dessus ne sont présentées dans aucun ordre particulier*

Valuation

6.2 Primary Metrics Analyzed in an Investment Context

- In addition to the traditional financial metrics analyzed in any investment decision (sales, growth rate, operating margin, free cash flow, etc.), the following table presents some examples (non-exhaustive list) of metrics and ratios specific to each business model:

HARDWARE

Growth vs. cost of growth ratio

- Ratio of additional revenues to additional costs
    - Consistency of anticipated market shares based on projected cost
    - Accepting a significant increase in initial costs to capture new market shares/new markets

Gross margin

- Ratio of revenue to COGS
    - Accepting a low gross margin at startup, reaching an acceptable level when economies of scale are achieved

CapEx level vs. working capital

- Accepting a certain level of working capital is required to generate growth in CapEx

Level of R&D expenditure vs. revenues

- Maintaining a sufficiently high ratio for the future development of the company and its products

Cost of managing recalls vs. revenues

- Setting a stable ratio between recall management costs and sales level

Duration of the production and commercialization cycle

- Accepting a realistic timeframe required for manufacture and delivery of products

SOFTWARE

Cost of customer acquisition

- Ratio between sales generated by a new customer and the associated cost to secure that customer
    - Accepting an increase in this ratio as the business grows

Human resource allocation as proportion of revenues

- Congruence between the number of resources devoted to a specific product/vertical and the proportion of revenue generated by this activity

R&D expenditures vs. revenues

- Maintaining a sufficiently high ratio for the future development of the company and its products

Sales vs. variable costs

- Maintaining a consistent ratio between sales levels and combined variable costs, which tend to increase rapidly as a result of growth

Cost of product/solution customization

- Ratio of sales generated by a new client to the costs required to tailor the product/solution to its needs

OPERATOR

Ratio between pricing and extraordinary variable costs

- Ability of the company to have appropriate pricing to withstand unexpected variations in variable costs (e.g. energy prices)

Congruence between cash flows and the natural cyclical nature of the business model

- Maintaining a minimum level of cash flow during off-peak periods throughout a year

Profitability of a new asset in growth mode

- Taking into account the realistic time needed to make a newly acquired asset profitable, based on its utilization rate, its uptime rate and the number of assets deployed at the same time

Consistency of growth according to demand

- Maintaining a realistic growth rate based on projected market demand

Inventory level vs. maintenance requirements

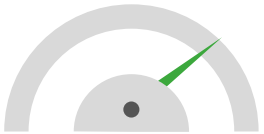
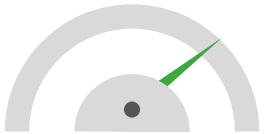
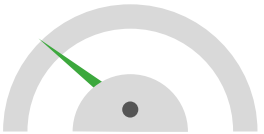
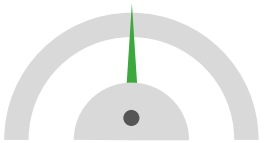
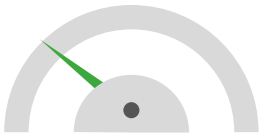
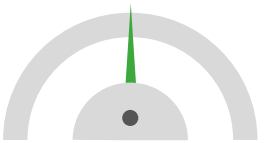
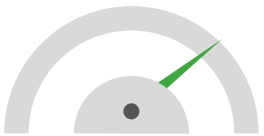
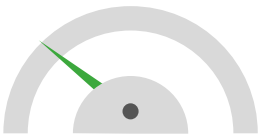
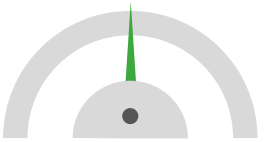
- Consistency in the level of spare parts and equipment inventory versus actual asset maintenance needs

Interface cost vs. revenues

- Maintaining a certain level between the expenses associated with the customer interface and the expected sales, allowing adequate continuous improvement

Valuation

3.4 Related Valuation Elements

	HARDWARE	SOFTWARE	OPERATOR
Importance of intellectual property in valuation	 High	 High	 Low
Residual value of assets in valuation	 Moderate	 Low	 Moderate
Valuation of synergies with other investor activities	 High	 Low	 Moderate

- Intellectual property (patents, industrial designs and trade secrets, trademarks, etc.) is of paramount importance for hardware- and software-based models because it allows the company to protect its competitive edge in the market.
- This is less important in the context of an operator model, where the competitive edge lies mainly in operational expertise, margin control and supply chain management.

- The assets employed in the hardware and operator models have a certain residual value, which can be taken into account in a valuation exercise. Industrial infrastructure and equipment are generally illiquid assets that can have a negative impact on their value. In the case of asset fleets, it's usually their relatively short lifespan that can negatively affect their residual value.
- The low capital intensity of software models explains why the residual value of assets is almost negligible.

- Many investors see synergies between companies that are primarily hardware-oriented when they combine their operations and pool their manufacturing infrastructure, sales channels, etc. These synergies can then play an important role in the valuation exercise and significantly increase the value of a company as compared to a stand-alone analysis.
- There are few synergies between companies that are primarily soft-ware oriented, while the combination of two "operator" companies can help achieve critical mass and generate economies of scale.

Valuation

6.4 Quantitative Analysis Methodology

All data presented in the rest of this section are in millions of US dollars

Methodology

- To complete the analysis of valuation issues and trends in the EST sector, we conducted a scan of recent transactions in the sector. Through this scan, we quantitatively analyzed more than 1000 transactions, which allowed us to identify certain trends and make certain observations about the valuation of EST companies.
- The scan was conducted primarily using the PitchBook database, and the selected transactions met the following characteristics:
    - Geography: Canada, United States and Europe
    - Date: January 1, 2018, October 1, 2022
    - Sector: all applicable EST sectors related to the Propulsion Québec classification
        - We also completed the sectoral analysis using precise key words, allowing us to capture transactions of companies initially classified in a sector other than EST.
    - Type of transaction: Series A, Series B and Series C
    - Size of transaction: Over US$1M
- Once the scan was done, we classified the transactions between hardware, software and operator, according to the dominant business model of the company.

Limitations of our work

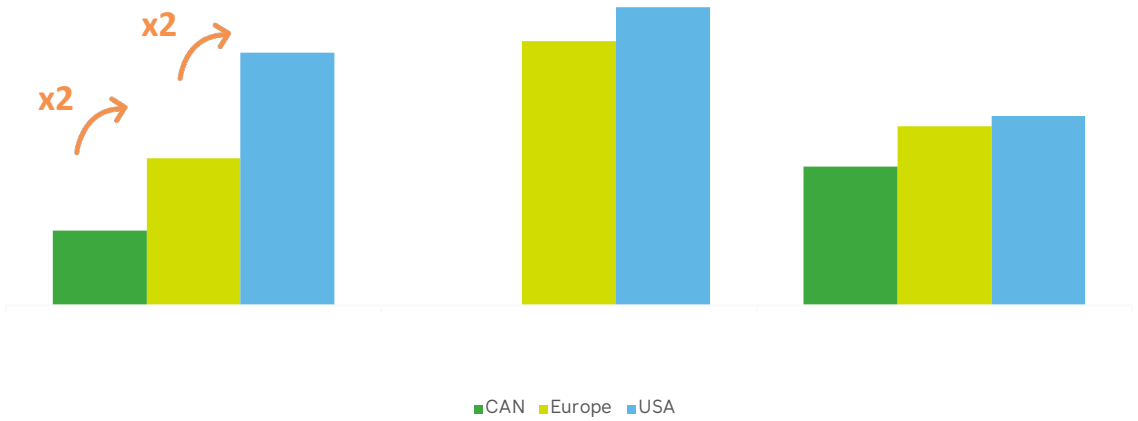
- The data analyzed and presented in this report were data obtained via PitchBook, a database to which EY has access through a paid subscription. No sensitive or privileged information directly from the companies concerned was included in this document.
- The availability and veracity of the data presented here is not the responsibility of EY, which relied entirely on the content available in PitchBook.
- Due to the challenge of accurately delineating the EST sector, some relevant transactions may not have been included in our analysis. However, the analysis we conducted was based primarily on the analysis of aggregate samples rather than individual transactions. We primarily analyzed mean values rather than absolute values, which limits the impact of not having one or more specific transactions on our analysis. Some "extreme" transactions and data were sometimes excluded from the analysis so as not to distort the statistical analysis.
- It should be noted that relatively little information is available for transactions in Canada, compared to the U.S. and Europe.

***Note**: The quantitative data presented in the hardware, software and operator sections are from the same exercise as described above.*

Valuation

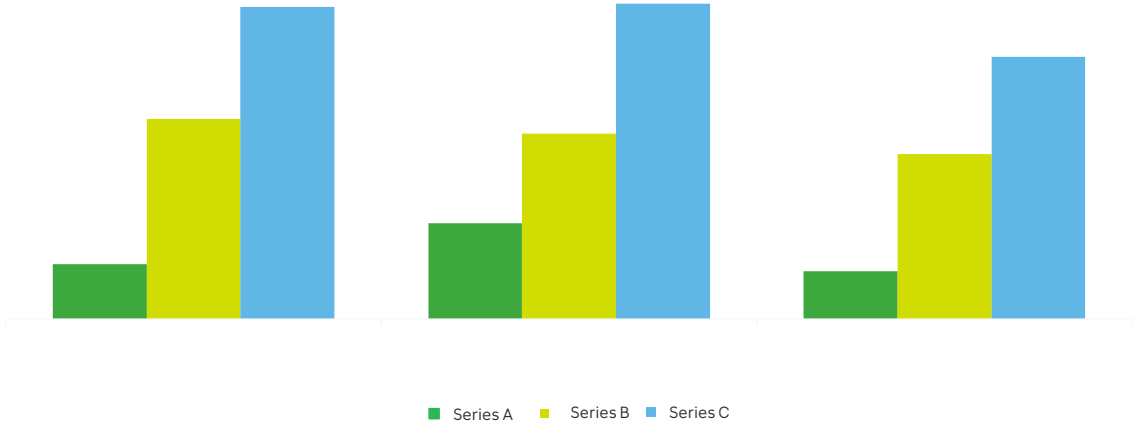
6.5 Average Ticket by Geography and by Round

BY GEOGRAPHY



- The average ticket trend continues through all three types of business model, the highest average ticket being in the U.S., then Europe and lastly Canada.
- The average ticket differences for the hardware business model are glaringly obvious: the average European ticket is 2x higher than the Canadian ticket and the average American ticket is 2x higher than the European ticket. An American company raises on average 4x more funds than a Canadian company.
- The differences are much smaller in the software business model with an average Canadian ticket of $23 million and an American ticket of $31.4 million.

BY TYPE OF ROUND

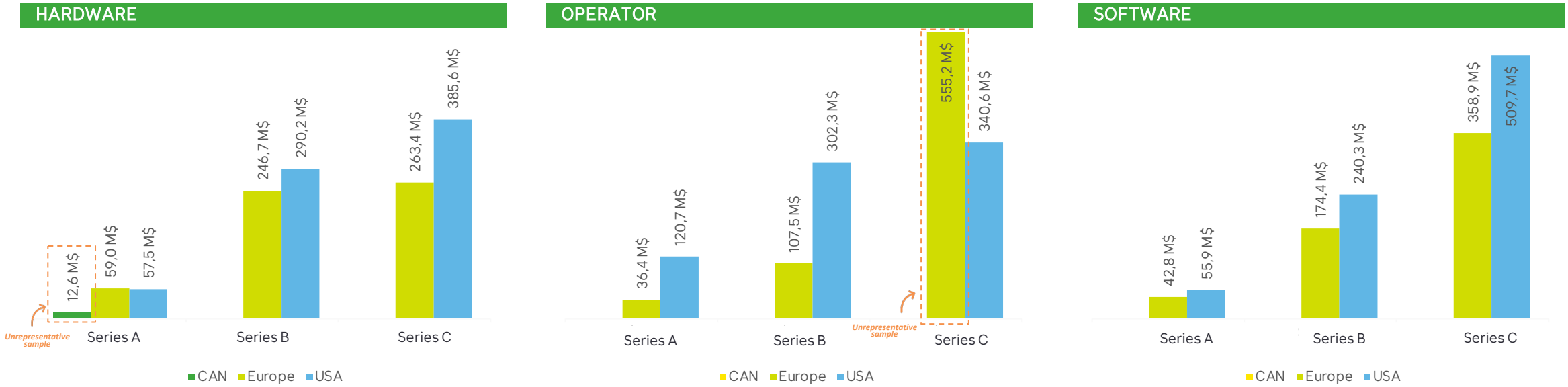


- The differences in the average ticket per round are very similar among the 3 types of business models. Typically, an average Series B ticket is 2 to 3 times the average Series A ticket and an average Series C ticket is less than 2 times the average Series B ticket.
- As the funding rounds advance, the more the average ticket decreases.
- In the startup phase, it's easier for the operator business model to raise large sums during their first round of funding (Series A).
- Typically, for all funding rounds, the average ticket of a software business model will always be smaller than the average ticket per round of a hardware or operator business model.

Source : *Pitchbook*

Valuation

6.7 Average Valuation per Investment Round (Post-valuation)

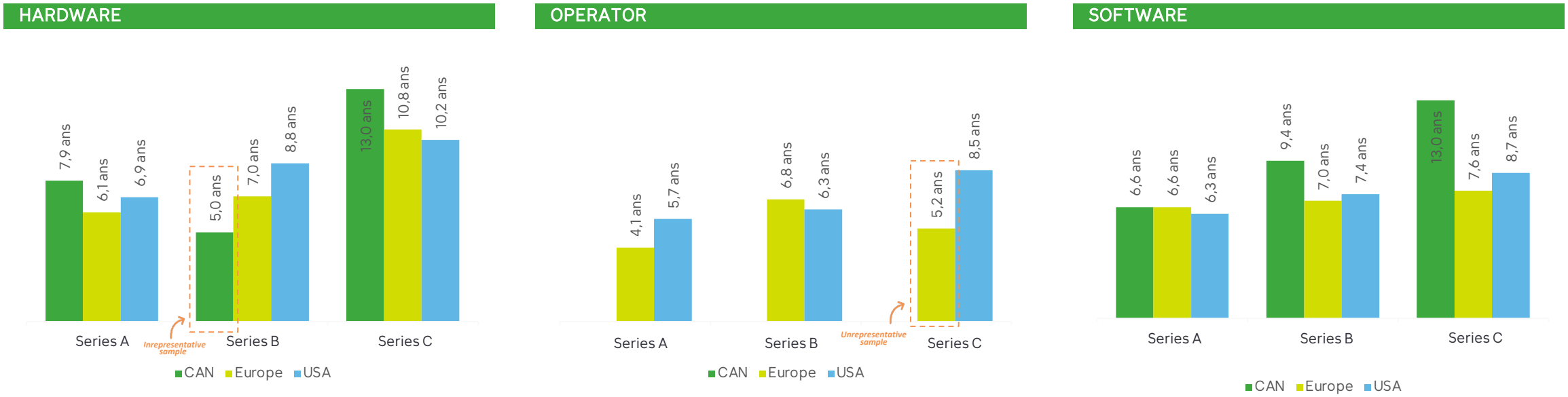


- For all models and jurisdictions, we observed a significant jump in valuation during Series B. This validates the assumption that companies reaching this round have reduced some of their risks, making investors less skittish.
    - This jump is particularly noticeable for the hardware model. The valuation between Series A and Series B is multiplied between 4 and 5 times, thus confirming that once the prototype stage is completed, investors are more inclined to massively deploy capital.
- However, for the operator and hardware models, there was a more moderate upward trend noted in average valuation between Series B and Series C. On the other hand, the valuation of companies using a software model seems to continue to grow at a similar pace between each round.

***Source** : Pitchbook* ***Note** : Very little data available for Canada*

Valuation

6.7 Average Age of a Company per Investment Round



- Overall, we note that companies with a predominantly software-based model have a faster pace of funding than for those with a hardware model. It takes an average of more than 10 years for a hardware company to get to Series C, whereas a software company reaches the same stage after 8 or 9 years (except Canada).
- As shown previously, the operator model is very capital intensive, which explains the faster funding pace than with the software model.
- In general, Canadian companies are in their investment rounds longer than their American and European counterparts, indicating that it's more difficult to raise funds in Canada than internationally.

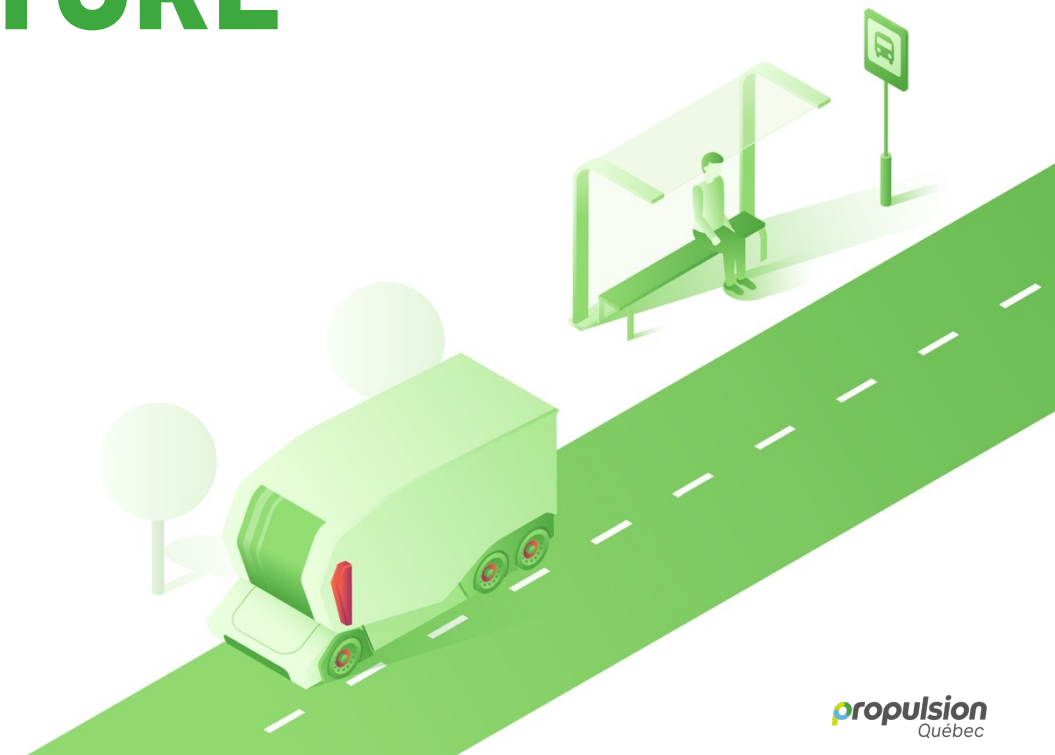
***Source** : Pitchbook* ***Note** : Very little data available for Canada*

6

MARKET OPPORTUNITIES IN THE EST SECTOR

6.1

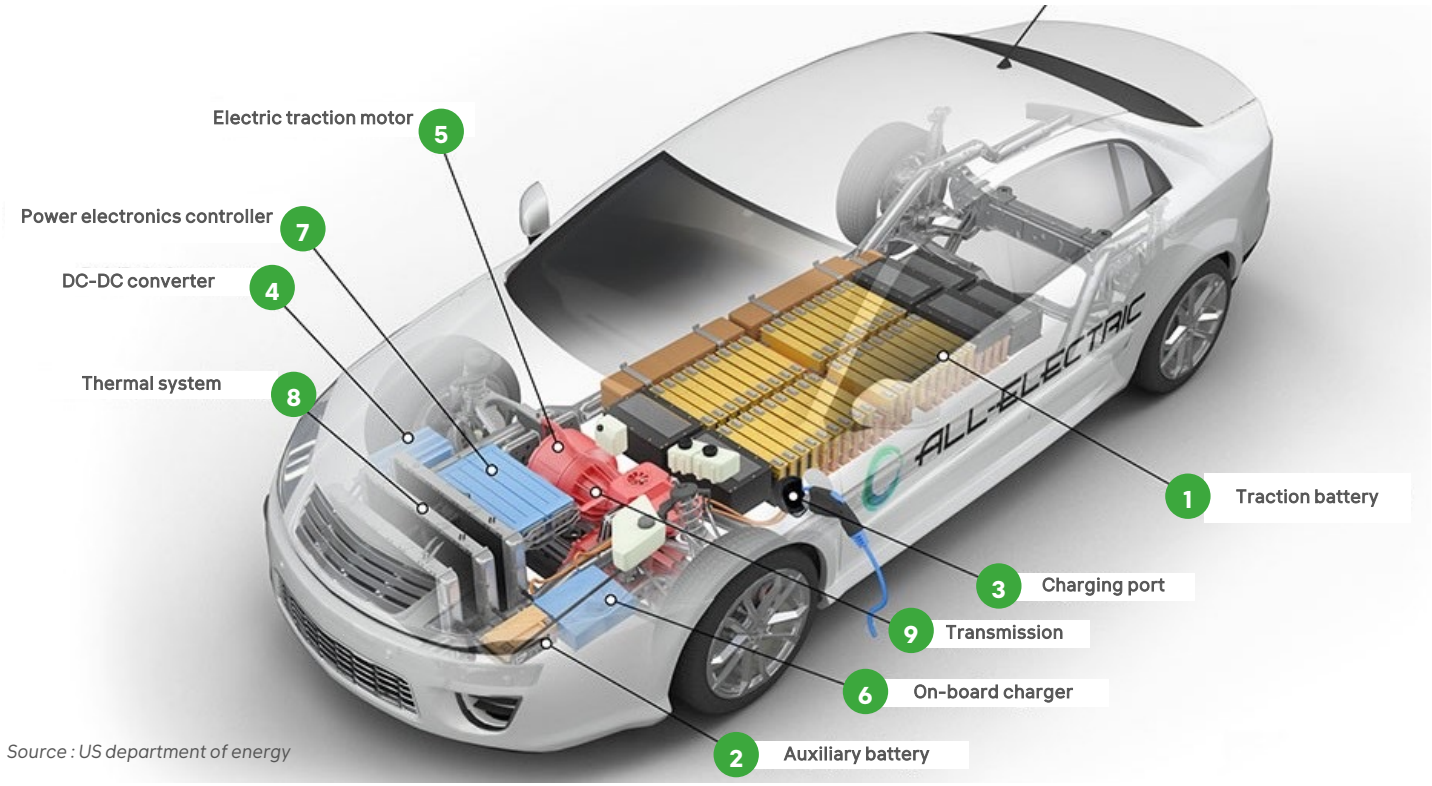
DESIGN AND MANUFACTURE OF VZE



Zero-emission vehicles

1.1 Primary Technologies Associated with the Market

- The diagram below provides a simplified description of the core technology components of an electric battery vehicle. A similar system applies to electric buses and trucks.
- Note that each component described here represents a portion of the electric vehicle value chain, and that many businesses specialize in specific sections of this value chain. The manufacture of an electric vehicle creates a snowball effect that involves many different and specialized companies.



Source : US department of energy

1. Traction battery pack: stores electricity that is used by the electric traction motor.
2. Auxiliary battery: provides electricity to power vehicle accessories.
3. Charging port: allows the vehicle to connect to an external power source to recharge the traction battery pack.
4. DC-DC converter: converts the traction battery's high voltage direct current (DC) into the low voltage DC power supply needed to operate vehicle accessories and charge the auxiliary battery.
5. Electric traction motor: uses traction battery energy to drive the vehicle's wheels. Some vehicles use engine generators that perform both drive and battery replenishment functions.
6. On-board charger: takes incoming alternating current (AC) power from the charging port and converts it to DC to charge the traction battery. It also communicates with charging equipment and monitors battery characteristics such as voltage, current, temperature and charge status during pack charging.
7. Power electronics controller: manages the flow of electrical energy supply from the traction battery by controlling the speed of the traction electric motor and the torque it generates.
8. Thermal system: Maintains an appropriate operating temperature range of the electric motor, power electronics and other components.
9. Transmission: Transfers mechanical power from the electric traction motor in order to drive the wheels.

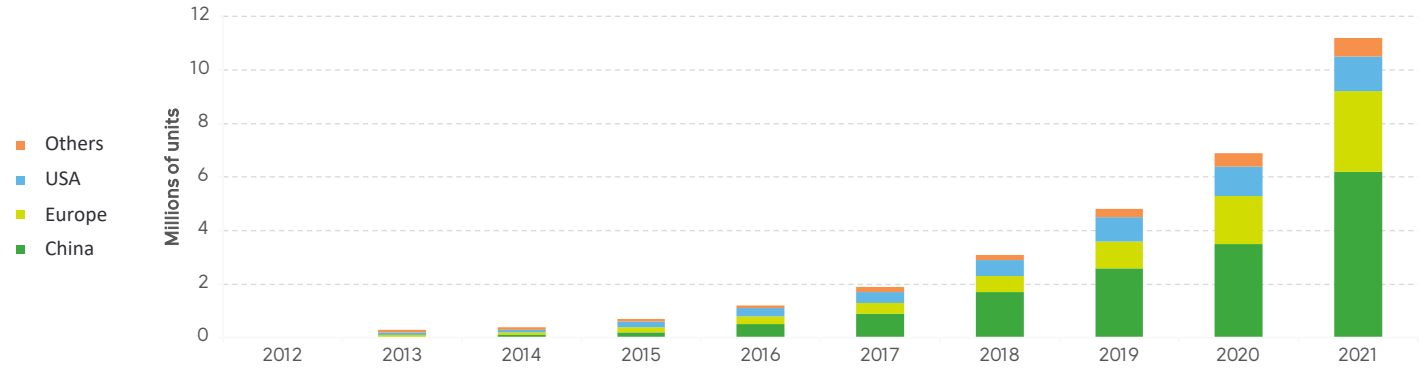
***Note** : Several other electric and/or zero-emission vehicle technologies are available today but are not analyzed in this report (plug-in hybrid, hybrid electric or hydrogen fuel cell).*

Zero-emission vehicles

1.2 Historic Size of the World Market

NUMBER OF ELECTRIC VEHICLES ON THE ROAD OVER THE LAST 10 YEARS

***Note** : Electric vehicles = Light Battery Electric Vehicles (less than 10,000 pounds) – Applicable for the following pages of the section*

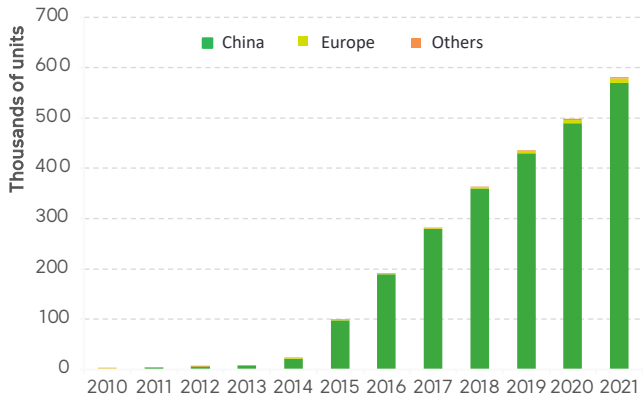


***Source** : International Energy Agency*

- A very strong demand for EVs exploded sales in the sector in 2021, nearly doubling the volumes reached in 2020.
  - Just over 4.6 million EVs were sold globally in 2021, compared to just under 120,000 in 2012.
- From 2016 to 2021, EV sales grew at a compound annual growth rate of.
  - 61% in Europe
  - 58% in China
  - 32% in the Unites States

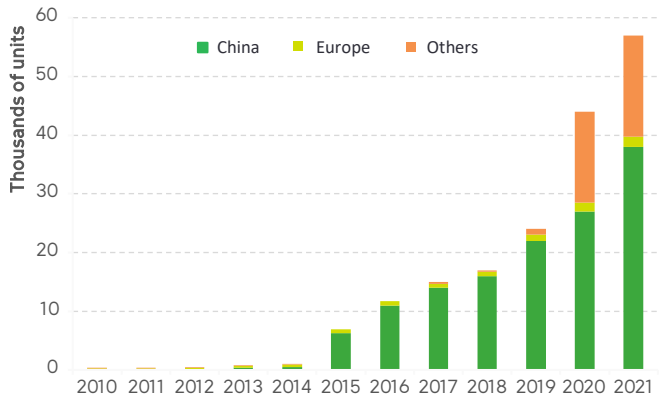
NUMBER OF ELECTRIC BUSES ON THE ROAD

***Note** : Electric buses and electric trucks = electric battery buses and trucks – Applicable for the following pages of the section*



***Source** : International Energy Agency*

NUMBER OF ELECTRIC TRUCKS ON THE ROAD



***Source** : International Energy Agency*

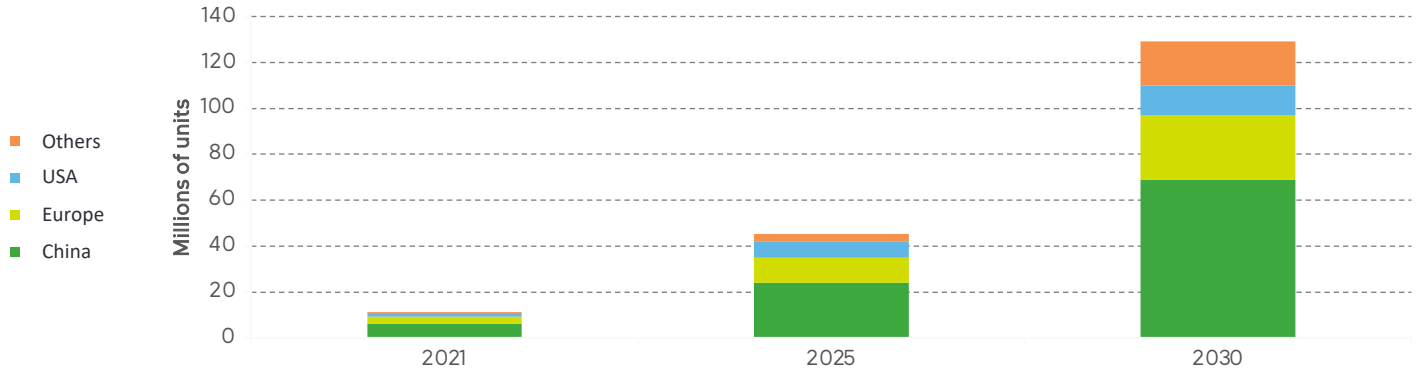
- Global sales of electric buses increased by 40% in 2021 over 2020. The total inventory of electric buses now stands at nearly 600,000 and of electric trucks it's nearly 60,000.
  - The overall fleet of electric buses accounts for about 4% of all buses on the road in the world, while electric heavy-duty trucks account for only 0.1% of all those on the road.
- While China accounted for almost 90% of new registrations of electric heavy-duty trucks in 2021, sales in Europe and the U.S. have been growing rapidly since 2017 with the development of various practical and more affordable models.

Zero-emission vehicles

1.3 Anticipated market size worldwide

***Note** : The data presented in these tables are based on current targets and regulations (conservative scenario).*

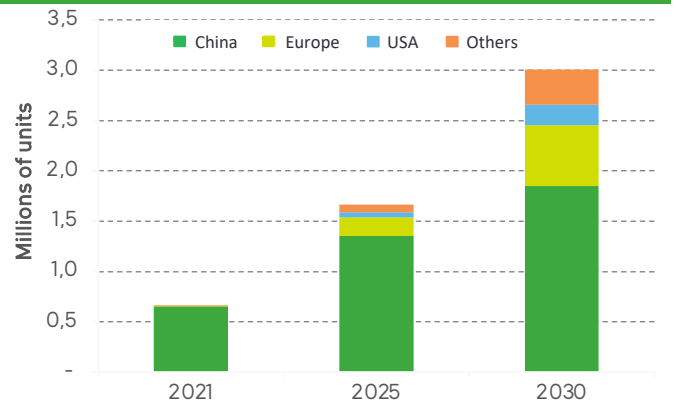
PROJECTED NUMBER OF ELECTRIC CARS IN USE WORLDWIDE BY 2030



***Source** : International Energy Agency*

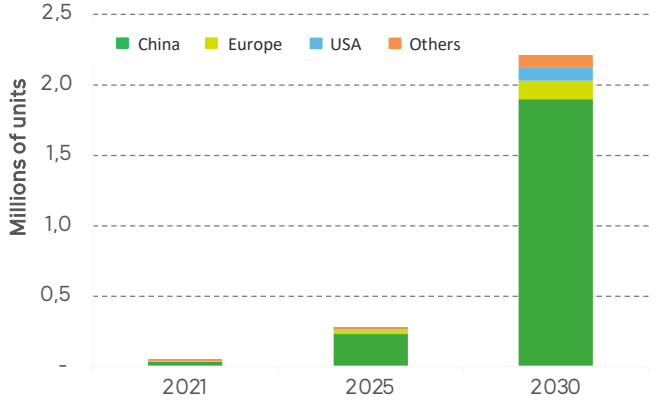
- Considering a conservative scenario where current policies/targets/regulations would still be in effect in the future, the growth of the global market in electric vehicles should accelerate in the coming years to reach more than 45 million units on the road worldwide in 2025. This would represent 10% of total cars on the road.
  - In 2030, if we apply the same scenario, the global inventory of electric vehicles on the road should more than double compared to 2025 and approach 130 million units.
- While demand for electric vehicles in the next few years seems to be strong, there are still doubts about manufacturers' ability to keep up with and meet this demand.

PROJECTED NUMBER OF BATTERY ELECTRIC BUSES BY 2030



***Source** : International Energy Agency*

PROJECTED NUMBER OF BATTERY ELECTRIC TRUCKS BY 2030



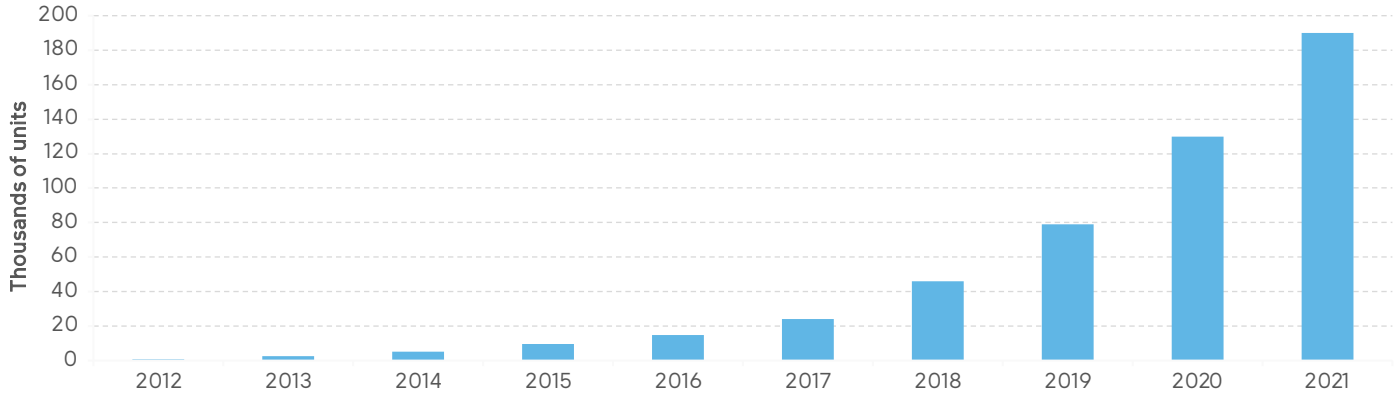
***Source** : International Energy Agency*

- The electric bus market is expected to grow linearly over the next 10 years, reaching three million units on the road by 2030, representing 11% of total buses on the road.
- On the other hand, whereas the market for electric trucks is expected to grow at a relatively moderate rate until 2025, exponential growth between 2025 and 2030 should exceed two million units on the road, representing 2% of total trucks on the road.
  - The relatively limited range of electric truck batteries seems to be the main factor explaining the moderate growth to 2025. Manufacturers are expected to develop models that can travel hundreds of kilometres between charges in the coming years.

Zero-emission vehicles

1.4 Historic and Expected Market Size in Canada

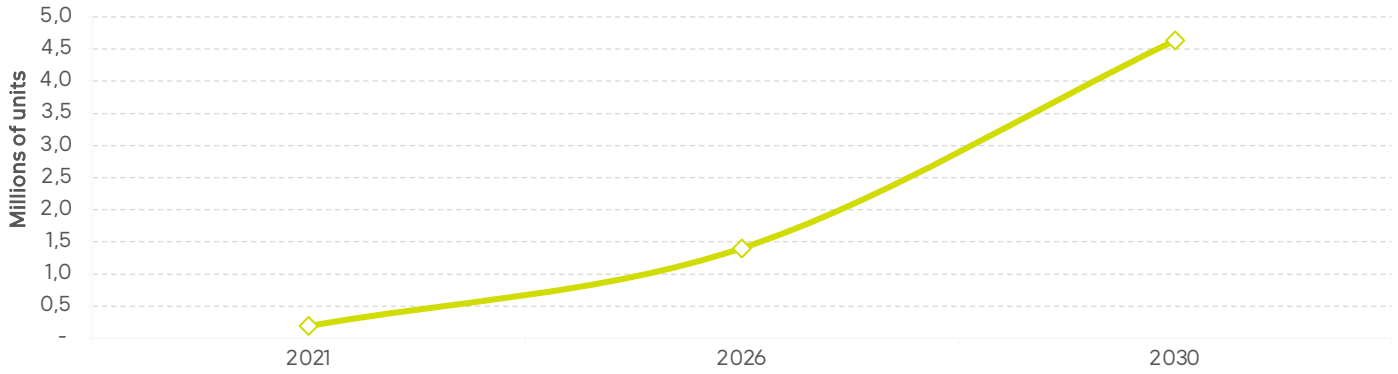
NUMBER OF EVS ON CANADIAN ROADS OVER THE LAST 10 YEARS



***Source** : International Energy Agency*

- The EV market grew by nearly 46% in 2021 over 2020.
  - The share of battery electric vehicles in 2021 represented 68% of all ZEVs on Canadian roads. The rest are mainly plug-in hybrid vehicles (PHEV).
- 43% of all new ZEVs registered in Canada in 2021 were from Quebec, compared to 28% from British Columbia and 23% from Ontario.
- By 2021, 9% of all new vehicles registered in Quebec were ZEVs. In comparison, the share of ZEVs was 12% in British Columbia and 3% in Ontario

PROJECTED NUMBER OF EVS ON CANADIAN ROADS BY 2030



***Source** : Transports Canada*

- The share of ZEVs on the road in Canada is projected to be 5% in 2026 and 16% in 2030.
  - In terms of the number of vehicles on the road, this represents nearly 1.4 million and 4.6 million, respectively, from the overall market for light-duty vehicles.
- Projected annual sales of ZEVs in Canada are estimated at nearly 395,000 in 2026 and over 1.2 million in 2030, accounting for 20% and 60% respectively of total new light-duty vehicles sold in the country.

Zero-emission vehicles

1.5 Growth Drivers and Potential Market Barriers

DRIVERS OF MARKET GROWTH

Decrease in total cost of ownership and government incentives

- There is a connection between EV sales and government incentives available in Canada. Although the purchase prices of EVs have declined in recent years, they remain high. The addition of government incentives, such as subsidies, tax credits or financial incentives for manufacturers in the sector, make these expensive vehicles accessible. This is especially true for the heavy-duty vehicle segment (buses, trucks) where government aid is a deciding factor for most operators in choosing fleet electrification.
- Some studies* show that these government incentives make it more economically advantageous in the long term to own an EV rather than an internal combustion vehicle.
- The electric bus segment reached a major tipping point around 2019/2020. In most settings it's now more economically advantageous throughout the lifespan of a bus to own/operate an electric bus instead of an internal combustion one. The phenomenon of a reduced total cost of ownership of an EV is expected to be achieved over the next few years.
- This expected decrease is mainly due to lower EV maintenance costs and the high cost of fossil fuels.

Increased battery life

- Electric vehicles battery life continues to increase. While today some long trips require good planning, it's reasonable to expect drivers/operators to quickly be able to travel longer and longer distances as vehicles and battery technologies evolve. This is particularly true for the bus and truck segment, which is currently relatively constrained by battery life and which should therefore benefit greatly from increased battery life in the future.

Accelerating plans to electrify manufacturer vehicle fleets

- Some automakers have made sweeping changes in their strategy toward a transition to a 100% electric world. Some are also more ambitious than the government targets. They all want to capture shares in this interesting market during this transition to electrification.
- Due to the increasing number of electric car models, the segment of heavy-duty vehicles (buses, trucks) and of specialized vehicles (ATVs, motorcycles, snowmobiles, scooters, boats, etc.) is booming. In addition to the new electric-only vehicle manufacturers, many traditional automakers are looking to diversify by offering electric models. This allows a range of choices for operators/buyers and speeding up the electrification of the heavy-duty and specialized vehicle fleet.

** https://energie.hec.ca/wp-content/uploads/2021/02/Rapport-d%C3%A9tude_2021-1_DOUILLARD.pdf*
https://afdc.energy.gov/files/u/publication/financial_analysis_be_transit_buses.pdf

Zero-emission vehicles

1.5 Growth Drivers and Potential Market Barriers (cont.)

DRIVERS OF MARKET GROWTH

More restrictive regulations for combustion vehicles

- Looking a little further down the road, some countries are beginning to introduce rules banning the sale over time of new gas vehicles (especially for medium- and heavy-duty vehicles - MHVs). This constitutes a growth driver for the ZEV market.
    - In Canada, the sale of new gasoline-powered vehicles will be banned starting in 2035 to eventually reach net-zero emissions by 2050.
        - In December 2022, the federal government announced a new standard requiring manufacturers to sell 20% light ZEVs staring in 2026 (including SUVs), then 60% in 2030 and 100% in 2035.
    - In 2023, Quebec is also expected to propose a standard to limit the sale of gasoline-based MHVs in the relatively near future.

Zero-emission vehicles

1.5 Growth Drivers and Potential Market Barriers (cont.)

CURRENT BARRIERS TO MARKET DEVELOPMENT

Supply chain constraints on materials and rare minerals used in the production of zero-emission vehicle batteries

- ZEV sales are skyrocketing, but manufacturers are unable to keep pace with demand. This is partly due to constraints on the supply chain for batteries that alone represent about 30-50% of the value of a vehicle (depending on the type of vehicle). The current supply of rare minerals, such as lithium, cobalt and graphite, cannot meet this extreme demand. It's now faster and easier to obtain an internal combustion vehicle, which may cause some buyers/operators to still favour this option.
- In addition, the Covid-19 pandemic created a shortage of semiconductors, a crucial component in the design of ZEVs. The shortage was a result of embargos imposed by the various countries that manufacture this particular substance. As a result, many manufacturers, including those in Canada, are now forced to rethink their supply chain model in order to keep pace with ZEV demand.

Initial purchase price for ZEVs

- The initial purchase price of ZEVs currently remains a potential barrier to market growth, as many buyers/operators consider that the purchase price of an EV is still prohibitive to making their operations profitable, particularly in the bus and truck segment. Moreover, if in recent years it was anticipated that ZEV prices would decline relatively rapidly, it's clear that a number of factors, such as shortages of scarce raw materials and supply chain disruptions, have undermined these assumptions, with the purchase price of a ZEV stagnating for several quarters.

The maturity of the charging network infrastructure

- The charging network needs to grow faster to keep pace with the growth of the ZEV market. The majority of drivers and operators still hesitate to buy an EV for fear of lacking electricity between point A and point B. Although the network of urban charging stations is relatively well developed in Canada today, the consistency of supply remains uneven, and the development of highway and rural charging networks still leaves much to be desired.
- This is particularly true for the heavy-duty vehicle (buses, trucks) segment, where relatively few charging stations are accessible today, outside of specific areas. This significantly complicates the operations of bus and truck fleet managers, thus slowing down the adoption of ZEVs.

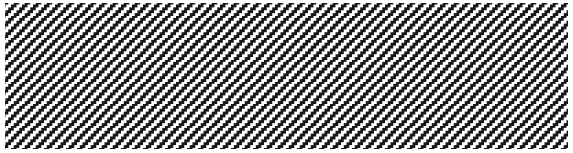
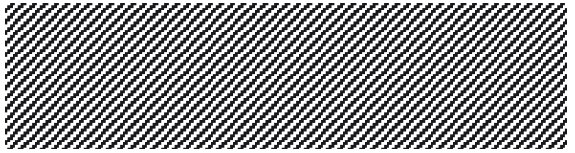
Waiting time for charging the charge

- It takes a lot longer to charge a battery than to fill up with gas. Due to the lack of fast charging infrastructure, depending on the type of vehicle and charger, it requires between 3 and 12 hours to fully charge a battery via so-called "slow" stations. Even with today's fastest options, it takes between 20 and 40 minutes to "quickly" charge 80% of the battery.
- This is particularly applicable to the heavy-duty vehicle segment, especially trucks. Many operators feel that with current technologies, the charging time is too long to make operations profitable because trucks are immobilized when charging.

Zero-emission vehicles

1.6 Key Market-Specific Business Models

Dominant model ...

	HARDWARE	SOFTWARE	OPERATOR
"Pure" models	A very common model with ZEV manufacturers and with many companies that manufacture ZEV parts/components	A model observed with specific players in the ZEV value chain offering software solutions to ZEV manufacturers and ZEV fleet operators	A model that is evolving; operators are choosing to green their operations by electrifying all or a portion of their fleet
... with an ascendant			
Hardware		A model rarely observed in the ZEV market, but some startups, initially software-based, are starting to look at manufacturing/assembly	A relatively small model in the ZEV market; electric vehicle fleet operators are sometimes involved in vehicle design, but rarely cross the barrier not production.
Software	A model observed more and more in the ZEV market; vehicle manufacturers looking to design increasingly smart and connected vehicles, particularly to improve product safety and performance and to also collect data generated by the vehicle		A model that is gaining momentum; some EV fleet operators want to incorporate the software component into their value proposition
Operator	A model rarely observed in the ZEV market	A model rarely observed in the ZEV market	
Combination	S + O A model rarely observed in the ZEV market	H + O A model rarely observed in the ZEV market	H + S A model rarely observed in the ZEV market. Early stages in the world of drones

Zero-emission vehicles

1.7 Key Players and Market Investors

KEY QUEBEC PLAYERS

LION	Class 5 to 8 trucks School buses and minibuses, adapted and public
BRP	Motorcycles, hydrofoils Aims to offer EVs in all its product lines by 2026
GEM	Scooters
kargo	Utility vehicles
GIRARDIN BLUE BIRD	School buses
DEMERS AMBULANCES	Ambulances
TAIGA MOTORS	Snowmobiles Personal watercraft
LETENDA	Buses
THERON	Off-road Quad
MOTREC	Industrial vehicles
VISION MARINE TECHNOLOGIES	Boats
NOVABUS	Buses

EXAMPLES OF INTERNATIONAL PLAYERS *(FOCUS ON HEAVY-DUTY/SPECIALIZED VEHICLES)*

NIKOLA, PACCAR, WORKHORSE, LORDSTOWN, GreenPower MOTOR COMPANY, DRR, BYD, brightdrop, CENNTRO MOTOR, NEW FLYER, PROTERRA POWERED, POLARIS

EXAMPLES OF INVESTORS IN THE MARKET

TRUCKS, FONTINALIS PARTNERS, AUTOTECH VENTURES, NPC NORTHERN PRIVATE CAPITAL, nel, ATLANTIC LABS, renu ventures, Contrarian Ventures, BLUE IMPACT, gm VENTURES, ARCTERN VENTURES, motus ventures

***Note** : This section presents a non-exhaustive list of specialized investors outside Quebec who have recently invested in the North American ZEV market.*

6.2

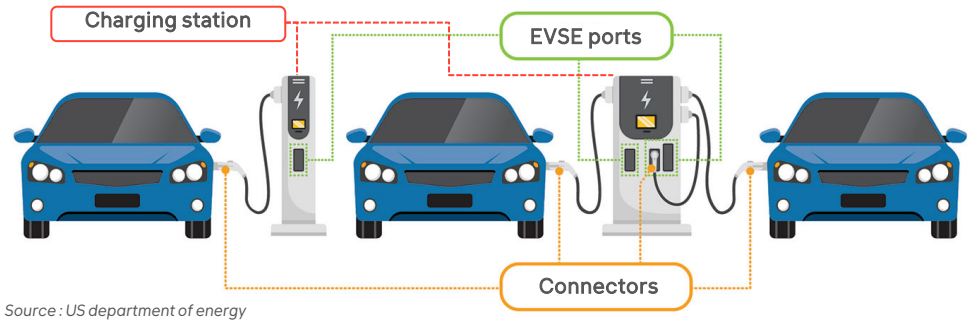
CHARGING – MANUFACTURING/OPERATION OF EQUIPMENT/SOLUTIONS

Charging

2.1 Primary Technologies Associated with the Market

- The North American charging infrastructure market has united with a common standard called the Open Charge Point Interface (OCPI), which specifies that charging stations have the following components: location, Electric Vehicle Power Supply Equipment (EVSE) port and connector.

EMPLACEMENT



Source : US department of energy

- **Station location**: A station location is a site with one or more EVSE ports at the same address, such as a parking space, a gas station, or a mall/commercial parking lot.
- **Charging station** and **EVSE port**: An EVSE port supplies power to charge only one vehicle at a time, even if it can have multiple connectors. The unit that houses the EVSE ports is called a charging station or charger, and may have one or more EVSE ports.
- **Connector**: A connector is what is plugged into a vehicle to charge it. Several connectors and connector types (such as CHAdeMO and CCS) may be available on an EVSE port, but only one vehicle will charge per connector. Connectors are sometimes called plugs.

- Three types of charging stations are currently available for light-duty vehicles: Level 1, Level 2 and Fast. They are all plug-ins

LEVEL 1 CHARGER	LEVEL 2 CHARGER	FAST CHARGER
120 volts/AC / 15-20 amps	240 volts/AC / 80 amps	480 volts/DC/ 300 amps
~2kW = 8 km (5 miles)/hour of charging	~7kW = 40 km (25 miles)/hour of charging	Between 50 and 350kW+ = 160-320 km (100-200 miles)/30 min of charging
Residential use	Residential and commercial use	Commercial use

Source : US department of energy

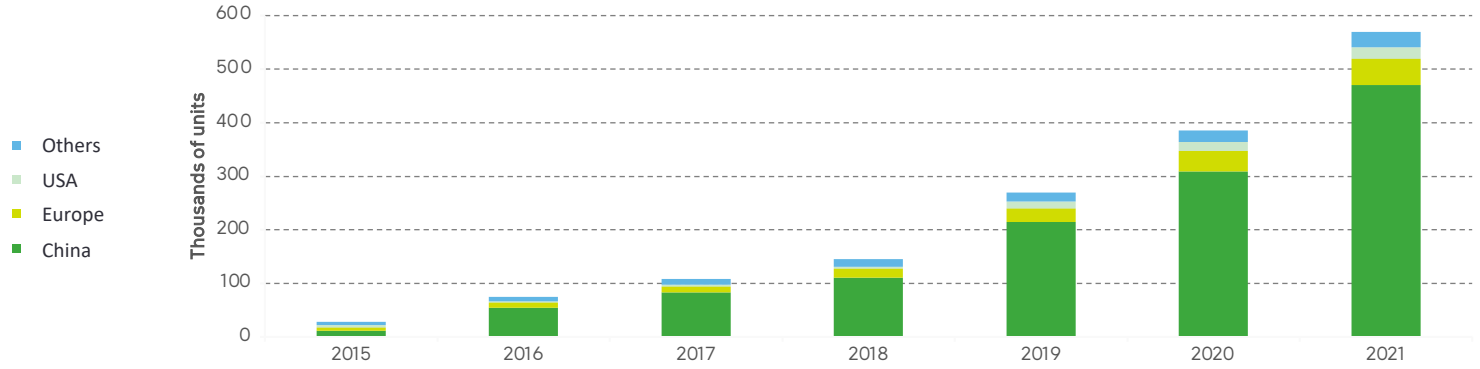
Note : Battery swap is another technology available for light-duty vehicles, but is very rarely used in North America today.

- For heavy-duty vehicles (buses, trucks), charging stations are generally fast-charging plug-in types with more than 50 kW DC (currently up to 450 kW). They can relatively quickly charge entire fleets of vehicles at the same time.
- Other technologies available for this type of vehicle include:
  - Induction charging technology is used for some applications, including in the transit and urban logistics industry.
  - Pantograph charging is mainly used to charge bus fleets.
  - Battery swap is used especially in the public transport industry (buses, taxis, etc.).

Charging

2.2 Historic Size of the World Market

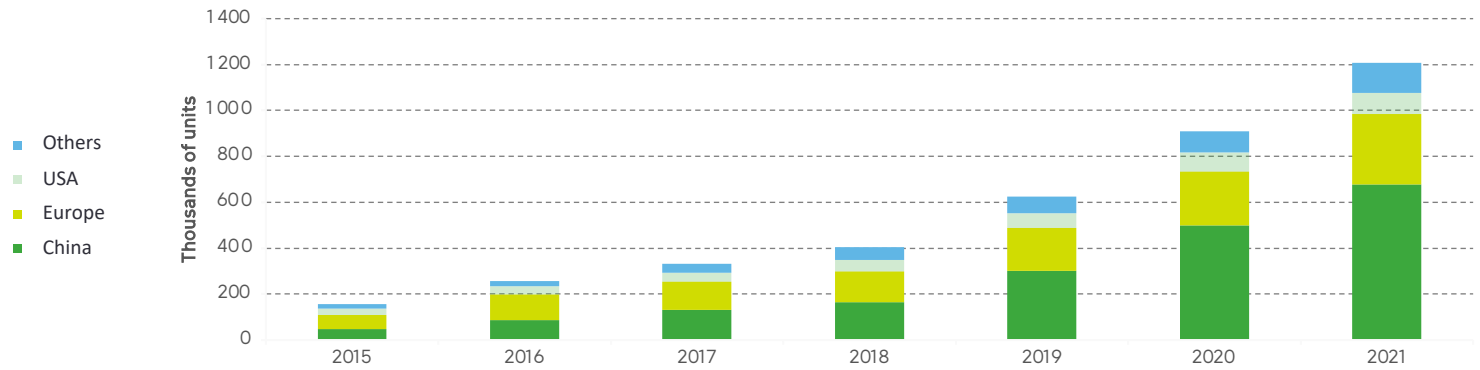
NUMBER OF FAST-CHARGING PUBLIC STATIONS IN THE WORLD OVER THE PAST 7 YEARS



Source : International Energy Agency

- Nearly 600,000 fast-charging public stations are now installed worldwide, mainly in China.
  - After relatively moderate growth until 2018, the fast charger market took off, and hundreds of thousands of fast charging stations were set up every year between 2018 and 2021.
- Europe is the second largest market as regards the number of stations. The European market recorded an annual growth of more than 30% in 2021 and now has nearly 50,000 units.
- At the end of 2021, there were nearly 22,000 chargers in the U.S.

NUMBER OF LEVEL 1/2 PUBLIC CHARGING STATIONS IN THE WORLD OVER THE PAST 7 YEARS



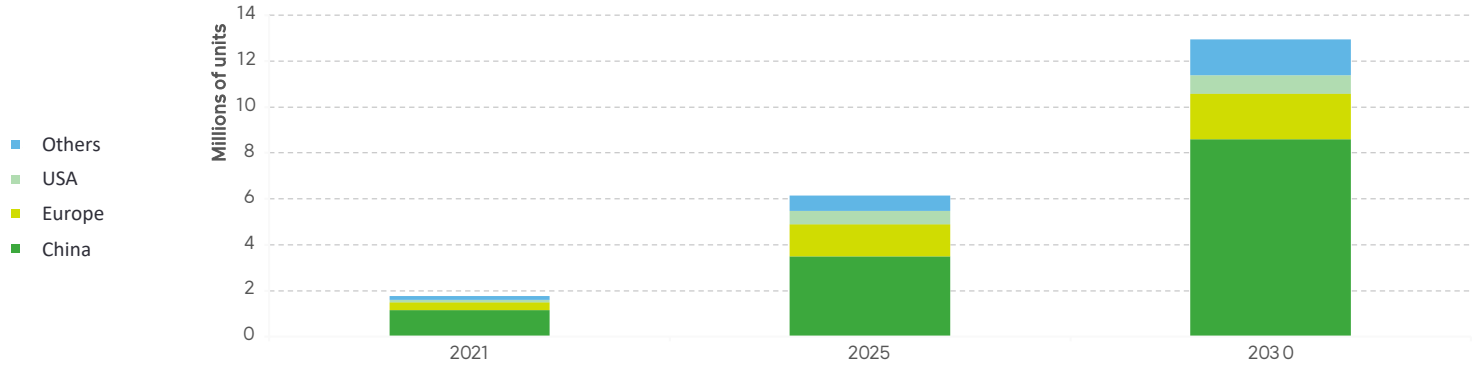
Source : International Energy Agency

- As of 2021, China also dominated the Level 1 and 2 public charging market with nearly 680,000 units installed However, the gap with other countries is smaller than with fast charging stations.
- Europe ranked second with a pool of approximately 300,000 Level 1 and 2 public charging stations in 2021, an annual growth of nearly 30% over 2020.
- The U.S. is a smaller market. It had a pool of over 90,000 Level 1 and 2 public charging stations in 2021, and also a more modest growth of 12% between 2020 and 2021.

Charging

2.3 Projected Size of the World Market

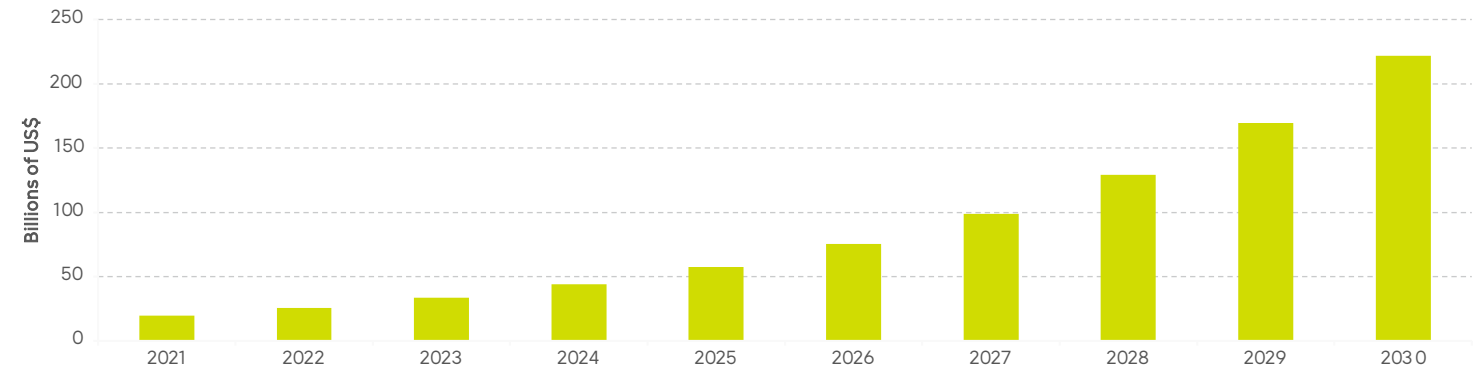
SIZE OF THE GLOBAL CHARGING STATION MARKET BY 2030, ALL LEVELS



Note The data presented in these tables are based on current targets and regulations (conservative scenario)
Source : International Energy Agency

- In line with the strong future growth of the EV market, the market for public charging stations of all levels is expected to increase more than six-fold between 2021 and 2030, from just under two million units in 2021 to nearly 13 million units in 2030.
- However, these numbers should be compared with the overall charging market. Public charging stations are expected to account for about 10% of the total electric charging market. Most market sales are for residential use.

SIZE OF THE GLOBAL CHARGING STATION MARKET BY 2030, ALL LEVELS



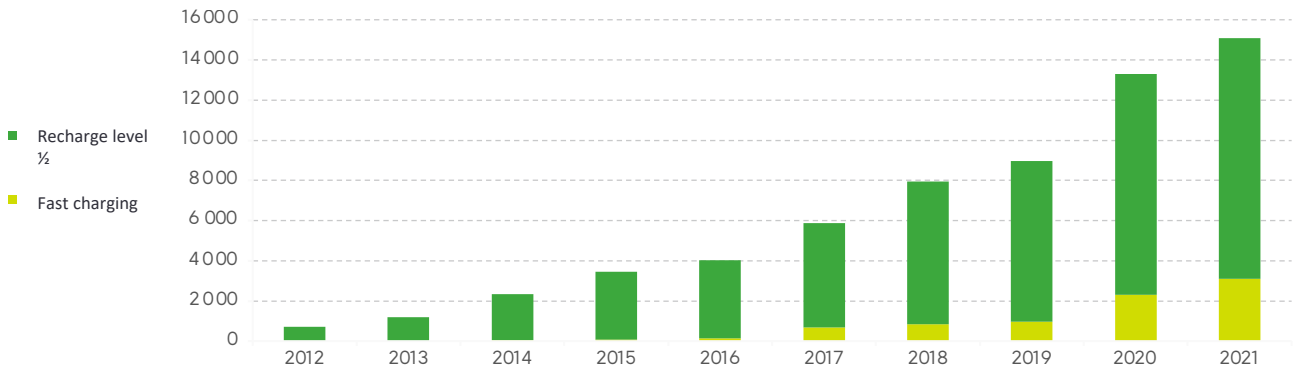
Source : Precedence Research

- The value of the charging station market (all levels) today stands at about US$20 billion.
- Between 2022 and 2030, the market's CAGR should be around 31%.
    - It's estimated that in 10 years, the market for public charging stations will increase nine-fold to nearly US$222 billion in 2030.

Charging

2.4 Historic and Projected Market Size in Canada

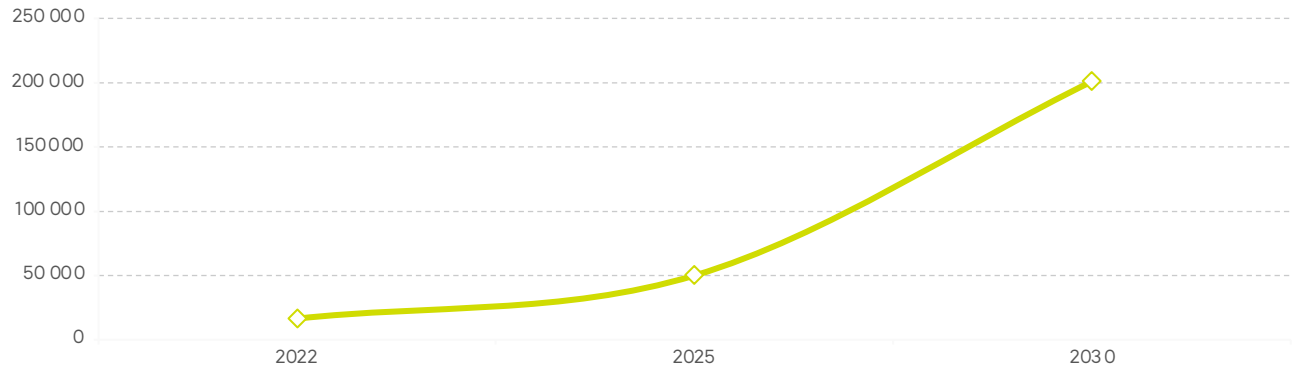
NUMBER OF PUBLIC FAST CHARGING STATIONS IN CANADA OVER THE PAST 10 YEARS



Note : The data presented in these tables are based on current targets and regulations (conservative scenario).
Source : International Energy Agency

- Nearly 15,000 public charging stations were installed in Canada by the end of 2021.
  - Despite their late arrival, public fast chargers are even more important on the network than Level 1 and Level 2 public charging stations, as consumers are now looking for a short charge time.
- Level 1 and 2 public charging stations accounted for a large proportion of the Canadian market, at nearly 79%.

NUMBER OF PUBLIC CHARGING STATIONS PLANNED IN CANADA BY 2030



Source : Natural Resources Canada

- According to Natural Resources Canada, it's estimated that Canada will need one public charging station per 20 EVs. That does not include the number of private charging stations that will be installed at home and at work.
  - The number of public charging stations on the network will need to more than triple by 2025 to meet the demand by EVs on the road at that time.
  - The number of public charging stations on Canada's road network by 2030 is expected to be around 200,000 units, just over 11 times the number of public charging stations deployed in 2022.

Charging

2.5 Growth Drivers and Potential Market Barriers

DRIVERS OF MARKET GROWTH

The growing popularity of EVs

- The exuberance of the EV market among consumers is the biggest driver of growth for the network of charging stations. The network will need to expand more rapidly in the coming years to provide EV owners with a reliable, well-serviced network and with fast charging stations for users who run out of battery power on the road.

Government incentives

- Various financial assistance programs are offered by governments around the world. In Canada, the Canadian government and some provinces have already put in place certain assistance programs such as CHRI, PIVEZ and carbon credits (e.g. CFR).

The cost of charging at home has become competitive with the cost of a full tank of gas

- With the price of oil on the rise, the consumer is finding the option of charging at home more and more appealing, a trend which could help sales of both EVs and charging stations.

CURRENT BARRIERS TO MARKET DEVELOPMENT

The capacity of electric power grids may be unable to respond to peaks in demand for electricity

- The management of peak demand and the capacity of electrical networks will require major changes in order to ensure energy supply to the many charging stations that will be part of various urban and rural networks. Access to this electricity will be needed for EV users to charge their batteries in remote areas.

The deployment and use of charging stations are directly affected by electricity prices

- Regions where electricity prices are stable could be favoured by charging station operators; where electricity prices are unstable, regions could be abandoned. The lower the price of electricity at a station, the more likely it's to be used.

Beyond major urban centres and main traffic routes, the commercial market for public charging is still in its infancy

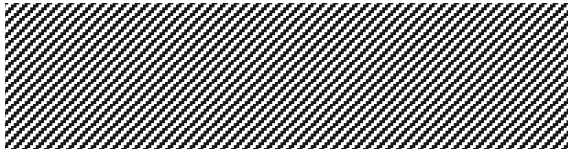
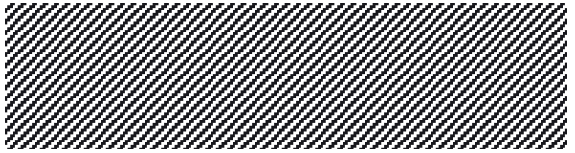
- Private operators may be less likely to deploy new stations on the network in commercial markets outside of major urban centres and main traffic routes. The level of usage of the stations is important for the profitability of the sector for operators and investors.

***Note** : Growth drivers and potential barriers in the charging market are closely linked to the development of the ZEV sector*

Charging

2.6 Key Market-Specific Business Models

Dominant model ...

	HARDWARE	SOFTWARE	OPERATOR
"Pure" models	A model less and less observed, as charging station manufacturers want to develop a holistic solution that integrates a software platform	A widely used model, with many software companies providing specific services to charging station manufacturers or operators	A widely used model, with companies focusing exclusively on operations, and purchasing third-party hardware and software; however, operators are increasingly integrating their own software platform into their value proposition
... with an ascendant			
Hardware		A model rarely observed today; charging station software manufacturers tend not to get involved in manufacturing the hardware	A model rarely observed in the charging field today
Software	A very natural model for many charging station manufacturers today. It allows them to control all the technical parameters (charging rate, usage rate, etc.) of the station via their own software and to operate it optimally, thus extending its service life.		A model observed more today among Charge Point Operator (CPO) companies that integrate software solutions into their value proposition
Operator	A model rarely, if at all, observed in the charging world because of a holistic approach, which includes a suite of software used by manufacturers that want to operate their stations	A model increasingly observed today among software companies (often eMobility Service Providers, or eMSPs) that actually operate charging networks, thus becoming charge point operators, or CPOs	
Combination	S+O A model that is evolving; charging station manufacturers hope to develop integrated solutions (hardware + software) and ensure natural outlets for their production by directly operating their own assets	H+O A model rarely observed in the charging field today	H+S A model rarely observed in the charging field today

Charging

2.7 Key Players and Market Investors

KEY QUEBEC PLAYERS

flo	Charging station manufacturer
Circuit électrique	Charging station network operator
Mogile Tech / ChargeHub	Interoperability hub, interconnection platform and eMSP
dcbel	Charging station manufacturer
rve	Modules for sharing charging in multi-unit residential buildings
evera TECHNOLOGIES	Charging station manufacturer
ELMEC	Charging station manufacturer

EXAMPLES OF INTERNATIONAL PLAYERS

CHARGE AMPS, ZAAP CHARGE. INC, wallbox, solaredge, chargemaster, MIGHTY RIVER POWER, Car Charger Pros, chargepoint, EVgo, blink, bp pulse, LEVITON

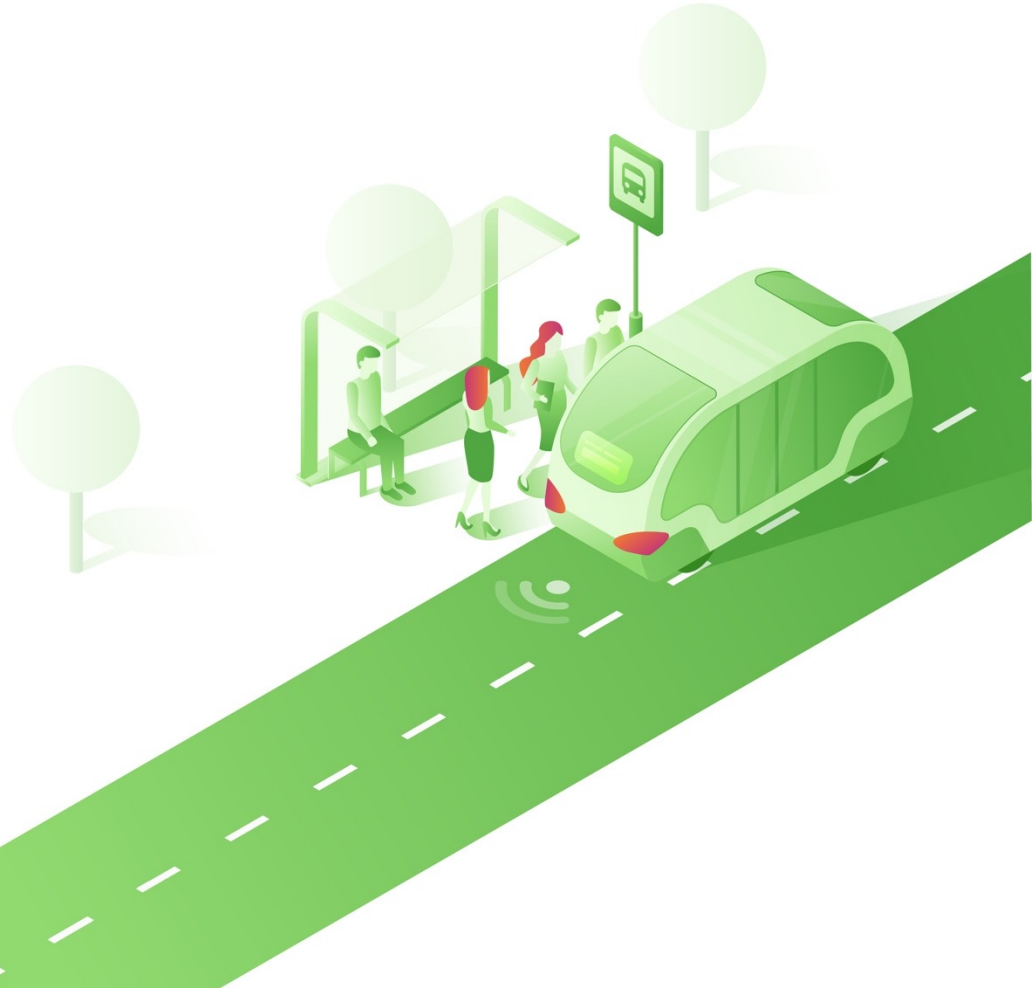
EXAMPLES OF INVESTORS IN THE MARKET

Shell, Volkswagen, SIEMENS, ABB, Schneider Electric, E8, QUANTUM ENERGY PARTNERS, BLUE BEAR CAPITAL, bp ventures, ENERGIZE VENTURES, Activate capital, ENERGY IMPACT PARTNERS

***Note** : This section presents a non-exhaustive list of specialized investors outside of Quebec who have recently invested in the charging market in North America.*

6.3

ADVANCED DRIVER ASSISTANCE SYSTEMS (ADAS)



ADAS

3.1 Core Technologies Associated with the Market

What is ADAS?

- ADAS stands for Advanced Driver Assistance Systems and refers to a driver support system that uses sensor technologies, radars and cameras to provide safety and comfort features for the driver. ADAS makes it possible to:
  - Avoid the occurrence of a dangerous situation that could lead to an accident;
  - Free the driver from a number of tasks that are likely to reduce their vigilance;
  - Help the driver perceive the environment (passing through detectors, risk of freezing, pedestrians, etc.);
  - Enable the vehicle to perceive the risk and respond in advance of the driver's reflexes.
- For example, ADAS includes features such as front-end collision warning, lane maintenance, sign recognition and following distance control (see next page for more details).
- ADAS consists of three key steps:

1 Connect, collect and analyze

- Visualization (camera)
- Detection (radar, lidar)
- Connectivity with the exterior of the vehicle

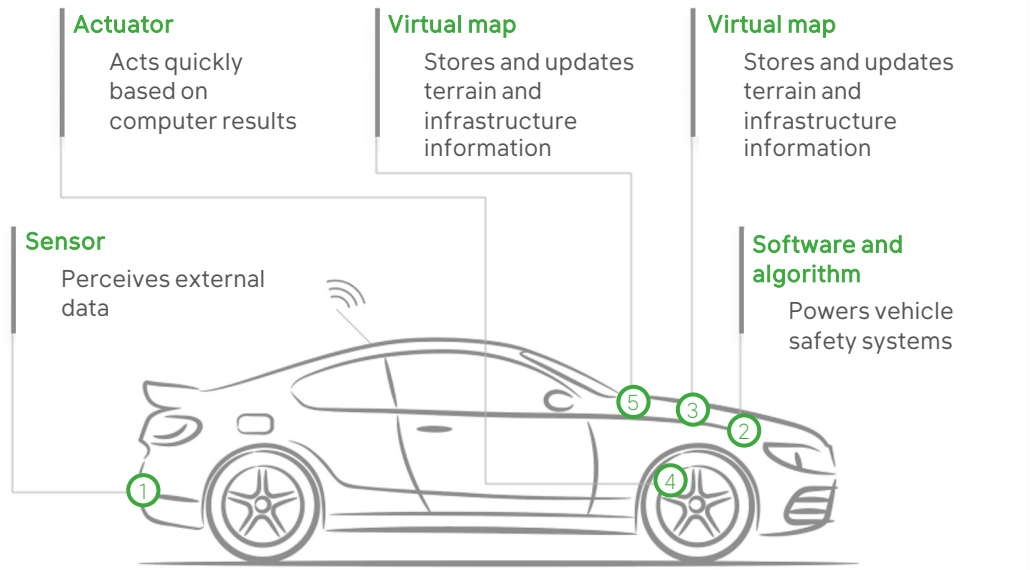
2 Decide

- Data collection and consolidation
- Data-based decision making

3 Control

- Avoiding
- Braking/accelerating
- Steering/driving

THE 5 PILLARS OF ADAS



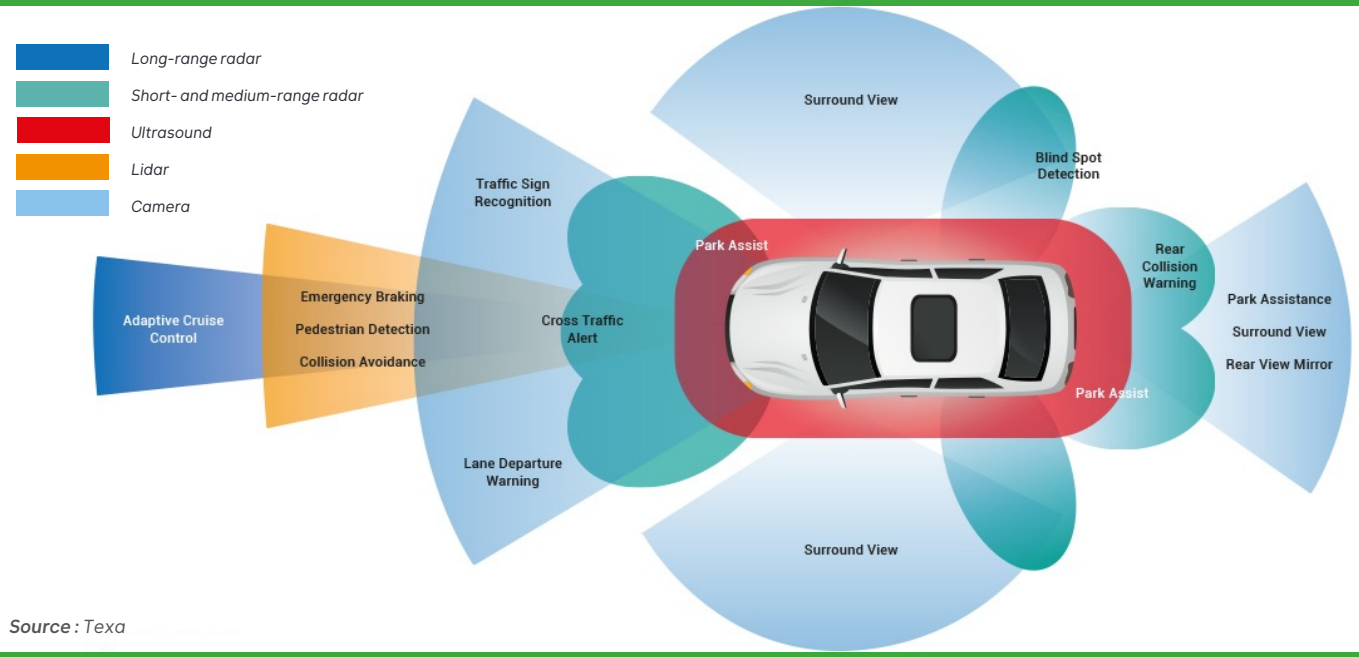
Source : McKinsey

1. Sensors collect information about the vehicle's immediate environment. They have a precise measurement range and signal bandwidth, which explains why there are many ADAS sensors on a vehicle.
2. Algorithms use the data (inputs) supplied by the sensors to synthesize and analyze in real time the environment surrounding the vehicle, which makes it possible to make a decision.
3. Data processed by the algorithms (outputs) are then processed by the processors, which execute the instructions based on the algorithms.
4. Actuators activate and enable the vehicle to respond to tasks controlled by the processors.
5. Virtual maps complement the vehicle's sensors by enabling accurate geolocation to be determined in real time.

ADAS

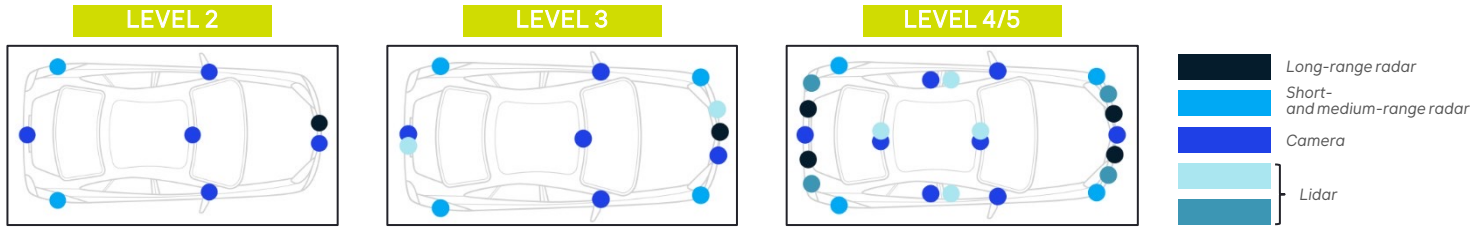
3.2 Primary Technologies Associated with the Market

MAIN ADAS COMPONENTS



***Source** : Texa*

STANDARD ADAS EQUIPMENT BASED ON THE VEHICLE'S LEVEL OF AUTONOMY



***Source** : McKinsey*

The current ADAS market is based primarily on three significant technologies, each with main applications/functions. These technologies are supported by software suites for the operation, optimization and integration of ADAS with the vehicle:

Radar

- Adaptive cruise control
- Cross traffic alert
- Rear collision warning
- Blind spot detection
- Park assist

Lidar

- Emergency braking
- Pedestrian detection
- Collision avoidance

Camera

- Traffic sign recognition
- Park assist
- Surround view
- Lane departure warning

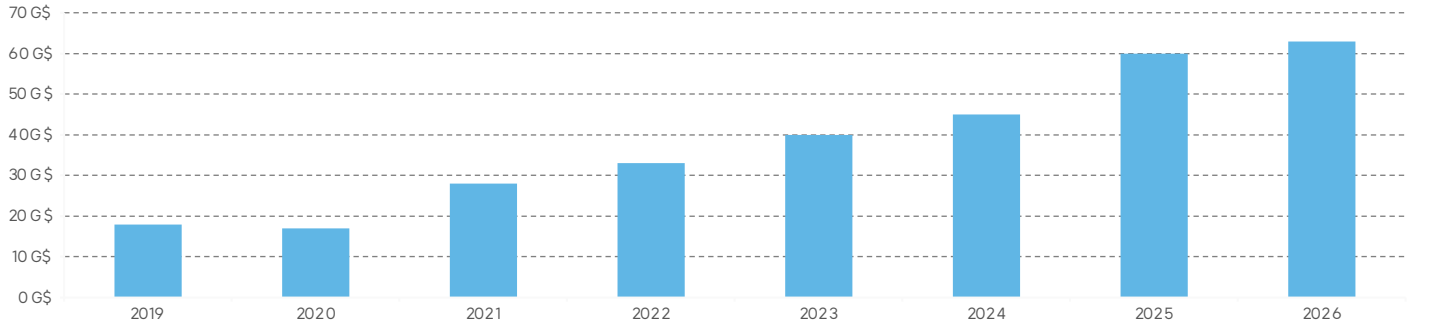
Software

- Allows the equipment to capture the data and to function optimally
- Allows connection and interaction between the different ADAS devices
- Analyzes and processes the data to make a decision

ADAS

3.2 Market Size – Current and Projected

SALES OF ADAS HARDWARE SYSTEMS/PRODUCTS WORLDWIDE



Source : IDC

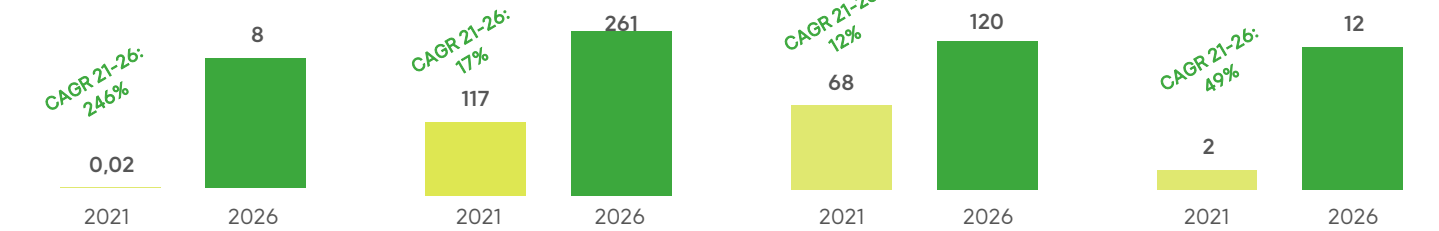
LIDAR SALES

OPTICAL SYSTEM SALES

RADAR SYSTEM SALES

CENTRALIZED DRIVER ASSISTANCE SYSTEMS SALES

***Note** : Number of hardware units sold (in millions)*



***Source** : : IDC/Note: CAGR = Compound annual growth rate*

- The value of the ADAS hardware market was close to US$30 billion in 2021. This market is expected to grow by more than 15% CAGR over the next decade, reaching over $60 billion in 2026.
- In 2021, the ADAS hardware market accounted for nearly 300 million systems/products sold worldwide. In line with the growing autonomization of vehicles, the market is expected to almost double to over 500 million units sold by 2026.
- LiDAR, an emerging ADAS technology, is projected to grow exponentially in the coming years, with a CAGR of 246% over the next five years. However, the total size of the market remains relatively small.
- The market for centralized driver assistance processing systems is also expected to experience strong growth in the coming years, and surpass 10 million units sold by 2026, for a CAGR of nearly 50% per year over the period.
- With a CAGR of around 15% over the next five years, optical and radar systems, which are more mature but larger in terms of volume, appear to have less potential for increased sales than the other two markets mentioned above.

THE ADAS SOFTWARE MARKET WORLDWIDE

- In 2021, the ADAS segment accounted for just over 22% of the total automotive software market, which was valued at $25 billion. The ADAS software market was worth almost $5.5 billion in 2021.
- The total software market in the automobile industry is expected to exceed $100 billion in 2030, with a compound annual growth rate of more than 17% over 2021-2030.

***Source** : Precedence research*

ADAS

3.3 Growth Drivers and Potential Market Barriers

DRIVERS OF MARKET GROWTH

ADAS functionality is proven and becoming increasingly standard

- Current ADAS technologies are becoming the norm in most new vehicles, and are now part of the basic packages offered by vehicle manufacturers.
- Many governments around the world are encouraging vehicle manufacturers to standardize ADAS features, chiefly with the aim of improving road safety and reducing road accidents.

Increasing autonomy of vehicles

- The features and complexity of autonomous operation of vehicles are compelling manufacturers to adopt the concept of "software-defined cars," a major consumer of ADAS technologies.
- Artificial intelligence will play an increasingly important role in vehicles (see box on the right).

Electrification of fleets

- ZEV drivers naturally expect a higher level of digitalization and security. The massive electrification of vehicle fleets will therefore generate expanding synergies in the development of ADAS technologies, bringing major benefits in terms of efficiency and sustainability.

Development of MaaS and logistics 2.0

- Geolocation is central to the development of Mobility-as-a-Service (MaaS) and logistics companies. This concept requires vehicles with ever more ingenious and efficient ADAS features.

Artificial intelligence, the future of the ADAS market

Established trends and current drivers of growth

Advanced Driver Assistance Systems (ADAS)

Connectivity and digitalization of cockpits.

- *Increase in ADAS units per vehicle*
- *Strong penetration over the next decade, fueling growth in the sector*

Fundamental changes and future drivers of growth

Autonomous driving

V2X – Vehicle to everything

Redesign of the vehicle architecture

- *Technologies at the R&D and testing stage*
- *Realistic scenarios do not forecast significant vehicle sales volumes before 2035*

Source : IDC

ADAS

3.3 Growth Drivers and Potential Market Barriers (cont.)

CURRENT BARRIERS TO MARKET DEVELOPMENT

The ADAS market is a highly standardized market where obtaining certifications/approvals is time-consuming and costly

- The functionality of ADAS products/solutions means that the market is highly regulated, to ensure the safety of passengers, vehicles and the outside world. The processes for approving products/solutions are extremely rigorous and require a significant investment, in both time and money.

Increasing vehicle autonomy requires redesigning vehicle architecture and networks to reduce production costs

- Many changes in vehicle design (architecture, network integration, etc.) will be necessary in order to reduce production and assembly costs and thus to allow the massification of near-autonomous vehicles for the general public. The features of today's vehicles incur hardware and software costs that are now very/too high to allow the production of affordable near-autonomous vehicles.

Massification of ultra-advanced near-autonomous vehicles is not expected in the short term

- In the short term, near autonomous vehicles remain on the horizon. There are many ongoing challenges involving both security and technology (for example, interpreting complex/extreme external data). In addition, acceptance by the general public is far from assured, as drivers still lack confidence in vehicles with a high degree of autonomy and are reluctant to own them. The first near-autonomous vehicles on the market will be commercial/specialty vehicles (~2030), whereas near-autonomous passenger vehicles will not be marketed on a massive scale until 2035.

Liability and insurance concerns

- Autonomous vehicles have caused a radical shift in liability in cases of problems or accidents. If today the driver is usually the main one responsible in the event of an accident (mechanical/major failure), what happens if there is an accident involving an autonomous vehicle? Will the manufacturer be responsible? Will they agree to mass commercialize vehicles and assume the risk of eventual problems/accidents? This major issue has a direct impact on liability as perceived by insurers.

Compatibility with support infrastructures

- The increasing autonomy of vehicles necessitates an evolution of the infrastructure enabling the vehicle to operate under acceptable/optimal conditions. Telecommunications infrastructure (wireless connectivity, fibre network, etc.), road infrastructure (paving, intersections, etc.) or digital infrastructure (servers, software, etc.) will inevitably have to evolve at a sufficient pace to allow the proper functioning of near-autonomous vehicles. Any delay or failure to adequately develop the supporting infrastructure will necessarily delay the widespread adoption of near-autonomous vehicles.

***Note** : We're talking about near-autonomous vehicles (Level 4) because many experts believe that a large-scale commercialization of fully autonomous vehicles (Level 5) is relatively unlikely to occur anytime soon.*

ADAS

3.4 Key Market-Specific Business Models

Dominant model …

	HARDWARE	SOFTWARE	OPERATOR
"Pure" models	Common market model, with companies specializing in the design and production of ADAS products, which are complemented by third-party software suites	Model very frequently observed on the market, with companies offering software services allowing the ADAS hardware to function optimally	n/a
… with an ascendant			
Hardware		This model exists on the market, but many software players are deliberately keeping away from the manufacturing aspect. It is common to see software companies working hand in hand with vehicle and/or parts manufacturers to develop an optimal product for the software solution	n/a
Software	Model observed on the market, some companies wishing to integrate the development of the hardware product with its software component. We can also observe companies with dual hardware/software skills trying to move away from the hardware model to focus on the software component (e.g. Leddartech)		n/a
Operator	n/a	n/a	
Combination	n/a	n/a	n/a

***Note** : le type de modèle « opérateur » ne s'applique pas au marché ADAS*

ADAS

3.5 Key Players and Market Investors

KEY QUEBEC PLAYERS

LeddarTech	Software for lidar, radar and camera
algolux	Software for lidar and camera
IMMERVISION see more, smarter	Camera software
in a blink	Camera, router
C2RO	Camera, AI-powered video analytics

EXAMPLES OF INTERNATIONAL PLAYERS

Radar/Lidar *(hardware and software)*

QUANERGY, Velodyne, Aurora, OUSTER, AEVA, Blickfeld (LiDAR / scan your world), LUMINAR, ibeo automotive, BARAJA, HESAI

Camera *(hardware and software)*

eyesight, Ambarella, XILINX, MOBILEYE, FLIR, TELEDYNE TECHNOLOGIES INCORPORATED, OmniVision, PROPHESEE METAVISION FOR MACHINES, onsemi

EXAMPLES OF INVESTORS IN THE MARKET

ECLIPSE, ibex INVESTORS, TYCHE PARTNERS, HELLA, STARTUP AUTOBAHN, iSource TheDifferentVC., SOFIMAC INVESTMENT MANAGERS, APTIV, IDT Integrated Device Technology, MAGNETI MARELLI, OSRAM, DRIVE CAPITAL

***Note** : This section presents a non-exhaustive list of specialized investors outside of Quebec who have recently invested in the North American charging market.*

6.4

DIGITAL TWINS

Digital twins

4.1 Market Overview

What is a digital twin?

- A digital twin is a virtual representation of an object or system, which takes real-world data (of an object or physical system) as inputs and produces predictions or simulations on how this physical object or system will be affected by the inputs.
- A digital twin uses simulation, machine learning and logic to help with decision-making.
- The main applications of a digital twin include activities or projects involving complex manufacturing tasks, large-volume physical assets/projects or complex mechanical/electrical/electronic assets. The main sectors involved are the automobile industry, the aviation industry, the construction sector, the energy sector and the manufacturing sector.
- There are four different levels of digital twins:

1. Component level	Basic unit of the digital twin, the smallest example of a functional product. Brings to light the most critical and essential element of the production process.
2. Asset/product level	When two or more components work together, they form what is called an asset. Asset twins make it possible to study the interaction of these components, creating a wealth of performance data that can be processed and transformed into actionable information.
3. System level	This level involves system or unit twins, which show how different assets combine to form a complete functional system. System twins offer visibility into asset interaction and can suggest improvements in performance.
4. Process level	Process twins reveal how systems work together to create a complete installation. Process twins can help determine precise timing schedules between different systems, ultimately impacting an organization's overall efficiency.

Source: GE Digital / IBM

Examples of digital twins applied to the EST sector

- Modelling the architecture of an EV, to allow optimizing its design before production
- Modelling the EV production line to optimize the company's manufacturing operations
- Modelling all intersections in a city, to optimize the coordination of traffic lights and traffic flow in a dense urban environment
- Modelling a dense and complex urban environment (roads, intersections, buildings, street furniture, signs, plantings, etc.) to simulate the behaviour of completely autonomous vehicles

Main benefits/advantages of a digital twin

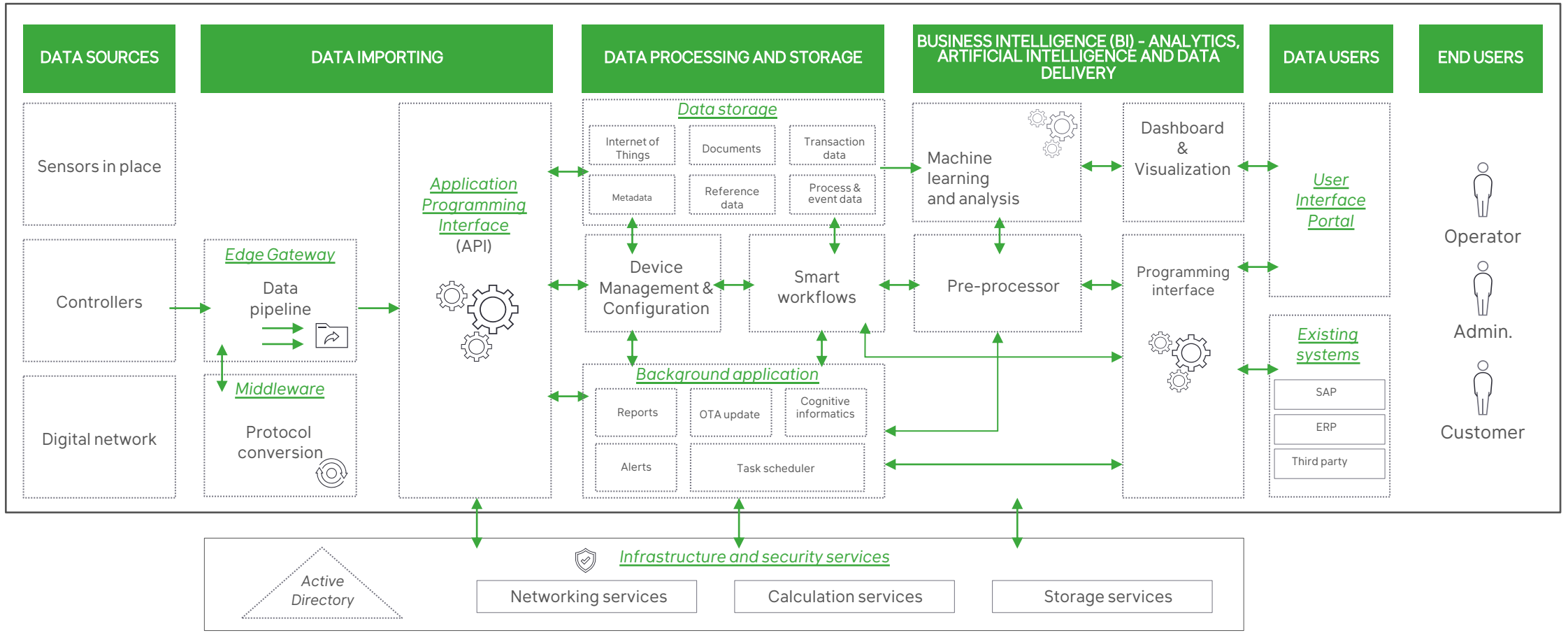
- Real-time performance monitoring
- Reduces time with low/no added value
- Yield improvement
- OEE* increase
- Predictive maintenance
- Quality optimization

**OEE = Overall Equipment Effectiveness*

Digital twins

4.2 How a digital twin works

- The diagram below schematically shows how a digital twin works.



Source *EY analysis*

Digital twins

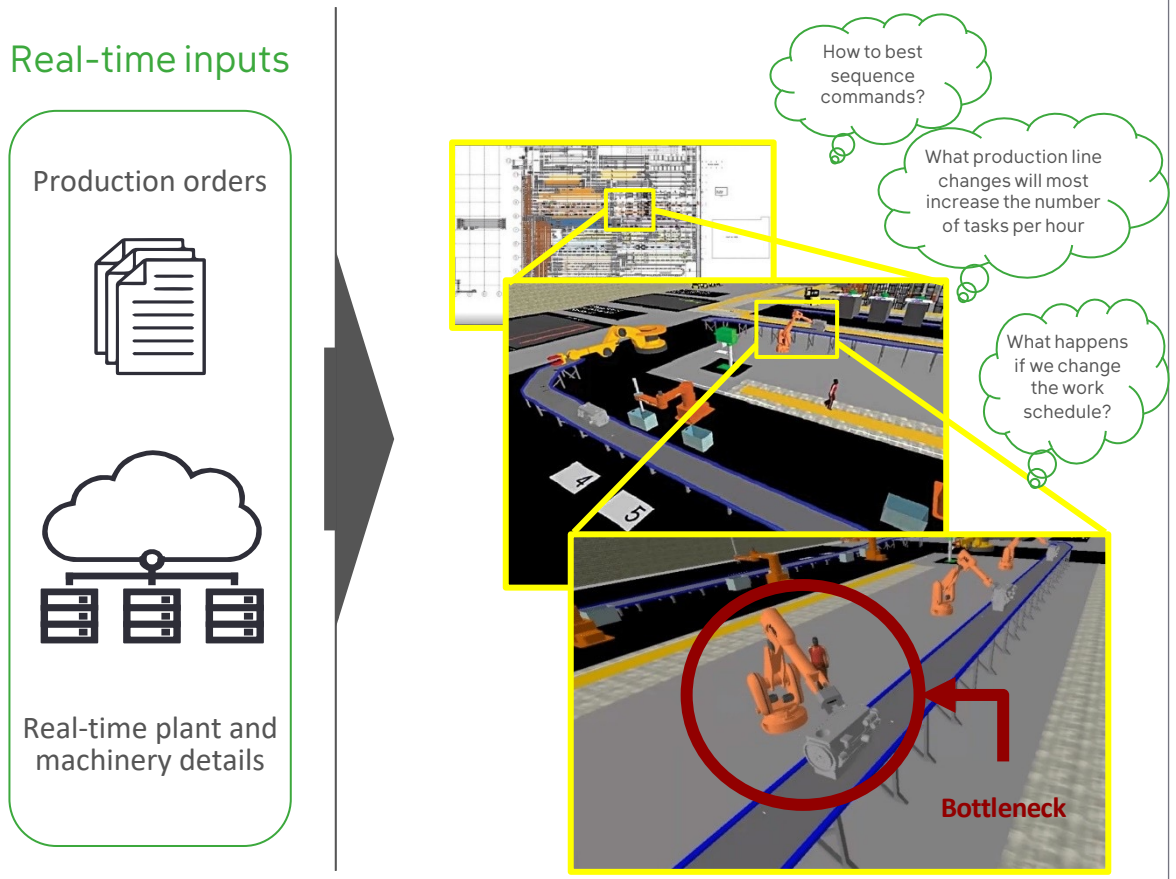
4.3 Digital Twin Case Study Applied to the Automobile Sector

- The diagram below schematically represents a concrete example of an application (anonymized) of a digital twin made for an EV battery manufacturer:

IDENTIFIED NEEDS

- The company launched a new EV battery but was unable to meet the target production schedule.
  - To build the battery, a complex combination of several dozen parallel and sequential tasks had to be executed, each with its own unique resource needs.
  - It was difficult to predict delays in synchronization, resulting in unexpected downtime.
- As a result, the company needed to quickly identify bottlenecks in its production line to improve the speed of manufacture, in order to meet meet the targeted production and commercialization schedule of the product.

CREATION OF THE DIGITAL TWIN



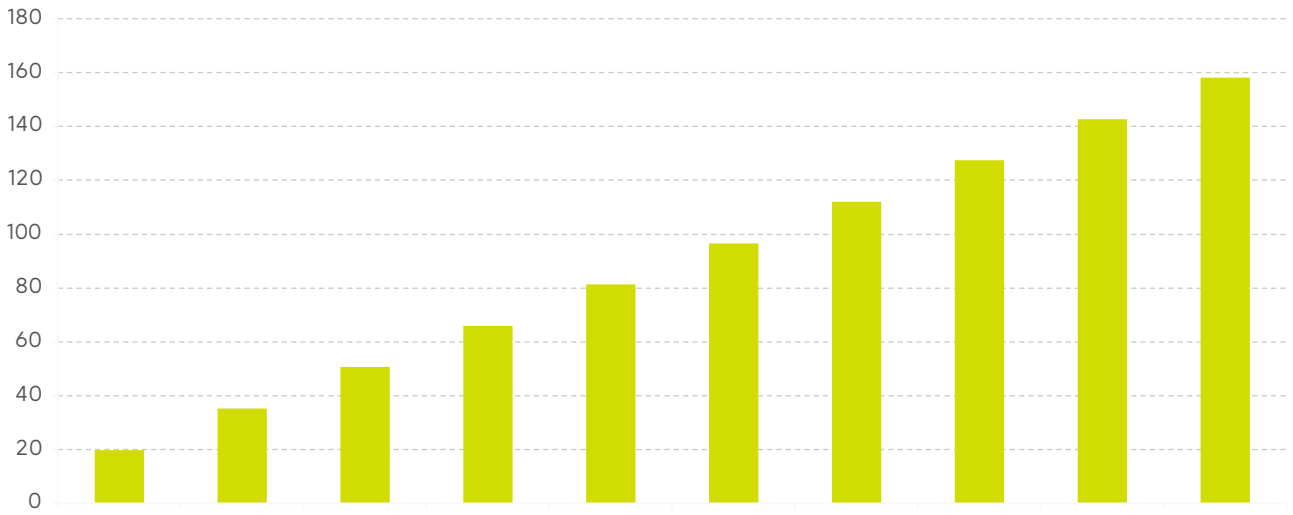
BENEFITS OF THE DIGITAL TWIN

- Through thousands of simulations, the digital twin made it possible to:
  - Identify major bottlenecks on the production line
  - Determine the optimal solution to eliminate them
  - Develop a detailed action plan to accelerate the rate of production in order to meet volume targets in a timely manner
- Quantitatively, the digital twin enabled the company to perform an average of 102 tasks per hour (vs.71 before). This saved them US$750K per month, including the costs of overtime and expedited transportation.

Digital twins

4.4 Market Size and Key Players

DIGITAL TWIN SALES



Source : Globalnewswire

- The global market for digital twins was estimated to be nearly US$20 billion in 2021.
  - The market is expected to grow to over US$80 billion by 2026 and close to US$160 billion by 2030.
  - The anticipated market CAGR for the period 2021-2030 is estimated to be more than 40%.
- The primary geographic market for digital twins is North America, which comprised over 35% of the global market in 2021.
- The transportation sector and the automobile industry present one of the main opportunities for the digital twin market, driven in particular by the strong growth of electric vehicles, the battery market (notably the BMS – Battery Management System) as well as the logistics industry.

QUEBEC PLAYERS

JAKARTO
AI-driven Digital Twin and Asset Inventories

niosense

EXAMPLES OF INTERNATIONAL PLAYERS

General Electric
Microsoft
SIEMENS
DASSAULT SYSTEMES
Ansys
BOSCH
aws
IBM
ptc
ORACLE
SAP
RIVERLOGIC

Digital twins

4.5 Growth Drivers and Potential Market Barriers

DRIVERS OF MARKET GROWTH

The number of devices/solutions for data capture and interoperability enables better use of digital twins

- In the mobility sector, end products in service are increasingly equipped with all types of sensor or detector, such as ADAS solutions/systems on vehicles. This makes it possible to collect large volumes of data in real time, which then feed into the digital twins, enabling them to be used more efficiently.
- The expanding interoperability of systems and products in the world of mobility also allows easy and optimal operation of digital twins.

Computational technologies are now adequately efficient and affordable

- The power, availability and standardization of current IT resources make it possible to provide efficient and optimizable digital twin services for each type of application.

Pressure on current margins and supply chain disruptions

- In a sector such as mobility where margins are sometimes tight (hardware, operators) and supply chain management is key, digital twins are an appropriate tool to optimize industrial and operational processes to optimize resources and capital allocation.

Digital twins for sustainable mobility and smart cities

- The development of sustainable mobility and cities that are smarter and more resilient is leading key players to appreciate the potential of applications and benefits provided by digital twins. Municipalities and other public contractors are extremely powerful growth drivers for digital twin companies. They can help them to optimize the planning and development of urban centres affordably and efficiently, as well as to streamline traffic flow, optimize energy consumption, improve security for citizens, etc.

POTENTIAL BARRIERS TO MARKET DEVELOPMENT

Implementing digital twin technology requires significant investment

- Implementing this technology is extremely costly to develop and maintain. This could dampen company momentum in implementing digital twinning solutions to improve their business.

The digital twin sector remains vulnerable to cyberattacks

- Numerous external connections on sometimes poorly protected servers are required to get as much information as possible to form the core of the digital twin. All these external sources represent potential security vulnerabilities for the digital twin user, who may see them as a significant cybersecurity risk.

Data collection and mathematical models bring complexities to the sector and may provide unsatisfactory results

- Digital twin models can be very complex and some applications/activities may not be suitable for integrating a digital twin. This could, for example, complicate rather than simplify decision-making.

Digital twins require a powerful support infrastructure to optimize their use

- Bandwidth and latency constraints mean that support infrastructures (fibre network, 5G, etc.) can limit some digital twin applications in real-time.